GP-1104 - Measurement & Control Asset Management Plan

Gas Plan

Document Number: GP-1104

August 1, 2016

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1. Executive Summary

This asset management plan provides an assessment of condition and risk of the Measurement and Control (M&C) asset family and includes a program plan detailing risk mitigations based on strategic objectives and asset management, applied over the life cycle of the assets.

The plan is developed with a 5-year planning horizon to align with the Gas Operations 5-year financial outlook and will be updated annually. It describes the physical assets included in this asset family, the current condition and desired future state of the assets, the key risks associated with the asset family, and the investments planned or in progress to mitigate and reduce these risks. Beyond the physical assets, the plan considers the impact on support areas such as training and guidance documents.

This AMP is consistent with the STAMP, the guidance document for the development of AMPs

1.1 Asset Overview

The Measurement and Control (M&C) asset family is one of eight asset families into which gas transmission and distribution assets have been grouped. The physical assets within this family include: 3 gas terminals, 428 gas transmission pressure regulating and meter stations, 2397 distribution pressure regulating stations, 2433 farm taps, 26 large customer meter sets, and 48 gas quality analyzers.

During preparation for PAS-55 certification, PG&E reviewed the categorization of the distribution and transmission assets using 49 Code of Federal Regulations (CFR) 192.3 and recent Pipeline and Hazardous Materials Safety Administration (U.S. Department of Transportation) (PHMSA) interpretation letters. As a result, PG&E is reviewing the classification of the transmission and distribution regulating stations.

1.2 Strategic Objectives

Gas Operations sets annual corporate Line of Sight (LoS) goals that cascade throughout the organization. Asset Family objectives are created using these LoS goals as a framework and developed from both a bottom-up and top-down approach. After analyzing asset risk and condition within the LoS framework, the 2015 M&C strategic asset objectives are:

1. Apply Facility Integrity Management principles to all transmission and distribution stations by 2025
2. Eliminate large overpressure events by 2018
3. Complete physical security upgrades at critical facilities by 2021
4. Implement corrosion monitoring programs to enhance existing programs by 2018
5. Develop action plan for the “extent of condition” study issues by 2017
6. Accomplish Obsolescence Management by maintaining the turnover of the fleet to 60 years
7. Complete Critical documents defined by TD-4551S by 2019 for Transmission, and by 2024 for Distribution

8. Evaluate 100% of Transmission Total Station Features by end of 2019

9. Implement a program to improve visibility of condition and criticality of distribution stations by 2018

1.3 Asset and Data Condition

The physical assets within the Measurement and Control (M&C) Station asset family include transmission and distribution stations that control pressure and gas measurement equipment. A study to evaluate the health of all PG&E transmission station facilities, including M&C facilities, has been completed. The study established a baseline condition assessment. It also generated recommendations that will be incorporated into and serve as a key component of the asset plan going forward.

The condition assessment for gas transmission M&C facilities provides a determination of station condition (or health) by utilizing a set of metrics to score major components within a station and then to roll-up these component scores to a system level condition score. The overall goal of the component and station condition metrics and scores is to provide an on-going basis for evaluating station condition to assist the asset family owner in defining and prioritizing projects and programs for the gas transmission M&C facilities.

Additionally, a pilot program was performed for the distribution stations for about 5% of district regulator stations designed to H-14 Design Standard.

The condition assessment used data available from the following sources to assess the condition of the M&C station components:

- SAP (asset and work management tool)
- PLM (asset and work management tool)
- PSRS (project planning and tracking tool)
- Surveys and interviews
- Previous reports and assessments
- Site inspection information
- Operating diagrams
- Piping and Instrumentation Diagrams (P&ID's)
- Corrective Action Program (CAP) reports

There are still gaps in the data, but overall the information reviewed allowed for a reasonable determination of station and component condition. Data quality and availability still remains a focus for attention moving forward to ensure that decisions are made on current and accurate information. The current data provides valuable information when leveraged by subject matter experts, knowledgeable in the facilities and systems, to define risks and mitigations. However, data for this asset family is limited in terms of quality, completeness, and accessibility to support a complete quantitative analysis of asset risk. Further, there are gaps in the available data which limit its reliability and use for monitoring program impact on risk reduction and tracking metrics. Enhancing data collection and quality is an area of focus in this plan to enable decision making going forward.

1.4 Key Risks

This and the other asset families within Gas Operations take a risk-informed approach to managing the assets to reduce risk. Proposed programs of work are risk scored with a process for prioritization across all asset families in an effort to implement investment plans that is driven by risk and considers constraints.

Gas Operations identifies risks for each asset family. For each threat (as defined in ASME B31.8S), risk drivers and risks are identified for each asset family based on available data and SME input. The result of this process is a set of Gas Operations risks as shown in Figure 1. The risks are re-evaluated on an annual basis and the results of the 2016 refresh are included in Figure 1. For this effort, risk is defined as the potential for an adverse event that can impact company's ability to achieve its objectives. Risk drivers are defined as factor(s) that could cause risk to occur. These risks are defined with a significant degree of granularity and are defined and discussed in each of the Gas Operations Asset Management Plans (AMPs). The risks for the M&C asset family are shown in Section 1.5.

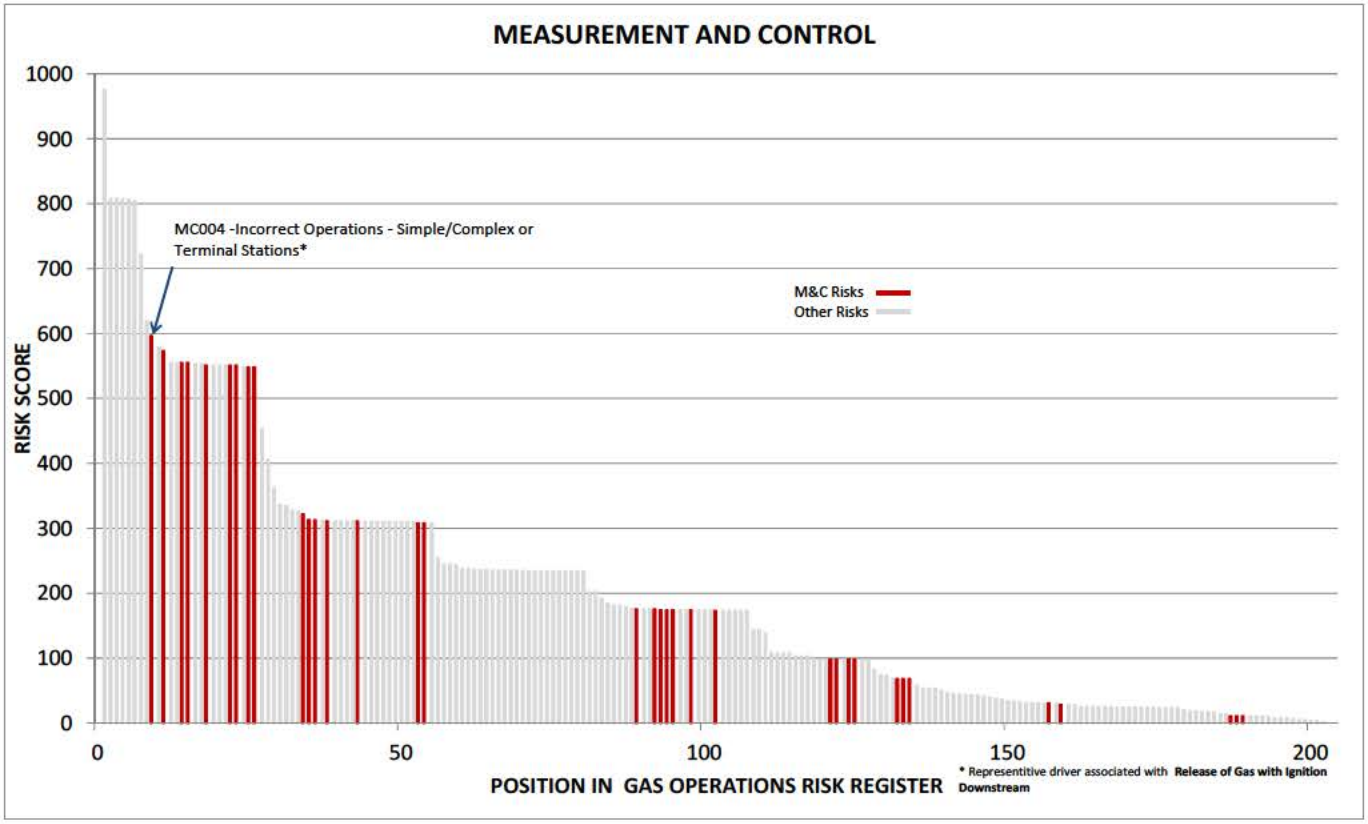
PG&E Enterprise Operational Risk Management (EORM) also defines risks at the enterprise level. The enterprise level assessment ensures that all lines of business have risks defined at a consistent basis for enterprise level decision-making. Furthermore, due to Gas Operations' level of granularity, the risk drivers were aggregated or "rolled up" to allow for consistent calibration with all PG&E lines of business. The rolled up risks incorporate multiple "risk drivers" from the Gas Operations risk register. Additional details regarding the roll up methodology can be found in the Strategic Asset Management Plan. The development of the Gas Operations enterprise risks is performed by treating the Gas Operations risks as "risk drivers" to develop higher level enterprise risks. Therefore, the enterprise risks incorporate many of the "risk drivers" (or risks from the Gas Operations histogram). The enterprise risks are addressed in document GP-1100: "Asset Management Strategy and Objectives".

This asset management plan is based on the risks developed for Gas Operations. Risks are derived based on a risk score that considers the likelihood and consequence of failure. The complete listing of M&C risks identified and evaluated is found in Appendix C. The two enterprise risks associated with the M&C asset family are:

- The risk of failure at a gas Measurement & Control transmission or distribution facility with loss of pressure control may result in loss of containment with ignition downstream at customer location, and
- The risk of failure at gas Measurement and Control Transmission or Distribution facility may result in loss of containment with ignition

The histogram below in Figure 1 displays the position of the M&C asset family risks (red) within the Gas Operations risk register.

Figure 1 - M&C Risk Profile



1.5 High Level Program Overview

In the near term, the asset management plan focuses primarily on managing and reducing risk. As the plan matures focus will move to managing the assets in a way that optimizes costs, risks, and performance within the asset family.

For the time period covered by this asset management plan, several programs have been proposed to address risks that are not currently adequately mitigated. The proposed programs are both capital and expense and can address more than one area of risk. Detailed description of the scope of each program is found in Section 4. The pace, trajectory, scope, and anticipated budgets for these proposed programs will align with the submittals included in the 2014 General Rate Case for distribution assets and the 2015 Gas Transmission and Storage Rate Case for transmission assets. This plan has been revised to align with the 2017 GRC proposed programs for distribution assets.

Table 1 below provides a brief description of the primary mitigation measures and metrics for the highest risks among multiple threats that have been identified across the M&C assets.

Table 1 - Key Risks*

Threat	Risk ID	Risk Description	Primary Mitigation	Mitigation Metric
Incorrect Operations - Simple/Complex or Terminal Stations	MC004**	The risk of an overpressure event caused by incorrect operation of a local transmission complex station or terminal station may result in failure of downstream assets with loss of containment	Training SCADA Process Safety	Number of large overpressure events in a calendar year
Weather Related/Outside Forces - Seismic	MC032**	The risk of failure of a station to perform its pressure control function due to seismic impact of greater than 6.7 magnitude causing loss of containment with ignition at a facility.	Seismic Assessment Condition Assessment	Completion of assessments
Incorrect Operations - LoC Simple Stations	MC003	The risk of an overpressure event caused by incorrect operation of a local transmission simple station may result in failure of downstream assets with loss of containment	Training SCADA Process Safety	Number of large overpressure events in a calendar year
Incorrect Operations – Backbone (PLS) Stations	MC006	The risk of an overpressure event at complex stations (backbone / PLS stations) caused by incorrect operations may result in damage to downstream assets with loss of containment	Training SCADA Process Safety	Number of large overpressure events in a calendar year
Incorrect Operations – LP Distribution	MC001	The risk of an overpressure event caused by incorrect operation of low pressure distribution assets may result in failure of downstream assets with loss of containment	Training SCADA Process Safety	Number of large overpressure events in a calendar year
Equipment Related – Customer Serving Facility	MC015	The risk of an overpressure event caused by equipment failure in a complex/simple station may result in failure of downstream customer assets with loss of containment	Maintenance Guidance Documents Obsolescence Programs Station Rebuilds	Number of large overpressure events in a calendar year

Threat	Risk ID	Risk Description	Primary Mitigation	Mitigation Metric
Third-Party/Mechanical Damage - Vandalism	MC030	The risk of failure of station piping from vandalism/terrorism damage causing may result in loss of containment	5-Year Program to implement vulnerability assessment study recommendations	Progress of program to perform security upgrades at critical facilities
Equipment Related – LP Distribution	MC016	The risk of an overpressure event caused by equipment failure in low pressure distribution assets may result in failure of downstream assets with loss of containment	Maintenance Guidance Documents LP Vent Program Obsolescence Programs Station Rebuilds	Number of large overpressure events in a calendar year
Welding/Fabrication - Overpressure Event	MC012	The risk of an overpressure event caused by design or fabrication issues with high pressure distribution assets may result in failure of downstream assets with loss of containment	Construction QC Program Borescope Procedure	Number of large overpressure events in a calendar year Number of CAP items related to construction or fabrication issues
Third-Party/Mechanical Damage - Train Derailment into Antioch terminal	MC030.2	The risk of significant station failure at Antioch terminal due to train derailment may result in loss of station and fatalities	Emergency Preparedness Procedures Physical Security	Progress of program to perform security upgrades at critical facilities
Welding/Fabrication Related – Complex Station	MC014	The risk of a loss of containment event caused by design or fabrication issues a local transmission complex station may result in fire or explosion at a complex station.	Construction QC Program Borescope Procedure Process Safety Reviews	Number of large overpressure events in a calendar year
Welding/Fabrication - LoC Simple Station	MC013	The risk of a loss of containment event caused by design or fabrication issues a local transmission simple station may result in fire or explosion at a simple station.	Construction QC Program Borescope Procedure Process Safety Reviews	Number of large overpressure events in a calendar year

Threat	Risk ID	Risk Description	Primary Mitigation	Mitigation Metric
Equipment Related - LoC Terminal or Complex/Simple Station	MC018	The risk of an overpressure event at a terminal or large complex station or simple/complex stations caused by equipment failure may result in damage to downstream assets with loss of containment	Maintenance Guidance Documents Obsolescence Programs Station Rebuilds	Number of large overpressure events in a calendar year
Equipment Related - Backbone (PLS) Stations	MC019	The risk of an overpressure event at complex stations (backbone / PLS stations) caused by equipment failure may result in damage to downstream assets with loss of containment	Maintenance Guidance Documents Obsolescence Programs Station Rebuilds	Number of large overpressure events in a calendar year
Incorrect Operations - LoC HP Distribution	MC002	The risk of an overpressure event caused by incorrect operation of high pressure distribution assets may result in failure of downstream assets with loss of containment	Training SCADA Process Safety	Number of large overpressure events in a calendar year
Equipment Related LoC HP Distribution	MC017	The risk of an overpressure event caused by equipment failure in high pressure distribution assets may result in failure of downstream assets with loss of containment.	Maintenance Guidance Documents Obsolescence Programs Station Rebuilds	Number of large overpressure events in a calendar year

* All risks with a score of 200 or higher as a result of the 2016 Session D process
** Enterprise Level Risk

1.6 Continuous Improvement Since Revision 2 of M&C Asset Management Plan

The M&C asset family has made significant progress since the last version of the Asset Management Plan was published in August of 2015. Highlights of these improvements include the following items:

- Framework for Facility Integrity Management Program (FIMP) has been established and associated Maturity Model has been developed (Section 4)
- Electrical Principal Engineer has been hired to develop electrical maintenance procedures at large M&C facilities
- Implemented a program approach to mitigate risks to employees performing work on energized electrical equipment
- Created a standing Electrical Safe Work Practices team with a goal of developing, implementing and maintaining a comprehensive electrical work safety program
- Inventoried and corrected deficiencies related to insulated tools and appropriate Personal Protective Equipment (PPE) at all districts
- Implemented program to install enhanced physical security upgrades at critical M&C facilities (Section 4)
- Completed seismic assessments at Milpitas terminal
- Performed global benchmarking study with companies from Europe, North America, and South America to identify best practices for management of M&C assets
- Seeing more consistent year-to-year scoring of P95 and Enterprise M&C risks in Session D process
- Competed review of Strength Test Pressure Reports (STPRs) for M&C facilities via the ECA 1 project
- Completed ECA 1 pre-work (records collection) for components at M&C facilities
- Performed Critical Document upgrades at pilot M&C facilities
- Performed control assessments at M&C complex facilities

2. Asset Inventory and Condition Overview

2.1 Asset Overview

The Measurement and Control (M&C) asset family assists in the safe and reliable delivery of natural gas by providing control of pressure and flow within the gas transmission and distribution systems. The physical assets within the Measurement and Control (M&C) Station asset family include transmission and distribution stations that control pressure and gas measurement equipment.

The station[1] facilities provide protection of downstream assets from system pressure excursions and gas quality degradation. The station facilities have been designed for continuous, safe and reliable supply and for peak performance during normal and critical gas demand periods. They have been designed for specific loads and pressures and are operated to both manage risk and to conform to applicable state and federal codes and standards

The locations of transmission M&C stations throughout the PG&E system are shown in Figure 2.
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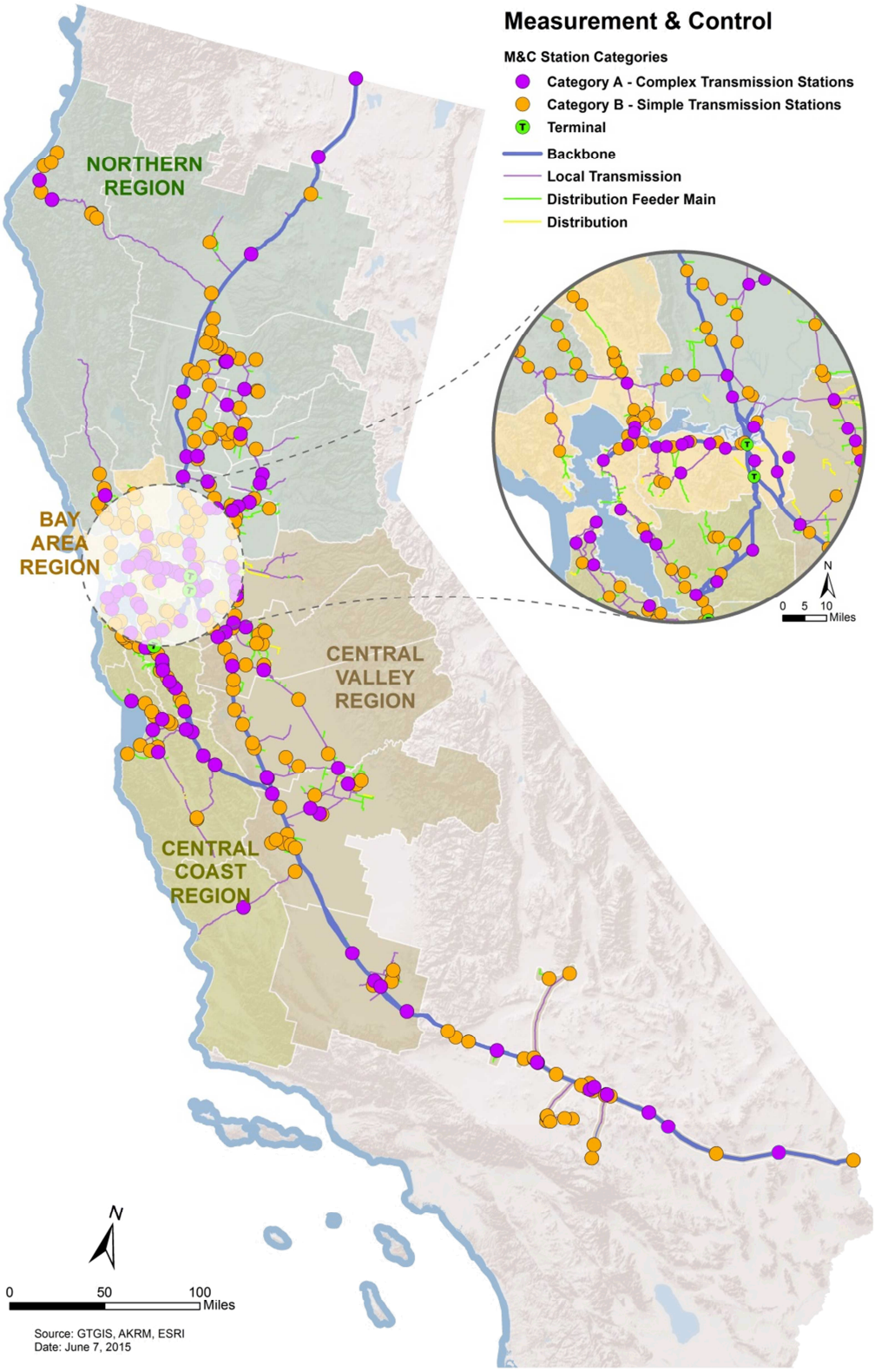
[1] The terms “station’ and “facility” are used interchangeably throughout this document. All Transmission stations are facilities. However, not all Transmission facilities are classified as stations. Similarly, not all Distribution facilities are stations, and those not so classified are not subject to the same inspections and maintenance requirements.

Figure 2 - Gas Transmission Asset Locations



The asset family can be broken down into seven sub-families as defined below:

1. **Gas Terminals:** Gas terminal stations function as hubs in the gas transmission system to route gas from the backbone transmission lines to local transmission lines, which in turn supply distribution systems.
2. **Complex Transmission Stations:** Gas transmission stations containing valves and equipment that are controller-operated or controlled by either an algorithm in a Programmable Logic Controller (PLC) or Remote Terminal Unit (RTU). Classified as Category A Stations
3. **Simple Transmission Stations:** Gas transmission stations containing only self-contained and pilot-operated pressure regulation and over-pressure protection (OPP) equipment and simple operational metering devices. Stations may also include SCADA RTUs or electronic pressure recorders which monitor operating parameters. Classified as Category B Stations.
4. **Distribution District Regulator Station:** A pressure regulator station, including both single and multiple stages of pressure regulation, which controls pressure to a distribution main serving more than one service line. The regulator station contains, as a minimum, pressure regulating valve(s) and an over-pressure protection device, such as a monitor, relief valve, or automatic shut-off device.
5. **Distribution High Pressure Regulator (HPR) Set:** A pressure regulator that reduces pressure from the transmission system to distribution system and that serves a single service line and few customers.
6. **Large Customer Meter Sets:** Commercial/industrial ultrasonic and orifice customer meter sets without controller operated pressure regulation equipment. Includes gas gathering and minor 3rd party pipeline interconnect custody transfer meter sets including meters that may include flow computer equipment and RTUs.
7. **Gas Quality Equipment:** Monitoring equipment that is used to ensure gas quality requirements are met, including gas chromatographs, moisture and sulfur and hydrocarbon dew point analyzers.

2.2 Asset Inventory and Condition

A summary of M&C assets is provided in Table 2. Examples (photographs) of these assets are shown in Appendix H.

Table 2 - Summary of Measurement and Control Assets

Station or Equipment[1]	Number of Assets	Examples
Gas Terminals	3	Milpitas Brentwood Antioch

Complex Transmission Stations[2]	152	Pressure Limiting Stations Automated mainline or crosstie valves Regulation & Metering Stations Underground Gas Holder Stations Line rupture control valves (LRCV)
Simple Transmission Stations[3]	276	Pilot operated regulating stations Interconnect or intertie stations Odorizer, dehydrator, or meter stations
Distribution District Regulator Stations [5]	2397	High or Mid-pressure District Regulator Stations Low Pressure District Regulator Stations Low Pressure Relief Valve Stations HPR Sets managed and maintained as District Regulator Stations
Distribution High Pressure Regulator (HPR) Sets	2433	Farm Taps
Large Customer Meter Sets[4]	25 1	Ultrasonic Orifice Plate
Gas Quality	48	Gas Chromatographs Moisture Analyzers Sulfur Analyzers Hydrocarbon Dew Point Analyzer

Note (1): Excludes measurement and valve control equipment utilized for operations involving the specialized functions of storage field injection and withdrawal, gas dehydration, gas compression and LNG/CNG utilization.

Note (2): Measurement or regulations stations with equipment controlled by a PLC, RTU or pneumatic controller.

Note (3): With RTU used for monitoring purposes only.

Note (4): All customer turbine, diaphragm and rotary meter sets and associated regulation are part of the Customer Connection Equipment (CCE) Asset Family. Smart Meter and AMR equipment are also included within the CCE Asset Family.

Note (5): District Regulator and Farm Tap Sets counts based on data included in SAP as of 4/16/2015. Various operations and system needs will result in changes to the overall counts over time as stations are removed, design basis changes, etc.

PG&E has performed a condition assessment over the past year to quantify health of the M&C stations based on existing available data. The condition assessment was based on evaluating the major components in the M&C stations against a set of metrics to determine a component health score. The components were then grouped by station and health was determined on a station level. This method

provides a means to evaluate the health of components across the system and within a station. The condition assessment was focused in 2013 on the gas transmission stations – Category A, Category B, and Gas Terminals. The condition assessment for these assets is being updated to reflect current information. Therefore, the major health input from the condition assessment is provided for these assets. Additionally, a pilot program was performed for the distribution stations for about 5% of district regulator stations designed to H-14 Design Standard. See for more details on the distribution stations. Information is provided on the other asset family assets at the end of this Chapter.

This section provides a description of the following:

- Condition Health Scoring Model and Criteria
- Station Health Target Scores
- Current Condition Results, including non-gas transmission M&C assets, and
- Asset Data for Health and Performance Monitoring

The information included in this section changes over time as projects and programs result in changes to component and system condition and risk. Therefore, the condition information is a snapshot of the condition at a specific time.

2.2.1 Station Condition Health Scoring Model and Criteria

The condition assessment for M&C facilities defines the evaluation of health for the components and systems of the facility. The condition assessment employs a set of component-level elements that are utilized to provide an indication of the component health. The scoring elements included in this assessment include both leading and lagging indicators. These scoring elements are defined in Table 3 below. Elements 1-3 can be viewed as describing past condition; 4-6 as describing current condition; and 7-10 as indicators of future performance.

Table 3 - Component Condition Health Metrics

Element No.	Element Type	Scoring Element	Definition
1	Leading	Component Age	Percent of component age vs. expected life of component
2	Leading	Obsolete Equipment	Component make and model matches equipment on obsolescence list
3	Leading	Problem Equipment	Component make and model matches equipment on problem equipment list
4	Leading	Physical Condition	Assessment of component from visual inspection based on site inspection criteria
5	Lagging	Functional Performance	Assessment of component performance based on review of maintenance and operations history against performance criteria
6	Leading	Operational Efficiency	Measure of operational efficiency based on review of maintenance hours spent on component over past three years against efficiency criteria
7	Leading	Engineered Maintenance Strategy	Component included in maintenance database (PLM or SAP) with defined maintenance strategy (preventive maintenance or maintenance for cause)
8	Lagging	Corrective Maintenance Tasks	Number of corrective maintenance tags against equipment with defined maintenance strategy, excluding maintenance for cause strategy
9	Leading	Planned Maintenance Tasks Overdue	Occurrence of preventive maintenance tasks overdue greater than 30 days
10	Lagging	Percent Corrective Maintenance vs. Total Maintenance	Percent of work hours associated with corrective maintenance against the total work hours on the component

The scoring elements defined in Table 3 have been used in the initial assessment of component condition assessment. The description of how these metrics are determined, the data sources utilized, and future needs for these metrics is presented in Appendix I.

2.2.2 Station Health Target Scores

Category A and B Stations

The station health scores are based on a set of 10 metrics that are weighted for scoring each component in the station. Category 1 and Category 2 components are defined for use in determining the overall station health score. Appendix I provides the details of the component and station level health scoring. Additionally, for each station, the consequence of failure (COF) has been defined for each of 6 risk

categories as shown in Appendix L. The station health target is defined based on a target component and station score along with the COFs for health and safety and reliability. The key assumptions and approach are defined in Appendix J.

The criteria for defining the station target health scores are applied as shown in the Table 4 below.

Table 4 - Final Target Station Score Recommendations

Components in Station	COF for H&S or Reliability at 5 or Greater		COF for H&S and Reliability Less Than 5	
	Target Score	No. of Stations	Target Score	No. of Stations
Class 1 & 2 (Cat. X)	54.8	234	65.4	149
Class 1 Only (Cat. XA)	36.5	17	43.6	28
Class 2 Only (Cat. XB)	18.3	8	21.8	29

Note: The Cat. X, Cat. XA, and Cat. XB designations provide the target score category associated with each station in Appendix K. X can be either 1 for H&S or Reliability COF at 5 or greater or 2 for H&S and reliability at 4 or below.

Gas Terminal Stations

The station health scores are based on a set of 10 metrics that are weighted for scoring each component in the station. Category 1 and Category 2 components are defined for use in determining the overall station health score. Appendix I provides the details of the component and station level health scoring. Additionally, for each station, the consequence of failure (COF) has been defined for each of 6 risk categories as shown in Appendix L. The station health target is defined based on a target component and station score along with the COFs for health and safety and reliability.

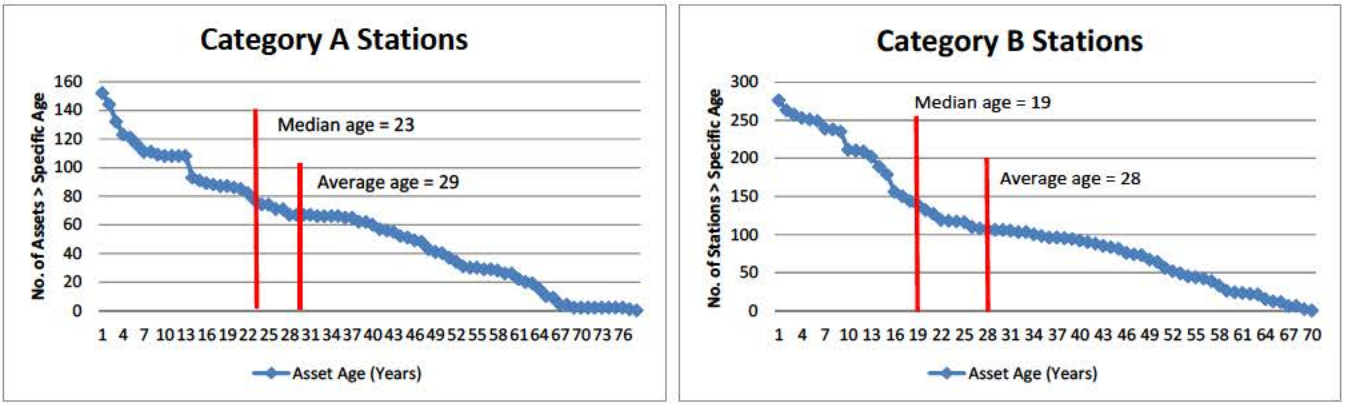
The gas terminals are identified as having COF for safety and reliability at 6 or above. Therefore, for these gas terminal stations, the target criteria will be established as more limiting. The assumptions and approach are defined in Appendix J. There is only one criterion for the gas terminals and the target score is 38.3.

2.2.3 Current Condition

The condition assessment performed in 2015 has resulted in component and system health scores for the gas transmission M&C stations. The detailed component and system information is captured in the FIMP condition database and ultimately will be captured in SAP. The current condition discussion is prepared to provide a snapshot of current condition and issues. Information on other assets in provided in Table 5. The overall condition of the M&C assets is summarized in the following sets of graphs.

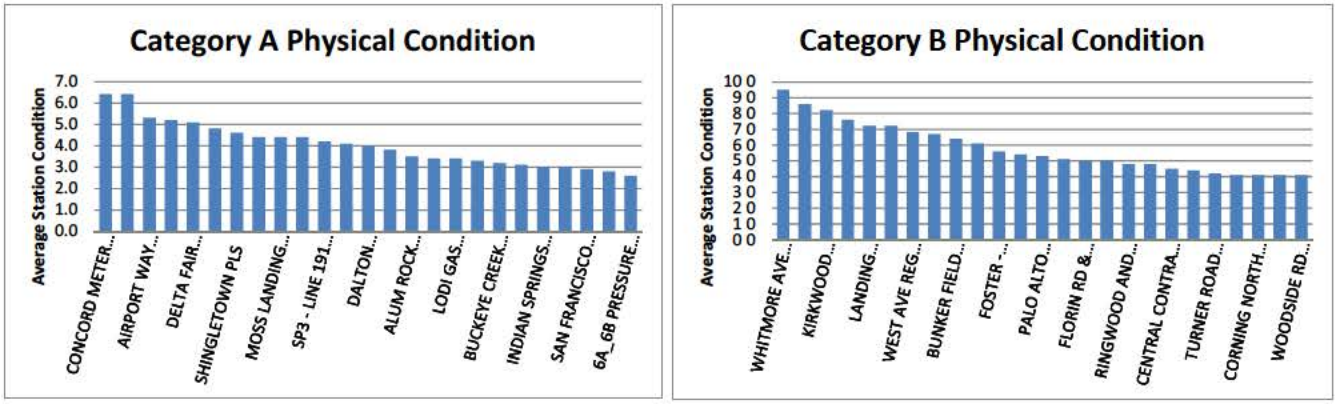
The station age represents one measure of the overall state of the M&C assets. The station aging graphs (Figure 3) show the number of stations above a specific age for Category A (complex) and Category B (simple) stations. While the average station age is reasonable, there are about 50 stations (approximately 12% of stations) greater than 60 years. This indicates the need for a fleet-wide program to manage this aging infrastructure. For the three (3) terminal stations, they are rebuilt over time, but these stations were commissioned 47, 52, and 60 years ago, respectively.

Figure 3 - Station Age by Category (Initial Installation) (Data as of 5/2013)



The condition assessment included physical condition as a health metric and this metric was based on visual inspections for the stations. A station physical condition assessment was conducted based on the average physical condition of the station components. Based on this review, there were 16 simple stations identified with an average score of greater than 5 (on a scale of 1 to 10 with 10 being the poorest). There were 4 complex stations showing an average score above 5. The key point in this review is the susceptibility of the vaulted station to physical condition deterioration (extensive rust and corrosion). This condition indicates the need for reconsidering the maintenance approach to these stations relative to dewatering frequency, inspection frequency or possibly water monitoring in the vaults.

Figure 4 - Physical Condition (Average of All Station Components)

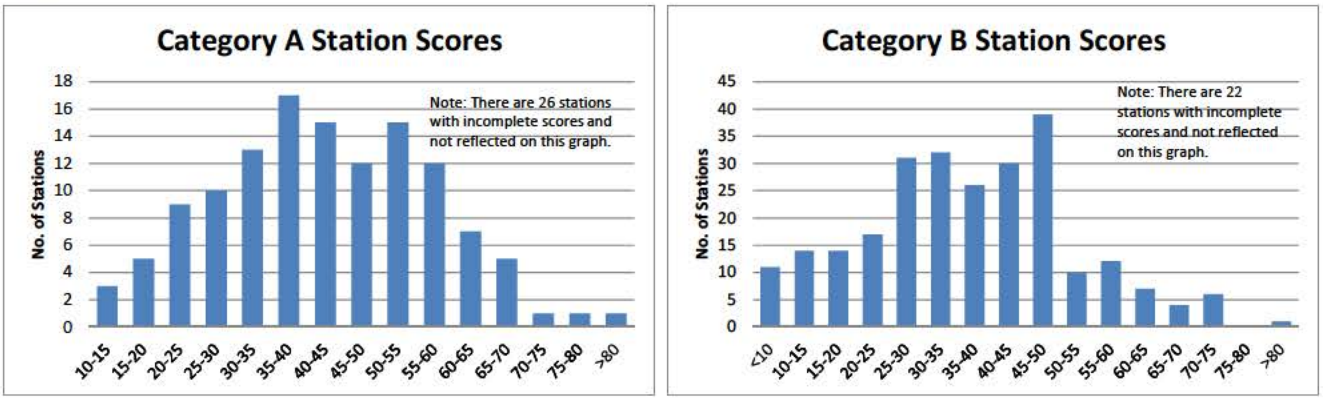


The charts in Figure 4 indicate the health score for all complex and simple stations. The station scores can range from 5 to 150 (if all metrics were at the poorest score of 10). However, the range of station health score (all categories) varies from about 7 to 82 with an average score of about 39. The general station findings from condition assessment were used along with the COF for health & safety and reliability to determine the mitigation measures for the stations. These mitigation measures included actions such as:

- Replace or repair valve actuators and controllers
- Replace obsolete or problem equipment
- Repair inadequate supports

- Address rust issues with a painting and coating program
- Consider station rebuild to manage overall fleet age

Figure 5 - Total Station Health Score



The station scores are included in the station equipment database and in Appendix K. Each station is shown in Appendix K with its current station condition score, the target score and the variance between target and current condition. The results in these station scores are to guide the selection of stations as candidates for rebuilds. This information can also be used on a component level for each station to drive targeted mitigations actions.

The condition assessment included other analysis including a review of the overall station functional performance score to assist in identifying stations that required additional inspection and functional review of the actuated valves, controllers, and coordination. These special assessments are intended to supplement the normal maintenance program for stations identified with poor functional performance.

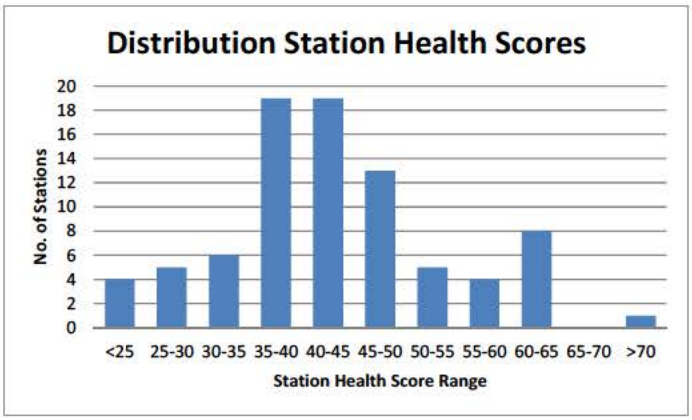
The condition assessment also identified several programmatic issues relative to the data collection process that supports the condition health scoring. The key focus areas here included are:

- Improvement in collection of asset data (make, model, installation year) from both the maintenance programs and the capital projects and inclusion in SAP that is easily retrievable for analysis.
- Improved definition of maintenance strategy for all assets, including those with “run-to-failure” strategies, in order to provide for improved management of the assets.
- Improved data collection and information from the maintenance program to provide more information regarding components that have been found in poor condition or that demonstrated operating problems. This information requires improvement in identification of specific equipment items, description of actual failed or faulty condition, ensuring that all corrective maintenance is captured under a notification, and collection and incorporation of this information in the maintenance management system (SAP).
- Improved identification and tracking of obsolete and problem equipment through better use of the material problem reporting system.

For Distribution stations, several studies have been conducted at PG&E over the past year that provide insight into the condition of these assets. These studies include:

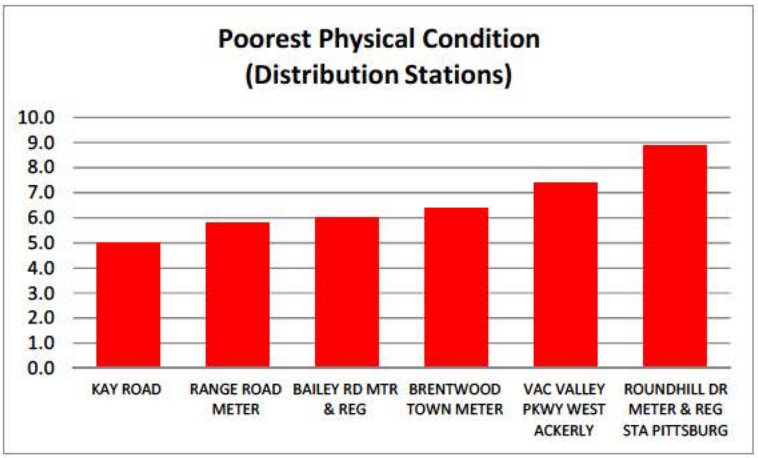
- A pilot condition assessment of 83 stations provides input into the overall condition of the assets. The district regulator station score distribution is shown in Figure 6 (with higher score indicating poorer condition). This distribution of condition scores is similar to the overall transmission assessment station scores as shown in the 2014 M&C Asset Management Plan.

Figure 6 - Distribution Station Health Scores



Additionally, a key observation from the original transmission condition assessment was the physical condition of the stations. This specifically led to the observation that vaulted stations required additional attention. Since most of the distribution stations are vaulted, a review of the physical condition scores is provided to compare the distribution stations to the overall assessment results. Figure 7 provides the physical condition results for the distribution stations from the pilot with average score greater than 5. [Note that in these figures, "red" columns represent vaulted stations and "blue" columns represent above ground or buried stations.] Based on the pilot assessment, about 7% of the stations evaluated have high average physical condition scores (average component score greater than 5 on scale of 1 to 10, with 10 being poorest condition).

Figure 7 - Distribution Station Physical Condition Scores



- A survey was conducted to solicit input on stations requiring attention. The survey of the various divisions indicated the following:
    - There is a wide range of district regulator station and farm tap set conditions over the various divisions relative to both physical condition of the assets as well as safety concerns.
    - Safety concerns are primarily focused on accessibility of the station relative to its location or ability to enter and work at the various locations. The surveys indicate that 1-2% of the stations may have safety concerns related to the accessibility issues.
    - Conditions of stations are primarily focused on existence of obsolete equipment (such as Fisher 399 valves) that requires replacement and on the physical condition (rust, etc.) of vaulted stations. The surveys indicate 5 -10% of stations with physical condition issues. [Also, the transmission assessment identified concerns with vaulted stations that flood and about 80% of the district regulator stations are vaulted.]
    - There is a need for station upgrades related to the SCADA program where some stations may be too small to incorporate SCADA.

Table 5 below summarizes some key asset information for the M&C assets not currently addressed by the condition assessment. These include distribution district regulation stations, HPR's, and measurement assets. The asset health information for these assets is based more on expert opinion from those knowledgeable with the assets. The M&C Asset family is also responsible for gas quality monitoring, which is discussed in more detail in Appendix O.

Table 5 - Non-Gas Transmission Assets Health Commentary

Station Category	Asset Condition	Key Issues/Comments
Distribution Stations		
Distribution District Regulator Stations	Fair, but individual stations Good-Poor	• Receive annual maintenance. • A significant number of issues were corrected as a result of Exponent audit findings (2009). • Many of the stations are old with aging components, and have designs that do not fully conform to current standards. • Development around some stations has caused accessibility issues.
Customer HPR (Farm Tap) Regulator Sets	Poor	• Infrequent inspection and maintenance only for cause has led to multiple problems. • Tight space in boxes makes work difficult to perform. • Atmospheric corrosion issues. • Program to replace or rebuild all customer HPR sets is in progress.
Measurement		
Large Customer Meter Sets	Fair-Good	• Typically minimal performance issues due to simple, reliable equipment. • Some issues with oversized meters and regulation, and with sets having accessibility problems. Many sets have deteriorated condition of paint.
Gas Quality Monitoring Equipment	Good	• Gas chromatographs (GCs) are in good shape and reliable; Concord Test Lab performs audit every few years and results are good. • Need to document maintenance on sulfur analyzers.

As SAP fully incorporates these assets, the condition health model is applicable and can automatically provide health scores in the future. There are two key scoring elements – physical condition and functional performance – that are not yet automated. However, after automation or retrieval of these metrics, then all M&C assets can be evaluated for condition health.

2.2.4 Asset Data for Health and Performance Monitoring

The current condition assessment provides a snapshot of station condition and defines a set of metrics and the basis of the metrics.

More detailed discussion of the condition scoring model is provided in Section 5 of this plan. The current condition information is provided in the Gas Transmission Condition Assessment Report (Reference 1) and the data resides in the Station Equipment Database (SEDB) maintained on PG&E's T-Drive (Reference 2).

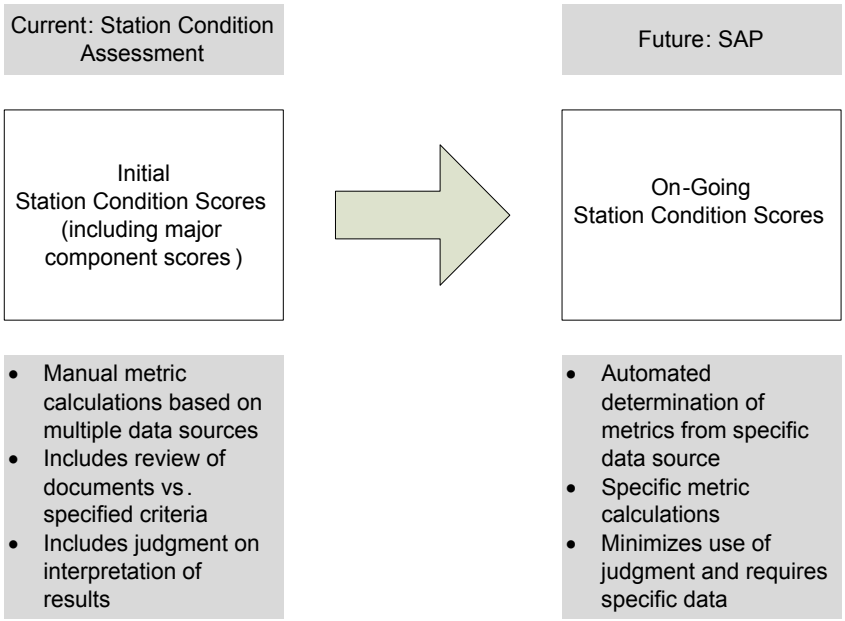
The condition assessment completed in 2014 established a baseline condition assessment for the M&C assets and provides an on-going basis for evaluating station condition to aid in defining and prioritizing

investments and programs for these facilities. As noted in Section 2.3, the condition assessment was based on evaluating the major components in the M&C stations against a set of scoring elements to determine a component health score.

For gas transmission M&C facilities, it provides a determination of station condition (or health) by utilizing a set of metrics to score major components within a station and then to roll-up these component scores to a system level condition score. The overall goal of the component and system condition metrics and scores is to provide an on-going basis for evaluating station condition to assist the asset family owner in defining and prioritizing projects and programs for the gas transmission M&C facilities.

A roadmap or process for capturing the metrics and scoring approach is shown in Figure 8 - Metrics and Scoring Roadmap.

Figure 8 - Metrics and Scoring Roadmap



There are still gaps in the data, but overall the information reviewed allowed for a reasonable determination of station and component condition. Data quality and availability still remains a focus of attention moving forward to ensure that decision-making is made on current and accurate information.

The current data provides valuable information when leveraged by subject matter experts, knowledgeable in the facilities and systems, to define risks and mitigations. However, data for this asset family is limited in terms of quality, completeness, and accessibility to support a complete quantitative analysis of asset risk. Further, there are gaps in the available data which limit its reliability and use for monitoring program impact on risk reduction and tracking metrics. Enhancing data collection and quality is an area of focus in this plan to enable decision making going forward.

The Asset Maintenance – Backbone & Stations (AMBBS) project has been completed. It migrated the backbone transmission, stations, and storage asset information from multiple systems and platforms into SAP, as a single system of record. This will help improve the maturity of data used to determine the condition of the Transmission Pipe assets.

3. Threats and Risks

Risks are tracked in an enterprise-wide risk register, a central repository where risk names, descriptions and scores, as determined by utilization of Enterprise and Operational Risk Management's (EORM's) risk criteria, along with other pertinent information are documented. The risk register is updated and refined as additional information is obtained and evaluated.

The risk management framework is fully integrated into PG&E's Integrated Planning Process (IPP) . This framework complements risk assessment processes already in place via integrity management programs. Additional information about the Integrated Planning Process can be found in the Strategic Asset Management Plan, GP-1100.

Continuous Process

While the formal IPP (annual review cycle) is employed as described above, risks are also identified and addressed continuously as new information is discovered either from working with M&C assets, or from experience elsewhere in industry. Risks when discovered or when a potential change is observed are analyzed, prioritized, and mitigation plans are developed and implemented on a schedule that may fall within the annual cycle described above.

This continuous process can also result in revisions to the risk assessments that are already within the Gas Operations risk register and addressed in the annual refresh cycles, either on the annual cycle schedule, or more immediately if warranted.

3.1 Threat and Risk Identification

The Asset Family Owners (AFOs) work with their teams to identify the threats to the assets in their families. The AFOs rely on ASME B31.8S as the basis for categorizing and evaluating the threats, as well as and 49 Code of Federal Regulations (CFR) Part 192, Subparts O (for Transmission) and P (for Distribution). Figure 9 below describes the threat categories from ASME B31.8S. Appendix B includes the current Threat Matrices for Transmission and Distribution assets.

Figure 9 - ASME B31.8 Threat Categories

Threat Category	Description	Specific Threats
Time-dependent	Potentially increase over time	• External Corrosion • Internal Corrosion • Stress Corrosion Cracking
Stable or "Resident"	Present, or potentially inherent in the pipeline, but do not grow over time or pose a threat unless influenced by another condition or failure mechanism	• Manufacturing • Construction/Fabrication • Equipment threats
Time-Independent	Not influenced by time	• Third Party Damage • Incorrect Operation • Weather and Outside Forces

In addition to these threat categories, PG&E considers threats related to its obligation to serve, both in terms of ensuring reliable delivery of natural gas and increasing capacity to meet demand, as well as threats posed by an inadequate response to and recovery from emergencies.

Threats are identified through the Corrective Action Program (CAP) and various on-going maintenance and assessment programs. Each AFO works with his/her team and other Subject Matter Experts (SMEs) to determine the relative risk associated with each threat. Risks are calibrated across both Gas Operations and enterprise-wide.

3.1.1 Primary Threats and Mitigations

The threat matrix in Appendix B lists the primary threats that are deemed applicable to the Measurement & Control asset family. The discussion below highlights the reason for the threat and primary mitigation measures. These threats guide the identification of the risks contained in the M&C Risk Register.

3.1.2 Primary Measurement and Control Risks

Risks have been identified and annually updated for the M&C asset family, and prioritized for both Gas Operations (addressing risks across asset families) and within the asset family (as part of the risk and compliance process).

The EORM process addresses low likelihood, high impact risks. The M&C asset family identified 35 risks in 2016. The top M&C risk (MC004) ranked ninth among the 204 risks in Gas Operations. The M&C risk ranking against all other Gas Operations risks is shown in Figure 10 based on the analysis performed during 2016 Session D. The top risks for the M&C asset family are detailed in Table 6. All of the risks identified for the M&C asset family are shown in Appendix C

Figure 10: M&C Risk Profile

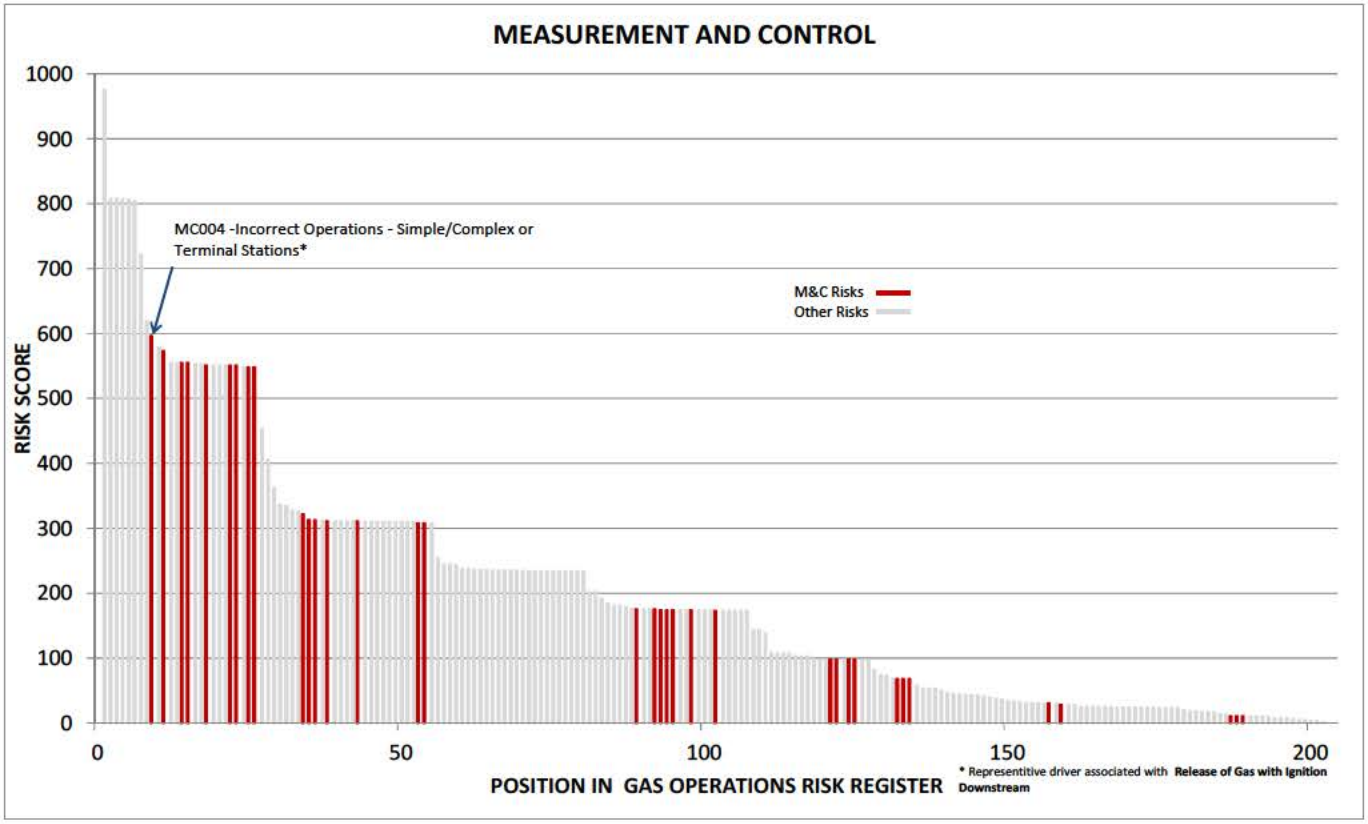


Table 6 - Key Measurement and Control Risks*

Risk ID	Risk Description	Threat
MC004	The risk of an overpressure event caused by incorrect operation of a local transmission complex station or terminal station may result in failure of downstream assets with loss of containment	Incorrect Operations
MC032	The risk of failure of a station to perform its pressure control function due to seismic impact of greater than 6.7 magnitude causing downstream under or over-pressure events.	Weather Related/Outside Forces - Seismic
MC003	The risk of an overpressure event caused by incorrect operation of a local transmission simple station may result in failure of downstream assets with loss of containment	Incorrect Operations
MC006	The risk of an overpressure event at complex stations (backbone / PLS stations) caused by incorrect operations may result in damage to downstream assets with loss of containment	Incorrect Operations
MC001	The risk of an overpressure event caused by incorrect operation of low pressure distribution assets may result in failure of downstream assets with loss of containment	Incorrect Operations
MC015	The risk of an overpressure event caused by equipment failure in a complex/simple station may result in failure of downstream customer assets with loss of containment	Equipment Related

Risk ID	Risk Description	Threat
MC030	The risk of failure of station piping from vandalism/terrorism damage causing may result in loss of containment	Third-Party/Mechanical Damage - Vandalism
MC016	The risk of an overpressure event caused by equipment failure in low pressure distribution assets may result in failure of downstream assets with loss of containment	Equipment Related
MC012	The risk of an overpressure event caused by design or fabrication issues with high pressure distribution assets may result in failure of downstream assets with loss of containment	Welding/Fabrication
MC030.2	The risk of significant station failure at Antioch terminal due to train derailment may result in loss of station and fatalities	Third-Party/Mechanical Damage
MC014	The risk of a loss of containment event caused by design or fabrication issues a local transmission complex station may result in fire or explosion at a complex station.	Welding/Fabrication Related
MC013	The risk of a loss of containment event caused by design or fabrication issues a local transmission simple station may result in fire or explosion at a simple station.	Welding/Fabrication
MC018	The risk of an overpressure event at a terminal or large complex station or simple/complex stations caused by equipment failure may result in damage to downstream assets with loss of containment	Equipment Related
MC019	The risk of an overpressure event at complex stations (backbone / PLS stations) caused by equipment failure may result in damage to downstream assets with loss of containment	Equipment Related
MC002	The risk of an overpressure event caused by incorrect operation of high pressure distribution assets may result in failure of downstream assets with loss of containment	Incorrect Operations
MC017	The risk of an overpressure event caused by equipment failure in high pressure distribution assets may result in failure of downstream assets with loss of containment.	Equipment Related

* All risks with a score of 200 or higher as a result of the 2016 Session D process

3.1.3 Station Risk Analysis

The component and system health scores also serve as a means to assess risk. A set of typical station configurations has been defined and categorized and the specific M&C stations are assigned to a typical category. The typical station configuration along with several of the component metric health scores are used to determine the likelihood of failure at each station. The consequence of failure is determined by reviewing information for each station for the six major risk categories. This information is compiled in a consequence of failure matrix for each station and is used in determining the risk level for each station. See Appendix M for details.

The following summary curves show the likelihood of each station failing closed and failing open.

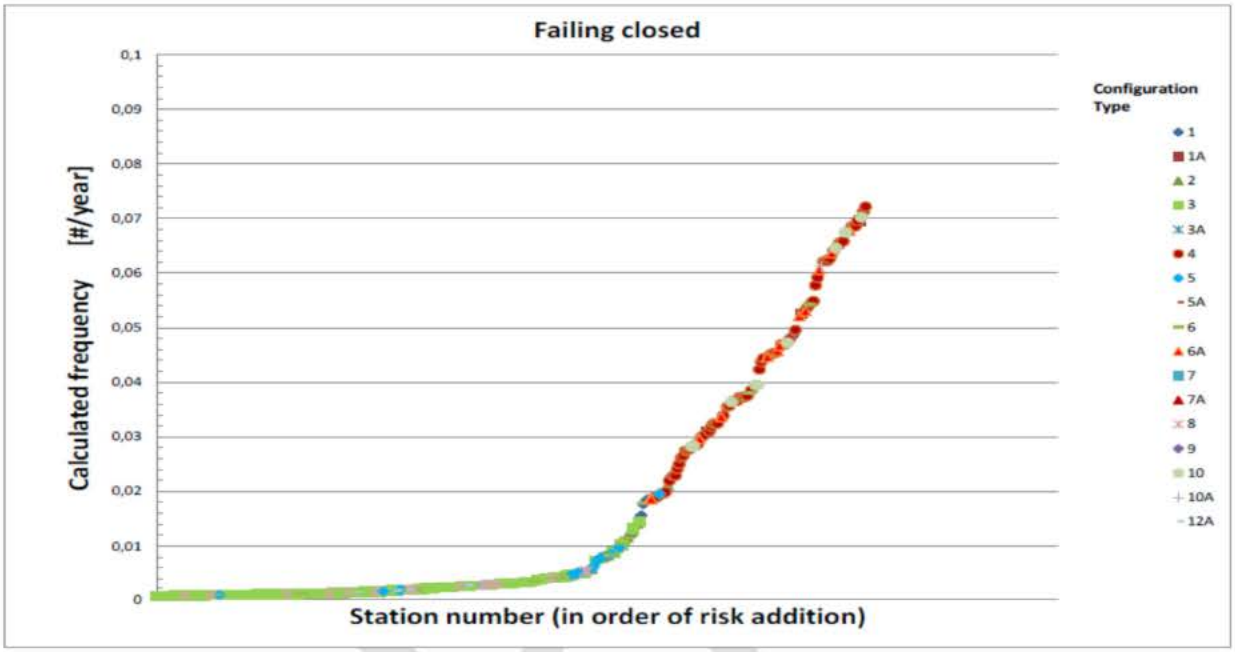
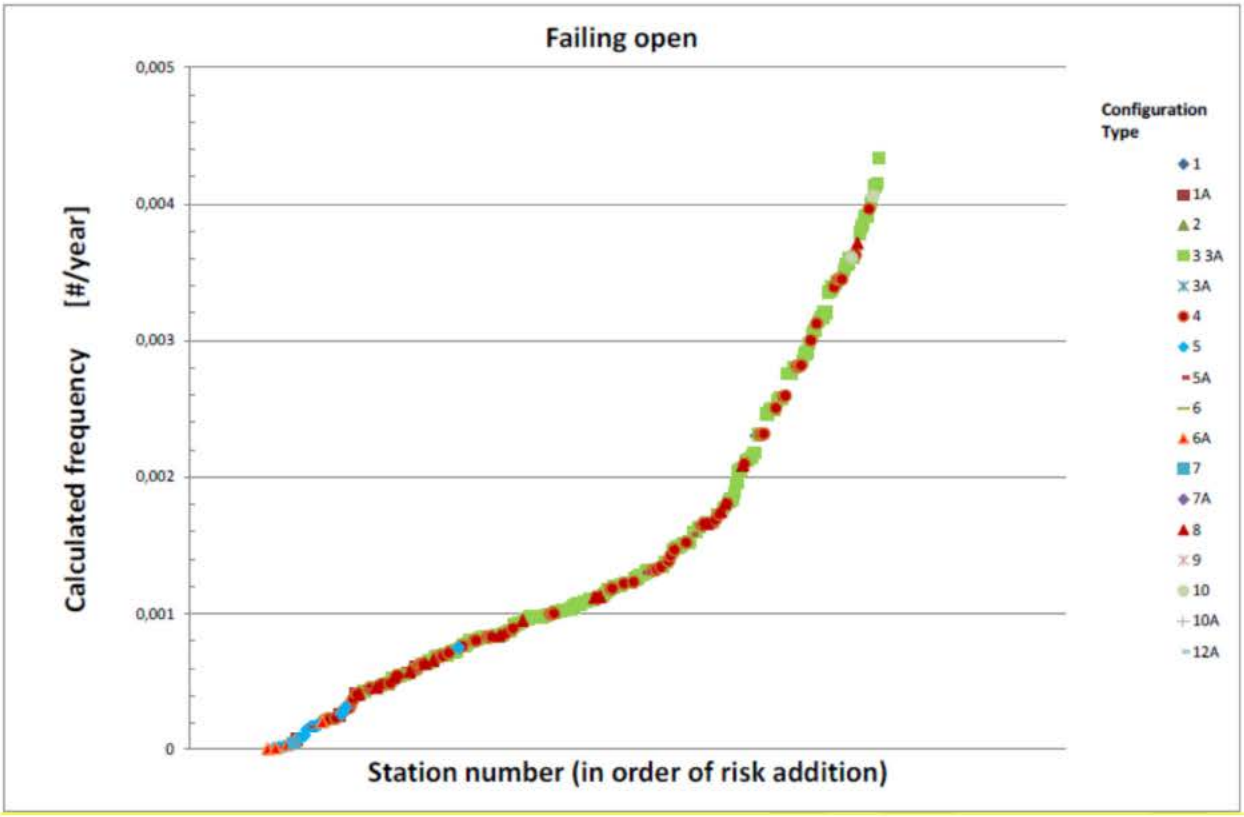


Figure 13: Calculated frequency of failing closed for the analysed stations, in order of frequency.



3.2 Integrity Management Programs

M&C Stations will be operated under the principles of the Facility Integrity Management Program (FIMP) and will interface with the Transmission Integrity Management Program (TIMP) and the Distribution Integrity Management Program (DIMP) at the station boundaries. In addition, the M&C asset family leverages information from TIMP and DIMP to identify asset risks. All three integrity management programs are described below.

Facility Integrity Management Program (FIMP)
PG&E's Facility Integrity Management Program (FIMP), identifies, assess, and mitigates risks in order to reduce both the likelihood and consequences of gas transmission facility incidents. This includes facilities within the Measurement & Control and Compression & Processing asset families. While the approach for assessing risk within FIMP has similarities to TIMP/DIMP, it should be noted that an integrity management program for facilities is, by definition, quite different from an integrity management program (IMP) for a pipeline. These differences are driven by the nature of the assets to be managed (scope) and the resulting objectives (program purpose) for those assets as well as vastly differing life cycles. These key differences are identified and summarized in Table 7.

Table 7 - Comparison of Facility and Pipe IM Programs

Source: Canadian Energy Pipeline Association, "Facilities Integrity Management Program Recommended Practice", 1st Edition, May 2013

Element	TIMP/DIMP	FIMP
Scope	Assets are relatively uniform (i.e., pipelines of varying grades, wall thickness, and diameter)	Disparate asset types
Program Goal	The safe environmentally responsible and reliable service of pipelines by working towards minimizing loss of containment events)	The safe environmentally responsible and reliable service of all pipeline system facilities, exclusive of pipeline, by ensuring control and containment of service fluids (e.g., gas, lube oil), and equipment meets or exceed design life given its intended purpose and actual operating conditions
Asset Life Cycle	Long life cycle	Life cycles vary significantly and assets with long life cycles often contain numerous components with short life cycles

Transmission Integrity Management Program (TIMP)
The TIMP program is a mature, well-defined program for assessing the risk related to different segments of pipe on the system and taking action to prevent or mitigate these risks. The approach for assessing risk is based on an assessment of likelihood and consequence of a leak or rupture, and uses the nine threats listed in the threat matrix to identify high-risk segments. While the TIMP risk management process contains many elements that overlap with risk assessment processes within the risk register, it is a separate process that considers threats to individual segments of pipe as opposed to the system as a whole. *Please refer to document GP-1101: Transmission Pipe Asset Management Plan for more details.*

Distribution Integrity Management Program (DIMP)
PG&E's Distribution Integrity Management Program, based on the federal Distribution Integrity Management Program (DIMP) regulation (49 Code of Federal Regulations (DFR) 192, subpart P, adopted December 4, 2009 at 74 FR 63929), evaluates and ranks the risks to the gas distribution system and proposes mitigations to address those risks. The risk process for this program gathers, reviews and integrates data to calculate risk, prioritizes preventive and mitigative measures, and monitors for operational changes that may require additional actions. Additional information about the DIMP Risk Management Process can be found in PG&E Procedure Number RMP-15 Revision 5 (Risk Management Procedure - Gas Distribution Integrity Management Program).

4. Desired State, Strategic Objectives, Programs and Risk Mitigations

The long term vision for the Measurement & Control asset family is to improve the overall reliability of the assets through a combination of infrastructure improvements and promotion of a culture that focuses on long term reliability of the assets. While infrastructure improvement is a key element in improving reliability, having a culture that is focused on the long term health and reliability of the assets is necessary for sustained improvement. Goals supporting this vision include:

- Improve asset reliability over time via incremental change driven by data and metrics
- Shift focus and culture of engineers and maintenance and operations personnel from being purely reactive to planned long term reliability
- Utilize the results of the condition assessment effort to give visibility to the systems at greatest risk to prioritize and sequence capital investments for Measurement & Control assets
- Foster an improved culture of accountability by local crew and leadership for station reliability.

The strategic objectives of the M&C asset family align with PG&E's corporate vision to be the safest most reliable gas company in the US.". A world class asset management program includes the following key elements:

- Risk-based maintenance and inspection plan that defines preventive and condition-based maintenance tasks that address major system and operating threats and risks
- Data and records that provide for continual trending, monitoring, and prioritization
- Procedures and on-going personnel training that reflect the overall inspection and maintenance programs.

Directionally, we want to get to a state where Measurement & Control assets are routinely evaluated against condition targets specific to the facility. Resources are preferentially applied to those assets to which are below these targets.

A key program to ensure that the long-term vision for the M&C assets is carried out is the development and implementation of a robust Facility Integrity Management Program (FIMP). The FIMP defines the long-term desired state for the condition and the management of the M&C assets.

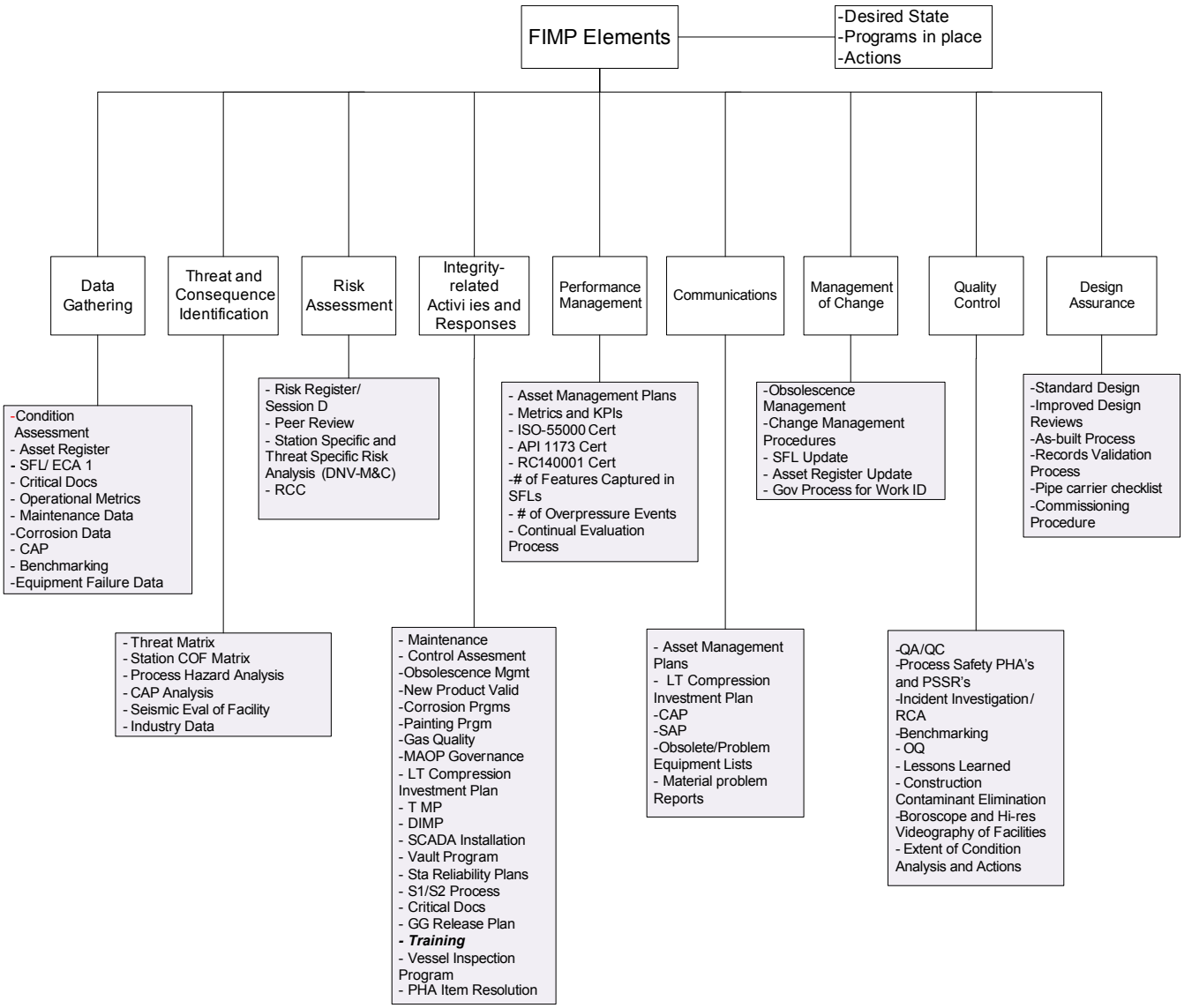
Facilities Integrity Management Plan (FIMP)
One of the strategic objectives is to Apply Facility Integrity Management principles to all transmission and distribution stations by 2025. PG&E's goal is to develop a world-class facility integrity management program. This task consists of preparing the roadmap and FIMP plan to guide the development and implementation of various program elements. This task includes working with PG&E stakeholders to prepare and review the plan and to define implementation actions. The FIMP plan will be prepared to address the following issues as well as recommendations from the station condition assessment program. The plan will focus on the integration of current activities along with newly identified actions.

1. Data gathering (including storage and retrieval)
2. Threat identification and consequences
3. Risk assessment and prioritization

4. Integrity-related activities (including the specification of maintenance and inspection activities to address compliance and reliability needs)
5. FIMP performance management
6. Reporting and communication of FIMP issues
7. Facility change management (how to address changes to facilities so that appropriate asset management information is updated and tracked)
8. Quality control requirements to ensure FIMP requirements are being met and lessons learned are incorporated into the program
9. Design-related activities to ensure that FIMP requirements are included in design of facilities

The M&C Asset Management plan will become a part of the FIMP, which is shown in Figure 11 below.

Figure 11 - FIMP Elements



FIMP Maturity Model

In order to evaluate whether 2025 represents the right pace for FIMP development, each of the elements is evaluated against a FIMP maturity model. The strategic objective will be reached when each of the elements is deemed to score a ten (10), which means that it has reached its desired state. Intermediate States are also defined and given a score (e.g., 4, 5, 8, etc). The element score is determined by evaluating the status of each of the programs that make up that element as to where they are on their path to their desired state. The model and scoring criteria are shown in Figure 12 below. As shown in that Figure, the current state of maturity at the end of CY 2015 was shown to be 24% of the desired state. Scores for each element are shown highlighted in yellow in the figure.

Once the current level of maturity was determined, an attempt was made to predict how where the FIMP would be at the end of 2016. This was calculated by analyzing the various specific actions that are planned for 2016 for their potential impact to improve the score in their respective elements. Based on that assessment, it is expected that the state of maturity at the end of 2016 will be 32% along the path to the desired state. This projection is highly dependent on the planned actions actually being accomplished and their having the desired effect.

Beyond 2016 the process described above will be repeated and the current status of the maturity of each element as well as a forecast for improvement in the following year will be established. This evaluation will include an analysis of how successful the actions planned for that year had been as well as the development of a specific set of actions for the following year with a forecast of the expected improvements they will bring.

A forecast has been made of expected progress through the year 2025 is shown in both tabular and graphical format in Figure 13. This forecast was highly dependent on the forecast completion dates of the major programs shown under each element in Figure 14. As large projects such as SFL/ECA 1 and Critical Documents are completed and their results become a routine part of normal business, it is expected that the maturity score of their element will improve. This longer term forecast will also be revisited each year as part of the continual evaluation process

Figure 12: FIMP Maturity Score

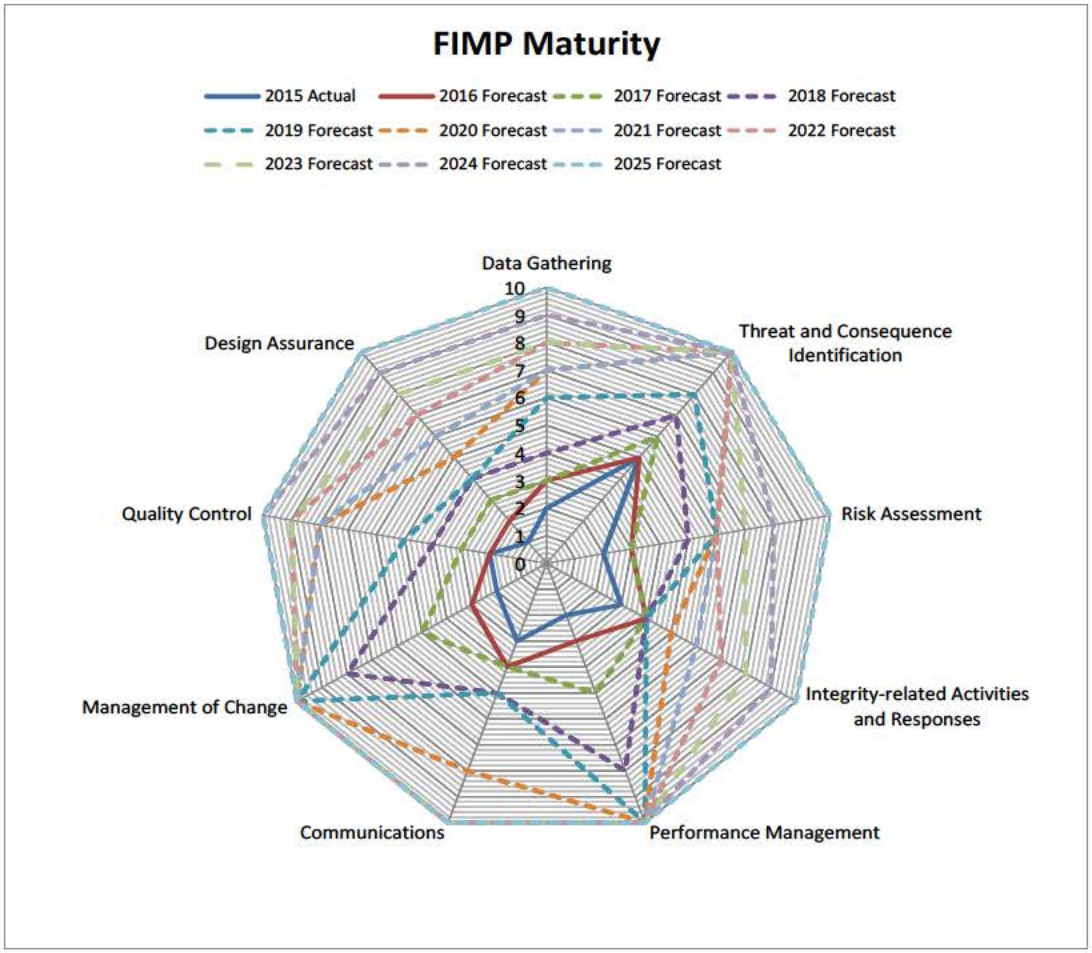
FIMP Maturity Score

Maturity Score	Data Gathering	Threat and Consequence Identification	Risk Assessment	Integrity-related Activities and Responses	Performance Management	Communications	Management of Change	Quality Control	Design Assurance	Overall Score
0	No data collection	No threat or consequence identification	No risk assessment	Reactive programs and projects	No asset management plan or metrics	No data collection	No data collection	Limited QC / no benchmarking	No standard designs / process safety	24%
1									**(2016 same as 2015)**	32%
2	Limited data collected; limited accessibility for analysis		General risk assessment; industry data		Asset management plan; limited metrics		Limited data collected; limited accessibility for analysis	Limited QC and benchmarking **(2016 same as 2015)**	Standard designs for Distribution	
3	All assets within SAP (T&D)		Risk models exist (T)	Condition informed programs and projects	Asset management plan; key metrics updated and available	Limited data collected; limited accessibility for analysis	SFL and Obsolescence Project Pilots are in place	PHA's, PSSR's and Incident Investigations are a normal part of business	Commissioning procedure in place for Distribution	
4	Ops diagrams updated			RCM studies for 2 locations; control assessments and training implemented; condition assessment snapshots		Condition data available for informing program and projects		Construction contamination elimination and boroscoping/ hi-res video inspections in place	PHA's and PSSR's are a normal part of business	
5	Maint and corrosion programs in place for T&D and included in SAP	Identify threats at P95 level annually at a fleet level (CAP, SME, Ops data, Benchmark)	Risk models exist (D)	RCM expanded; condition assessment automated; corrosion activities implemented	Asset management plan; key metrics updated and available. Data is easily accessible	Integrity management and condition information available for informing program and projects	MOC process rolled out to the entire FIMP Organization in accordance with Standard	Extent of Condition analysis and actions complete; mitigations in place	Standard designs for Transmission	
6	Data and assets from P&IDs in SAP (T)	Add seismic risk threat	S-Map models (fleet level)							
7	SFL/ECA1 (records) complete (T)	COF T complete on station basis	Risk models (T) at station level w/ data							
8	SFL/ECA1 (records) complete (D); Data and assets from P&IDs in SAP (D)	COF D complete on station basis	Risk models (D) at station level w/ data	Facility integrity management activities in place, updated regularly.	Asset management plan; metrics defined for all elements and available for informing programs and projects	Integrity management and condition information available for informing program and projects; automated updates	Asset Register update process in place	Lessons Learned and Benchmarking are incorporated into the normal business		
9	Integrated data in SAP (incl. SFL)									
10	Data is collected on a regular basis as part of a normal business process; data is stored where it is accessible for trending and analysis; and data is complete and accurate.	Complete and on-going identification and modification of threats and consequences at station level.	Risk assessment updated on a regular basis at a station or facility level.	Facility integrity management activities in place, updated regularly and risk-informed.	Asset management plans and programs driven by regularly updated metrics.	Integrity management activities underway; risk assessment and investment plan by station available and accessible; Regular updates of information based on data-driven information and analysis	Full implementation of mature, well-documented business processes	Full implementation of mature, well-documented business processes	Full implementation of mature, well-documented business processes	
NOTES	2015									
	2016									
2015 Score Basis	There are significant data collection programs underway to complete data sets; to migrate data sets; and to make data more assessable for analysis. However, the current information is not easily assessable for use.	Significant work has been done to identify and quantify risks at a P95 level. Less information has been prepared to address the lower consequence / more frequent events that represent most of everyday work.	Risk assessments are performed using industry data, but there is limited PG&E specific failure data available for use. Risk assessment is currently at a station level and less equipment specific.	There are many integrity related activities being performed and many are condition based. There is limited risk based specific equipment and system based risk analysis.	Asset management plans are developed, but limited use of metrics is being performed.	There are many tools being used to communicate asset information and problem information. However, there is no on-going approach to integrating and evaluating this information.	Significant work is underway for programs affecting this category, but there is still substantial effort required for data to support change management. There is a pilot being performed for FIMP MOC in the ECA1 program.	QC issues have been identified for recent projects and this item has been tagged "red" in the threat matrix.	Limited standard design standards for transmission. Recent issues with as-built process and QC.	Score is a percent based on total score of the 9 categories divided by 90 (maximum score)

Figure 13: FIMP Maturity Forecast

Year	Data Gathering	Threat and Consequence Identification	Risk Assessment	Integrity-related Activities and Responses	Performance Management	Communications	Management of Change	Quality Control	Design Assurance	Score	
2015 Actual	2	5	2	3	2	3	2	2	1	24%	
2016 Forecast	3	5	3	4	3	4	3	2	2	32%	Forecast
2017 Forecast	3	6	3	4	5	4	5	3	3	40%	Forecast
2018 Forecast	4	7	5	4	8	5	8	4	4	54%	Forecast
2019 Forecast	6	8	6	4	10	5	10	5	4	64%	Forecast
2020 Forecast	7	10	6	5	10	8	10	8	5	77%	Forecast
2021 Forecast	7	10	6	6	10	10	10	8	6	81%	Forecast
2022 Forecast	8	10	6	7	10	10	10	9	7	86%	Forecast
2023 Forecast	8	10	7	8	10	10	10	9	8	89%	Forecast
2024 Forecast	9	10	8	9	10	10	10	10	9	94%	Forecast
2025 Forecast	10	10	10	10	10	10	10	10	10	100%	Forecast

Figure 14: FIMP Maturity Spider Chart



M&C Strategic Objectives

The M&C asset family's strategic objectives are defined both top-down, from corporate line-of-sight objectives and goals, and bottoms-up, based on the condition and risks to the assets. Using these inputs, a 5-year program plan has been defined to meet M&C, Asset Management and corporate objectives. These objectives also align with PG&E's vision to be the "safest and most reliable gas utility in the United States".

The Gas Operations objectives are as follows:

- Safe: Safety First / Find It and Fix It
- Reliable: Do the Right Work in the Right Way
- Compliance: Do the Right Thing
- Affordable: One Company, One Way
- Customer: Do Say Ratio = 1
- People: Build Unity and Trust

After analyzing asset risk and condition within the LoS framework, the 2016 M&C strategic asset objectives are listed in Table 8 below.

Table 8 - M&C Strategic Objectives

Corporate Objective	Strategic Objective	Metric
Transmission and Distribution Facilities		
Public Safety / Reliability	Apply Facility Integrity Management principles to all transmission and distribution stations by 2025	Percent complete of implementation of FIMP elements
Public Safety / Reliability	Eliminate large overpressure events by 2018	Number of large overpressure events per year
Public, Employee & Contractor Safety	Complete physical security upgrades at critical facilities by 2021	Progress of program to perform security upgrades at critical facilities
Public Safety	Implement corrosion monitoring programs to enhance existing programs by 2018	Execution of execution of expense and capital programs to mitigate corrosion risks
Public Safety / Reliability	Develop action plan for the "extent of condition" issues by 2017	Number of CAP items related to construction or fabrication issues
Public Safety / Reliability	Accomplish Obsolescence Management by maintaining the turnover of the fleet to 60 years	Number of station re-builds
Employee & Contractor Safety/Reliability	Complete Critical documents defined by TD-4551S by 2019 for Transmission, and by 2024 for Distribution	Percent complete of Critical Documents project
Public, Employee & Contractor Safety	Evaluate 100% of Transmission Total Station Features by end of 2019	Percent complete of Transmission Total Station Features

Public, Employee & Contractor Safety / Reliability /Affordability	Implement program to improve visibility of condition and criticality of Distribution stations by 2018	Percent complete of condition assessment for Distribution stations

PG&E has developed the following programs to meet these strategic objectives, using the aforementioned risk-based investment strategy to address both enterprise and asset level risks, meet compliance requirements and maintain asset condition. Appendix P presents an overview of the M&C 5-year plan. Program descriptions are provided in Section 4.1.

4.1 Strategic Objectives, Programs and Mitigations Alignment

The following programs have been identified and developed to meet the strategic objectives using the aforementioned risk-based investment strategy to address both enterprise and asset level risks, meet compliance requirements and maintain asset condition.

Table 9 - Programs and Mitigation Alignment with Strategic Objectives

Programs & Mitigations	Asset Family Strategic Objectives								
	Apply Facility Integrity Management principles to (T and/or D) all stations by 2025	Eliminate large overpressure events by 2018	Complete physical security upgrades at critical facilities by 2021	Implement corrosion monitoring programs to enhance existing programs by 2018	Develop action plan for the "extent of condition" study issues by 2017	Accomplish Obsolescence Management by maintain the turnover of the	Critical documents defined by TD-4551S are completed by 2019 (T) / 2024 (D)	Evaluate 100% of Transmission Total Station Features by end of 2019	Implement program to improve visibility of condition and criticality of Distribution stations by 2018
Engineering Critical Assessment (ECA) Phase 1	X							X	
Engineering Critical Assessment (ECA) Phase 2	X							X	
Hydrostatic Testing Station Facilities M&C	X							X	
Critical Documents	X	X			X	X	X		
Physical Security (expense work)	X		X						
Becker Upgrade (expense work)	X								
Gas Quality Practices Assessment M&C	X	X		X					
Routine Expense Spending	X	X		X		X	X	X	X
Physical Security (capital work)	X		X						
Perform Simple Station Rebuilds	X	X				X	X		
Perform Complex Station Rebuilds	X	X				X	X		
Perform Transmission Terminal Upgrades	X	X				X	X		
Gas Transmission Supervisory Control and Data Acquisition (SCADA) Visibility	X	X							
Replace Obsolete Bristol Controllers	X	X				X			

Programs & Mitigations	Asset Family Strategic Objectives								
	Apply Facility Integrity Management principles to (T and/or D) all stations by 2025	Eliminate large overpressure events by 2018	Complete physical security upgrades at critical facilities by 2021	Implement corrosion monitoring programs to enhance existing programs by 2018	Develop action plan for the "extent of condition" study issues by 2017	Accomplish Obsolescence Management by maintain the turnover of the	Critical documents defined by TD-4551S are completed by 2019 (T) / 2024 (D)	Evaluate 100% of Transmission Total Station Features by end of 2019	Implement program to improve visibility of condition and criticality of Distribution stations by 2018
Replace Obsolete Limitorque Valve Actuators	X	X				X			
Electrical Upgrades Program	X	X				X			
Becker System Upgrades	X	X							
Routine Capital Spending	X	X				X			X
Hard-to Turn Valve Replacement Program	X	X							
Preventive Maintenance Program	X	X							
Condition Metrics and Operating Data	X	X							
Cybersecurity Measures	X	X		X			X		
Guidance Documents	X	X			X				
Station Design Standardization	X	X			X				
Training	X	X		X	X				
External Corrosion Control (Coatings, CP, ECDA)	X								
Process Safety	X	X			X				
Install Meter Stations at 3rd Party Facilities	X								
SCADA Visibility Distribution	X	X							X
HPR Program	X	X							X
District Regulation Station Rebuild	X	X				X			X
District Regulation Station Component / Partial Rebuilds	X	X				X			X

4.2 Programs and Mitigations Overview

The timeframes for the programs and mitigations shown in Table 10are based on the proposed 2018 GT&S Rate Case targets as of the publish date of this Asset Management Plan.

Table 10: Program Summary, M&C Assets

Program: Engineering Critical Assessment (ECA) Phase 1
Scope: PG&E will perform an ECA - Phase 1 for its station facilities at the start of 2015. This work is preceded by a record retrieval and document research project that started in 2013 and was substantially completed in 2014. The work carried out under ECA - Phase 1 will review and identify the issues that may compromise station asset integrity. ECA - Phase 1 represents a comprehensive and fundamental element of improving asset knowledge. This project will help identify situations that require additional risk mitigation, or changes to equipment or operations to achieve compliance, and will help prioritize downstream projects of ECA - Phase 2 and Hydrostatic Testing.
Desired State: Identification of discrepancies that require mitigation
Risks Addressed: MC-26
Timeframe: 2014-2019
Responsibilities: FIMP
Program: Engineering Critical Assessment (ECA) Phase 2
Scope: The scope of this program will mitigate discrepancies identified during the ECA Phase 1 program. This program will begin in 2015 and continue through 2018. ECA Phase 2 will use techniques such as determination of material property via non-destructive and destructive testing, fatigue life calculations and other evaluations that can substitute for a pressure test. The program may include small scale pipe or component replacement when the cost and/or operational impact of replacement is more favorable than the cost and/or operational impact created by station hydrostatic testing.
Desired State: Minimize the number of discrepancies that must be mitigated through pressure testing
Risks Addressed: MC-26
Timeframe: 2015-2019
Responsibilities:FIMP
Program: Hydrostatic Testing Station Facilities M&C
Scope: This program provides for the hydrotest of sections of pipe within M&C facilities that require it. . The full scope will be limited to stations/sections that require testing after ECA Phase 1 identifies risks that cannot be successfully mitigated by ECA Phase 2. This program will extend beyond the 5-year period

Desired State: Mitigate discrepancies remaining after completion of ECA Phase 1 and Phase 2 work
Risks Addressed: MC-26 , MC 28
Timeframe: 2018-2037
Responsibilities: Gas Operations
Program: Critical Documents
Scope: PG&E has developed and implemented a Utility Standard (TD-4551S) for the critical drawings that are required for each individual station based on the complexity of the operations at the station. Beginning in 2012, this program is expected to be completed by 2017 .
Desired State: Compliance with the requirements of TD-4551S
Risks Addressed: MC 1-9, MC 10.1, MC 11, MC 26
Timeframe: 2012-2017
Responsibilities: FIMP
Program: Physical Security (capital and expense work)
Scope: This program has been developed in order to implement physical security measures at large station facilities. Many of the critical defined Transportation Security Agency (TSA) facilities have been outfitted with security technology, including alarms, access systems and cameras. However, even with these security enhancements, additional security measures will be required in the future to meet a changing threat/risk. Projects moving forward would include a Security Vulnerability Assessment, performed by Lawrence Livermore National Lab, similar to the assessment being conducted at Metcalf substation, to clearly identify mitigation measures to address small arms, Improvised Explosive Devices and protection of other critical components associated with gas delivery. Security enhancements would include dedicating easement for a buffer zone, utilizing barriers to prevent vehicle attacks, including Vehicular Improvised Explosive Devices (VIEDs), deploying new radar/thermal imaging technology to identify threats outside the fence line, measures to protect communication/operating systems from physical attacks and utilizing ballistic protection around critical components. Also, the security enhancement would be deployed outside the facilities to improve protection of exposed transmission pipe, valves, and related communication systems.
Desired State: Reduced vulnerability of critical infrastructure to terrorist-type attacks
Risks Addressed: MC 30
Timeframe: 2015-2020
Responsibilities: Gas Operations

Program: Becker System Upgrades Expense and Capital
Scope: PG&E has created a program to investigate and correct issues with improper ventilation of Becker cabinets, and issues with quality control with Becker valves and controllers. Most Becker power gas systems and control valves are slated for replacement due to deficient design / performance. (This program will be completed within the 5-year period.)
Desired State: Find and fix problems with existing installations
Risks Addressed: MC 15, MC 18-20, MC 24, MC 35
Timeframe: 2015-2019
Responsibilities: Gas Operations
Program: Gas Quality Practices Assessment
Scope: This program has been established in order to ensure the quality of gas that is entering the PG&E system by combining new and existing PG&E activities in the area of Gas Quality into a single comprehensive program. Gas Utilities in California are required to employ "best practices" when conducting their operations. Evaluation of significant industry events such as the natural gas pipeline rupture and fire near Carlsbad, New Mexico in August of 2000 have identified the existence and effective execution of a comprehensive gas quality as a best practice.
Desired State: Comprehensive program document
Risks Addressed: MC 15 through 24, MC 29
Timeframe: 2015-2016
Responsibilities: FIMP
Program: Routine Capital and Expense Spending
Scope: These programs include on-going programs and projects to maintain and operate the system, such as: o Existing on-going programs o Routine equipment replacement such as valve and actuator replacements. o Small capital and expense projects, typically less than $1 million each.
Desired State: Current levels of service and reliability are maintained
Risks Addressed: All
Timeframe: On-going
Responsibilities: Gas Operations

Program: Perform Simple Station Rebuilds
Scope: The current plan includes a total of 6 rebuilds of pressure regulating facilities that have simple controls and operation in 2015, and then 8 per year thereafter. It is anticipated that all piping, manual valves, control valves, pipe supports, and control systems will be built in a new facility adjacent to the current facility. (This program is on-going to sustain the fleet of simple station assets and maintain asset health. This program will extend beyond the 5-year period.).
Desired State: Maintain targeted pace of station rebuilds
Risks Addressed: MC 15, MC 18, MC 20, MC 23,
Timeframe: 2015-2020
Responsibilities: Gas Operations
Program: Perform Complex Station Rebuilds
Scope: The current plan includes a total of 10 rebuilds per year of pressure regulating and metering facilities that have complex controls and operation in 2015, and then 2 per year thereafter over the life of the program. It is assumed that all of the replacement work will be performed within the existing fence line. Piping, manual valves, control valves, metering equipment, pipe supports, and SCADA equipment within the station block valves may be replaced, as warranted. (This program is on-going to sustain the fleet of complex stations and maintain asset health. The program will extend beyond the 5-year period.)
Desired State: Maintain targeted pace of station rebuilds
Risks Addressed: MC 15, MC 18-20, MC 24, MC 35
Timeframe: 2015-2020
Responsibilities: Gas Operations
Program: Perform Transmission Terminal Upgrades
Scope: The current plan includes a program to upgrade existing transmission terminals. It is assumed that all of the replacement work will be performed within the existing fence line. Piping, manual valves, control valves, metering equipment, pipe supports, and SCADA equipment within the station block valves may be replaced, as warranted. (The three terminal stations will have completed major rebuilds by the end of the 5-year period. This program will not extend beyond the 5-year period, but station rebuilds will be re-assessed in the future to avoid asset obsolescence and aging.).
Desired State: Complete major rebuilds
Risks Addressed: MC 15, MC 18-20, MC 24, MC 35
Timeframe: 2015-2020
Responsibilities: Gas Operations

Program: SCADA Visibility Transmission and Distribution
Scope: This program installs additional pressure and flow measurement sensors that will be connected to PG&E's Gas Transmission and Distribution Supervisory Control and Data Acquisition (SCADA) systems. The new data points will provide additional information needed to enable asset health and performance monitoring, improve gas control, and provide low point pressure monitoring of pipelines with significant elevation change. This program will also provide enhanced valve control capability for gas control operators to improve operating flexibility and enable them to more quickly respond to inadvertent valve closures within stations. (This program will extend beyond the 5-year period.)
Desired State: Complete planned additions
Risks Addressed: MC 1-9, MC 10.1, MC 11
Timeframe: 2015-2020
Responsibilities: Gas Operations
Program: Replace Obsolete Bristol Controllers
Scope: A program has been established to replace these obsolete units that have limited parts and service support and have reached the end of their useful lives. The actuators will also be replaced in addition to the controllers. It is anticipated that 12 actuators and controllers will be replaced per year over the life of the program, with an average of 3 replacements per location. The new controllers will be manufactured by Becker Industries, Inc. or equivalent
Desired State: Replace existing Bristol Controllers
Risks Addressed: MC 15, MC 18-20, MC 24, MC 35
Timeframe: 2015-2017
Responsibilities: Gas Operations
Program: Replace Obsolete Limitorque Valve Actuators
Scope: A program has been established to replace these obsolete units that have limited parts and service support and have reached the end of their useful lives. It is anticipated that 12 actuators will be replaced per year over the life of the program, with an average of 3 replacements per location. The actuators to be replaced are gas-powered piston-type units for 24-inch ball valves, on average.
Desired State: Replace existing obsolete Limitorque actuators
Risks Addressed: MC 15, MC 18-20, MC 24, MC 35
Timeframe: 2015 - 2017
Responsibilities: Gas Operations

Program: Electrical Program
Scope: This program has been established to address electrical area classification deficiencies. The scope of work includes piping, electrical, and mechanical modifications as warranted; estimate is based on a 100' x 100' M&C facility; 2 instrumentation panels to be relocated a minimum of 10ft; 10 instrumentation devices to be replaced; 10 two-inch diameter piping vent stacks to be re-routed
Desired State: No remaining classification deficiencies
Risks Addressed: MC 15, MC 18-20, MC 23-24, MC 35
Timeframe: 2012-2017
Responsibilities: Gas Operations
Program: Hard-to Turn Valve Replacement Program
Scope: This program has been established to identify valves that are hard-to-turn and systematically remove and replace. The costs for this program are captured in the Transmission Pipeline plan. (This is an on-going program to maintain the valve assets and will continue beyond the 5-year period.)
Desired State: Improve operability
Risks Addressed: MC 15-24, MC 35
Timeframe: On-going
Responsibilities: Gas Operations
Program: Preventive Maintenance
Scope: This program has been established to ensure that our preventative maintenance programs continue to meet or exceed code requirements and are consistent with best industry practices. The costs for this program are included in the District / Division maintenance budgets. This is an on-going program and will continue beyond the 5-year period.
Desired State: Minimize corrective maintenance backlog and deferred maintenance
Risks Addressed: MC 15-24, MC 35
Timeframe: On-going
Responsibilities: Gas Operations

Program: Cyber Security
Scope: Implement cyber security for all GT assets. Cyber security standards have been created because sensitive information is stored on computers that are attached to the Internet. Also, many tasks that were once done by hand are carried out by computer; therefore there is a need for Information Assurance (IA) and security. Applicable security management practice standards will be utilized in the development and implementation of this program. This program is on-going to address 3rd party threats and will continue past the 5-year period.
Desired State: Recommended actions for protecting critical data and systems
Risks Addressed: MC 30
Responsibilities: Gas Operations
Program: Guidance Documents
Scope: This program has been developed to ensure that comprehensive reference and guidance documentation is available or specifically prepared for all applicable processes that encompass the work performed by the M&C asset family. This includes applicable Utility Standards; methodology for compliance with federal and state codes and standards; applicable API, ASME, ANSI and other trade association and industry standards; engineering and design standards; recommended equipment operation and maintenance reference documents; and all other applicable documentation. Costs for this program will be captured in the operating plan of the Codes and Standards group.
Desired State: Guidance documents that have sufficient detail to ensure safe operation and maintenance of M&C asset components
Risks Addressed: MC 1-9, MC 10.1, MC 11-24, MC 35
Timeframe: On-going
Responsibilities: Gas Operations
Program: Station Design Standardization
Scope: This program has been developed to ensure consistency between M&C engineering and design work; to ensure that designs comply with applicable regulations and employ best safety practices; to ensure cost-effective design methodology; to provide uniformity in selection of equipment; and to streamline required training and operation & maintenance of installed systems. The Gas Transmission Engineering & Design Manual is being developed to accomplish these objectives. The costs for development of this manual are captured in the operating plan for the Engineering & Design Group.
Desired State: Published set of station design standards and guides
Risks Addressed: All
Timeframe: 2018
Responsibilities: Gas Operations

Program: Training
Scope: This program has been established to ensure that the training regimens for District / Division and engineering personnel are comprehensive, cover operation and maintenance requirements of all applicable equipment, and reflect best industry practices. The costs for this program are included in the individual PCC Standard Rates. This program is developed to ensure training of personnel and will be on-going past the 5-year period.
Desired State: Maintenance personnel have the necessary training to safely operate and maintain M&C assets
Risks Addressed: MC 1-9, MC 10.1, MC 11
Timeframe: On-going
Responsibilities: Gas Operations
Program: External Corrosion Control (Coatings, Cathodic Protection (CP), External Corrosion Direct Assessment (ECDA))
Scope: This program has been established to ensure that adequate coatings are present on equipment at M&C facilities. This program provides a methodology to inspect coatings on aboveground equipment, vessels and piping and provides for recoating these facilities as warranted. These costs are captured in the Integrity Management plan for Transmission and Distribution assets. (This is an on-going maintenance program that will extend past the 5-year period to properly maintain assets.)
Desired State: Implementation of structured corrosion monitoring program for stations
Risks Addressed: MC 25, MC 25.1
Timeframe: On-going
Responsibilities: Gas Operations
Program: Process Safety
Scope: This program is designed to ensure that safety is incorporated in all of the engineering and design work performed by the M&C asset family. This will include measures such as performing HAZOP reviews on process designs. A pilot program to ensure that safety is embedded in our designs has been established for the McDonald Island Whisky Slough Station Rebuild project. The costs of these process safety improvements are typically captured at the project level. This program is on-going and processes will be continually updated to meet regulatory and technology changes. This program will extend beyond the 5-year period.
Desired State: Process safety elements integrated into facility designs
Risks Addressed: MC 1-9, MC 10.1, MC 11-24, MC 35
Timeframe: On-going
Responsibilities:

Program: Install Meter Stations at 3rd Party Facilities
Scope: This program has been established to design and construct a meter station at various 3rd party facilities over the next 5 years. It is anticipated that the typical meter station will include an Ultrasonic meter, gas chromatograph, filters, valves, piping, ground grid, separate fenced area and other ancillary equipment. (This program will be ongoing and will extend beyond the 5-year period.)
Desired State: Properly functioning meter stations at 3rd party facilities
Risks Addressed: None
Timeframe: On-going
Responsibilities: Gas Operations
Program: HPR Program
Scope: This initiative is performed to mitigate risk of over-pressurization of downstream piping and reduce gas leaks. Accelerated gas transmission leak surveys identified a significant number of leaks associated with HPR sets. This initiative includes: 1) Elimination of the use of HPR Customer Sets wherever possible and redesign remaining sets (Redesign includes a bypass blind flanged versus hard pipe and a slam shut instead of a monitor valve). .
Desired State: Rebuild or replace HPR-type facilities
Risks Addressed: MC 37
Timeframe:2011-2023
Responsibilities: Gas Operations
Program: District Regulation Station Rebuild and District Regulation Station Component / Partial Rebuilds
Scope: Aging and obsolete equipment is a key threat area for the gas distribution M&C assets. As equipment ages and reaches the end of its service life, the probability it will either fail in service or become obsolete increases, which increases the risk of loss of service, reliability and over-pressure events. There are two methods for addressing conditions of obsolescence, condition and performance at a given station as part of an overall fleet management approach. These include targeted equipment/component replacement and station rebuilds. The capital expenditures within this program includes full station rebuilds (historically averaged about 10-15 per year) and replacement of failed or aging components (historically, about 55-85 projects per year). Full station rebuilds typically have been performed if the station vault(s) was/were in bad condition, piping needed to be replaced (e.g., severe corrosion),
Desired State: Manage the pool of assets to a replacement age of 60 years as a targeted pace.
Risks Addressed: MC 16-17, MC 21-22
Timeframe: On-going
Responsibilities: Gas Operations

5. Areas for Continuous Improvement

The M&C asset family has made significant progress since the last version of the Asset Management Plan was published in August of 2015. Highlights of these improvements include the following items:

- Frame work for Facility Integrity Management Program (FIMP) has been established and associated Maturity Model has been developed (Section 4)
- Electrical Principal Engineer has been hired to develop electrical maintenance procedures at large M&C facilities
- Implemented a program approach to mitigate risks to employees performing work on energized electrical equipment
- Created a standing Electrical Safe Work Practices team with a goal of developing, implementing and maintaining a comprehensive electrical work safety program
- Inventoried and corrected deficiencies related to insulated tools and appropriate Personal Protective Equipment (PPE) at all districts
- Implemented program to install enhanced physical security upgrades at critical M&C facilities (Section 4)
- Completed seismic assessments at Milpitas terminal
- Performed global benchmarking study with companies from Europe, North America, and South America to identify best practices for management of M&C assets
- Seeing more consistent year-to-year scoring of P95 and Enterprise M&C risks in Session D process
- Competed review of Strength Test Pressure Reports (STPRs) for M&C facilities via the ECA 1 project
- Completed ECA 1 pre-work (records collection) for components at M&C facilities
- Performed Critical Document upgrades at pilot M&C facilities
- Performed control assessments at M&C complex facilities

There are some areas in the asset management plans that have not been fully built out at this stage; these are highlighted in Table 11 below. These are areas that will continue to evolve and improve as more thorough data sets and understanding of asset condition are developed over time.

Table 11 – Areas for Continuous Improvement

Areas for Continuous Improvement
Performance Metrics • Refine leading and lagging performance indicators in order to measure, monitor and report on asset performance and condition
Repair vs. Replace • Documented criteria and decision-making when repairing vs. replacing a component

Areas for Continuous Improvement

Asset Health Scorecard

- Develop a new LOB-wide tool that will be used by all asset families; will be a "single source" of information based on data from multiple systems; and will help establish, implement and maintain process(es) and/or procedure(s) to monitor and measure the performance of the asset management system and the performance and/or condition of assets and/or asset systems.
- Replace the one-time, snapshot M&C asset health scorecards developed as part of the site visit condition assessments with a living tool that will be developed based on the metric requirements in Section 4.

Data Collection / Structure / Validation Areas of Need

- Development of credible asset register and development of asset hierarchy with taxonomy in accordance with ISO 14224 guidelines
- More comprehensive data assessment and identification of gaps in existing data
- Develop programs/processes to address data gaps
- Coordinate more with TIMP and DIMP. This program routinely gathers and retains information related to M&C assets
- Refresh of current asset register information to validate existing asset information in SAP
- Update of maintenance processes to ensure that maintenance data is captured in a consistent and meaningful way for analysis
- Increased use of the material problem reporting system to collect data on equipment to improve analysis and mitigation for problem equipment
- Need for on-going identification of obsolete equipment to inform the need for replacement programs
- Review of the design and construction processes to ensure that new equipment is consistently identified and captured into the asset register and maintenance management system of SAP
- Need to establish a means to automate capture of functional performance data for use in defining "functional performance" health metric
- Need to establish a means to capture component physical condition information for use in defining "physical condition" health metric
- This information was identified during the condition assessment as required to define component, system, and station health and risk. The data collection activities will be a key element of attention moving forward.
- The update of key documents is also required and this program is already included as the "critical documents", "ECA Phase 1 and Phase 2", and "Hydrostatic Testing Station Facilities M&C" programs defined in Section 4.1. Table 12 - Programs, Mitigation and Strategic Objectives

Investment Plan

- Prepare large facility investment plan (terminals and large facilities)

Personnel Implications

- Additional personnel/hours will be needed to develop and implement data quality issues resolution process
- Identify development plans for subject matter experts to ensure their skills/expertise remain

Areas for Continuous Improvement
current • Identify succession plans for subject matter experts and begin skill/expertise development for successor
Risk Analysis • The initiation of a quantitative risk analysis process will be developed to build on the condition health scoring model • The risk analysis is intended to be performed at a system and station level so that improved information will be available to populate the risk register • **Develop a strategy for replacement of low pressure regulation stations**
Management of Change (MOC) Process • A management of change process is required to identify, capture, and update key asset data from changes due to construction and maintenance. This change process will affect multiple organizations that manage and communicate the asset information. The management of change process will be developed and implemented for the M&C asset family. • As part the Facility Integrity Management Program, a pilot program is under development using the MOC procedure that has been developed by the Station Assessment group. The pilot program will consist of the development of an obsolescence management program using this MOC protocol.

Transmission Projects and Programs
• The physical condition deterioration (extensive rust or possible corrosion) of the vaulted station indicates the need for specific programs or actions in the future. These include:
  • Reconsideration of the maintenance approach to these stations relative to dewatering frequency, inspection frequency or possibly water monitoring in the vaults
  • Development of a painting and coating program to minimize rust and corrosion of the system
  • Identification of specific stations to the corrosion group for analysis for other activities (such as rebuilds), coatings or other remedial actions
• Additional programs are required to address other condition issues with the stations including:
  • Performance of control assessments to verify station regulation at identified Category A stations
  • Repair of identified deteriorated support conditions
  • Identification of obsolete equipment and development of the appropriate obsolescence programs

Distribution Projects and Programs (In progress but still needing improvement) • Improve visibility through on-going installation of SCADA at Distribution regulating stations • DIMP Matrix to provide repair/replace criteria • Distribution Low Pressure Vents • Distribution Vault Vent • Distribution Vault Ladders
Gas Quality Programs and Projects • Additional programs and projects that may result from Gas Quality Practice Assessment described in Section 4, above.

Appendices

Appendix	Title
A	Related Documents
B	Threat Matrix and Key Threats
C	Asset Family Risks
D	Stakeholder Roles and Responsibilities Matrix
E	Summary of Integrated Programs
F	Glossary of Acronyms and Abbreviations
G	Change Log
H	M&C Station Asset Photographs
I	Station Condition Health Scoring Criteria
J	M&C Station Condition Health Target Score Criteria
K	Station Condition Health Scores
L	M&C Stations Consequence of Failure (COF) Matrix
M	M&C Station Groupings for Risk Assessment
N	GRC White Paper
O	Gas Quality Monitoring

A. Related Documents

The following table lists documents associated with this asset management plan.

Table 12 - Related Documents

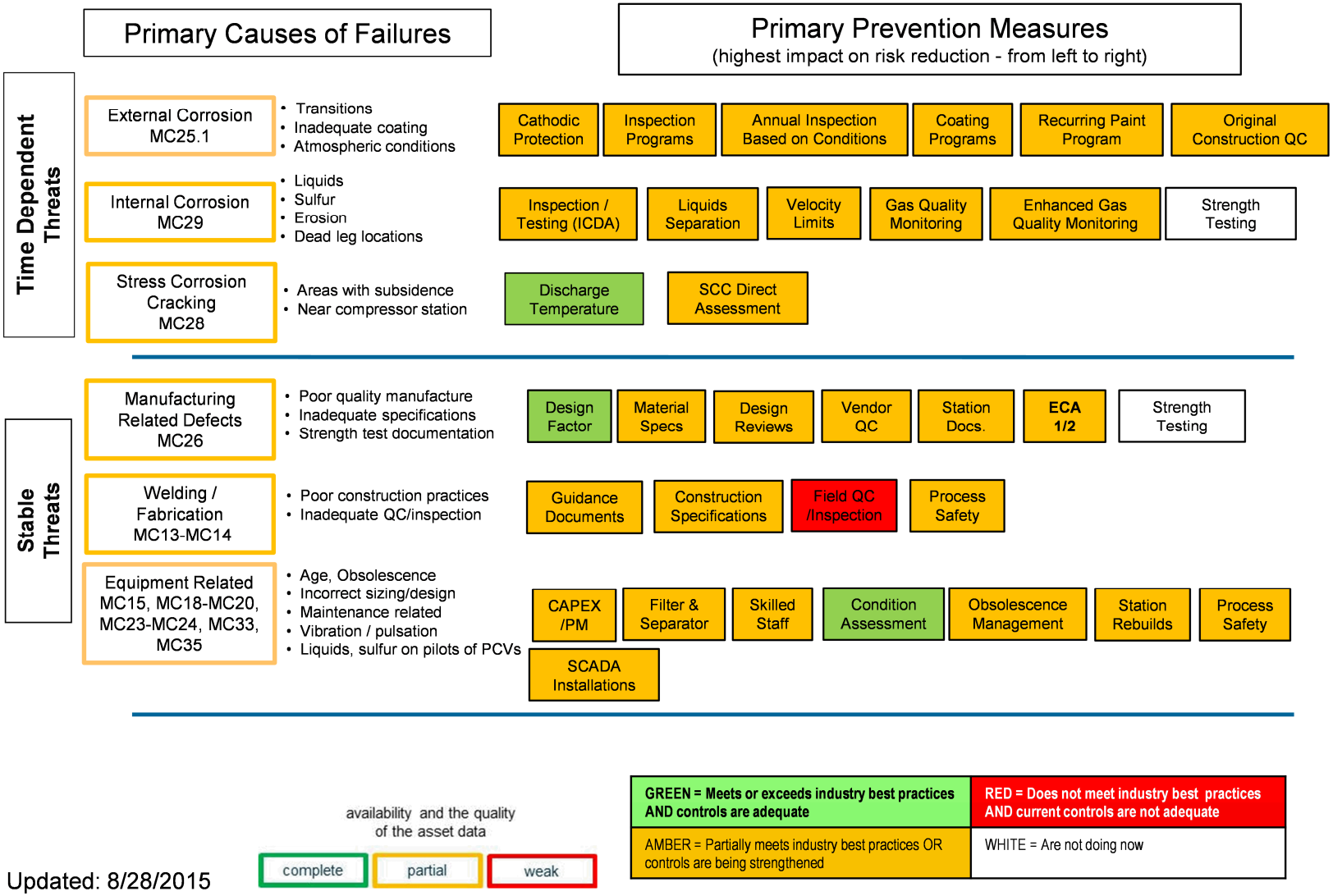
Related document	Document Number / Description	Link
Measurement & Control Risk Register	The risk register captures all risks outlined in this plan at the data of publish	http://gasrisk/
Asset family investment planning forecast	Retained by investment planning for S1 and S2 planning purposes.	Contact Investment Planning
Enterprise and Operational Risk Management Standard and Procedures	RISK-5001S, RISK-5001P-01, RISK-5001P-02, RISK-5001P-03	http://pgeatwork/Guidance/RiskCompliance/Pages/default.aspx
Gas Asset Management Policy	TD-01	TD-01
Gas Operations Asset Management System Risk Management Standard and Procedure	TD-4011S, TD-4011P-01	TD-4011S and TD-4011P-01
Gas Operations Risk and Compliance Committee Charter	GOV-1021S	http://pgeatwork/Guidance/Governance/Pages/default.aspx
Asset Management Strategy and Objectives	GP-1100	Gas Safety Plans / Asset Management
Transmission Asset Management Plan	GP-1101	
Distribution Mains and Services Asset Management Plan	GP-1102	
Customer Connected Equipment Asset Management Plan	GP-1103	
Compression and Processing Asset Management Plan	GP-1105	
LNG/CNG Portable Supplies Asset Management Plan	GP-1106	
CNG Station Asset Management Plan	GP-1107	
Gas Storage Asset Management Plan	GP-1108	

B. Threat Matrix and Key Threats

The threat matrix below displays threats, drivers, and mitigations associated with this asset family. The threats are outlined with a red, amber, or green status denoting the current availability and quality of asset data. The mitigations are color coded with white, red, amber, or green status to display how it currently compares to industry best practices as well as the strength of the controls. The color coding is assigned based on three factors:

1. Compliance Performance (e.g., has PG&E experienced any Notices of Violation (NOVs) or self-reports related to this mitigation?)
2. Benchmarking (e.g., does the mitigation meet or exceed industry best practices?)
3. Pace (e.g., is the mitigation funded to address the risk at an adequate pace?)

Threat Matrix (Measurement and Control) - Transmission



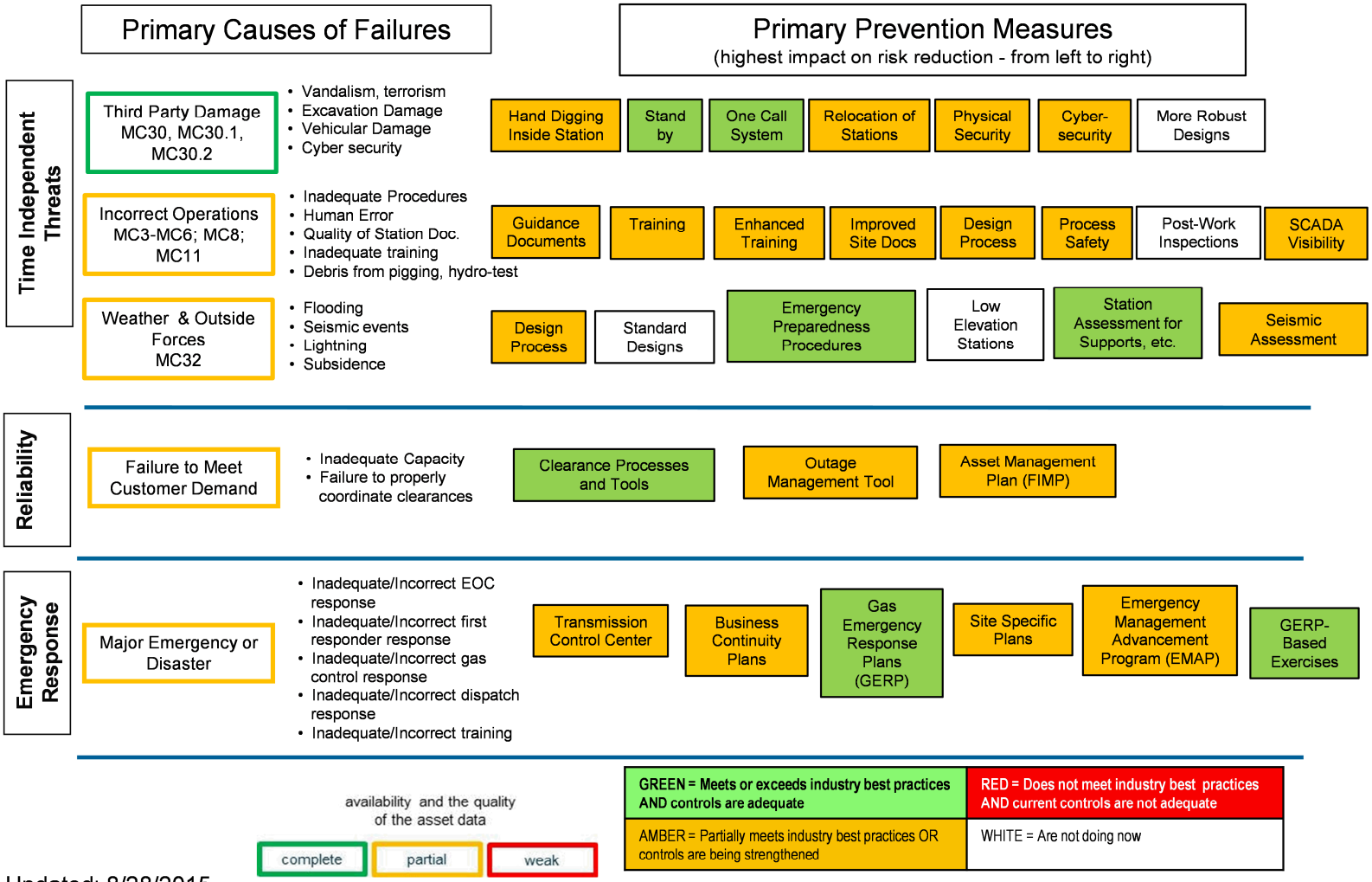
availability and the quality of the asset data

complete | partial | weak

GREEN = Meets or exceeds industry best practices AND controls are adequate	**RED = Does not meet industry best practices AND current controls are not adequate**
AMBER = Partially meets industry best practices OR controls are being strengthened	WHITE = Are not doing now

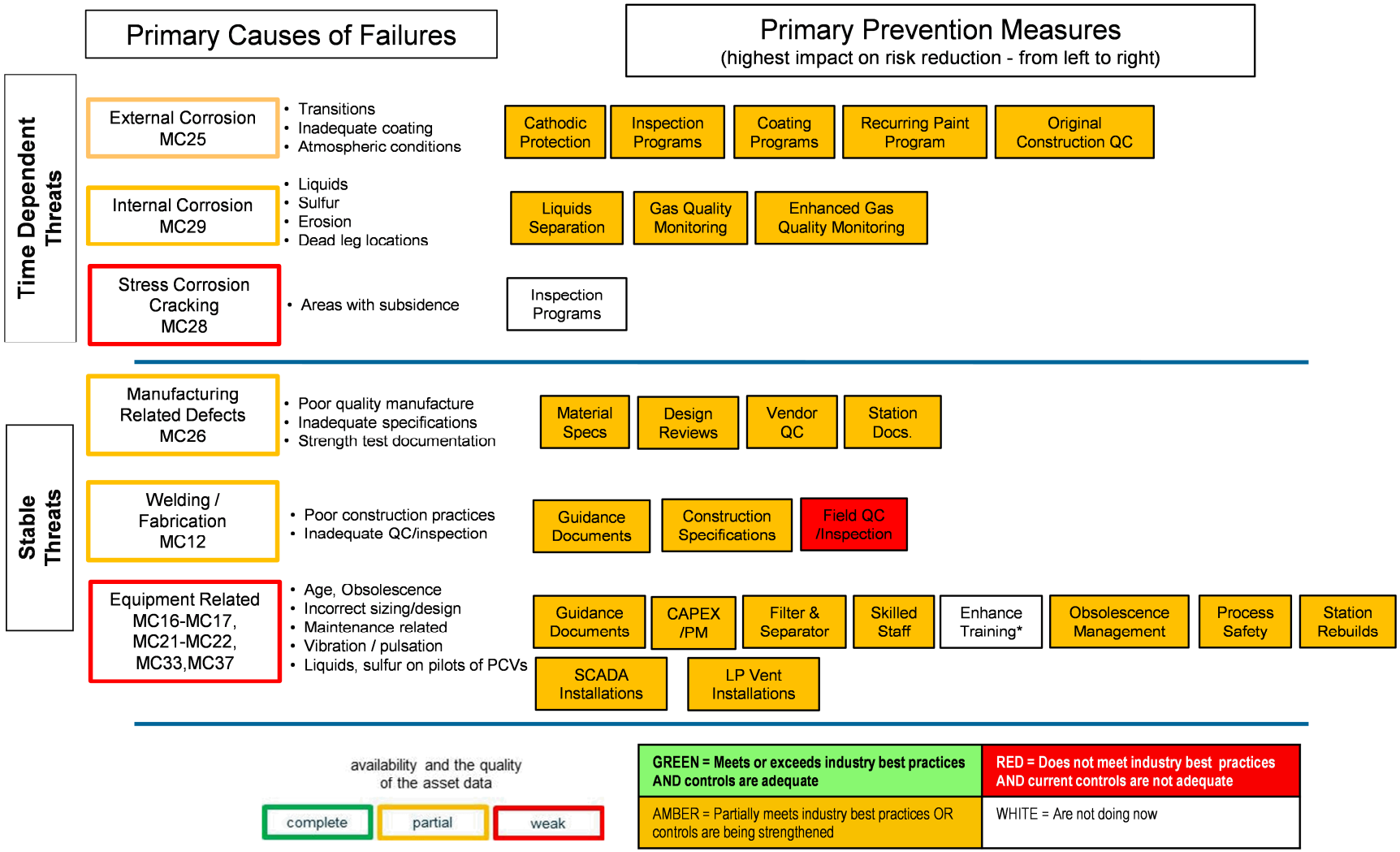
Updated: 8/28/2015

Threat Matrix (Measurement and Control) - Transmission



Updated: 8/28/2015

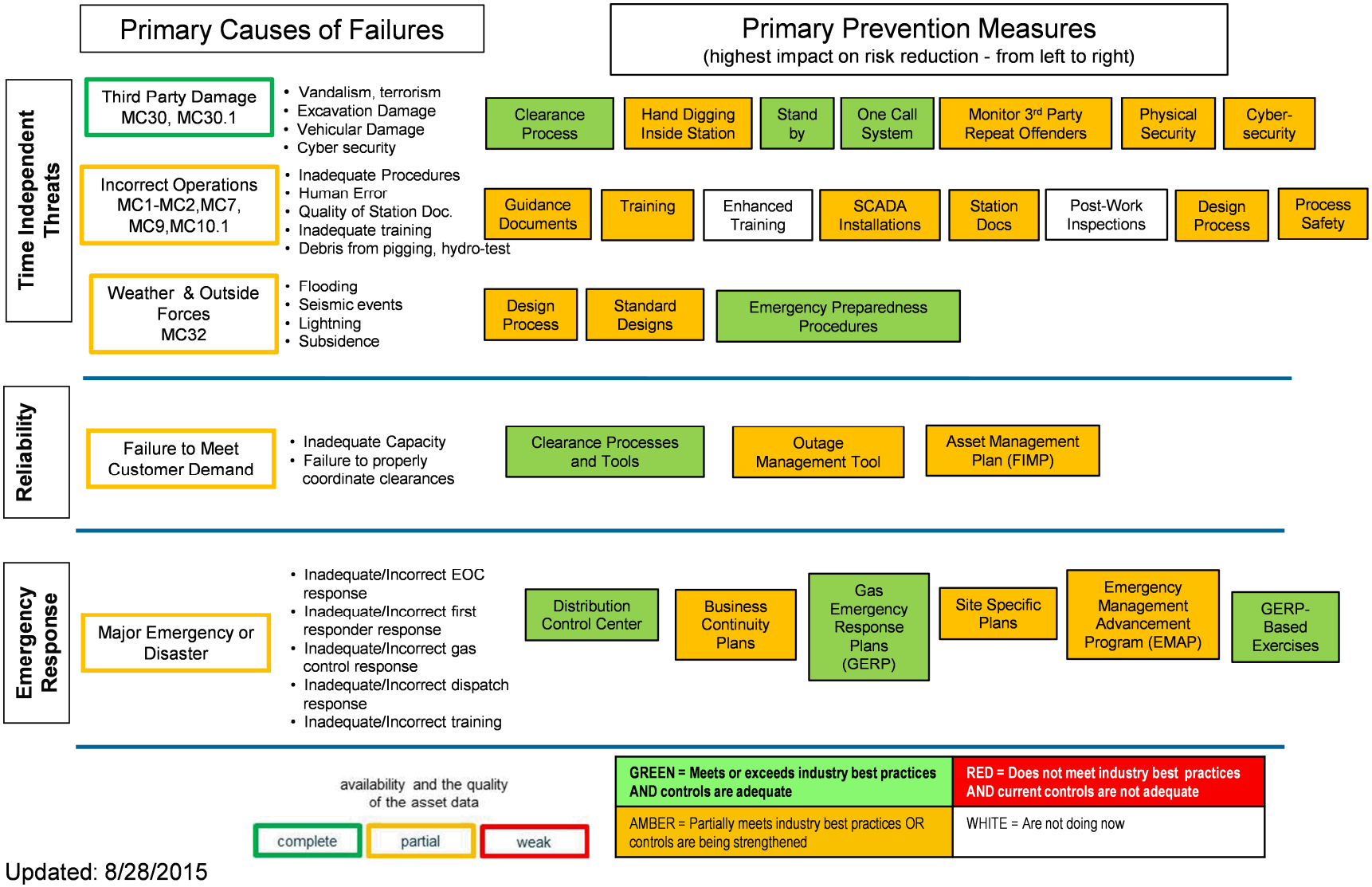
Threat Matrix (Measurement and Control) – Distribution



Updated: 8/28/2015

* Box is "white" because evaluation by Asset Family has not been completed.

Threat Matrix (Measurement and Control) – Distribution



Updated: 8/28/2015

External Corrosion
Material deterioration from external corrosion may cause leaks and potential failure of piping and equipment resulting in loss of pressure and in potential customer outages. External corrosion risks are produced by deterioration of material over time due to external environmental conditions. There are currently identified issues from prior assessments that indicate issues with material corrosion, support condition, and concrete condition at selected stations that will result in the need for station rebuild or refurbishment.

Internal Corrosion
Material deterioration from internal corrosion may cause leaks and potential failure of station piping and equipment resulting in loss of containment resulting in potential safety issues and/or customer outages. Internal corrosion risks are produced by deterioration of material over time due to impurities in gas or fluids in the station piping.

Manufacturing Related Defects
There is an increased focus on identifying and addressing possible manufacturing related threats affecting piping in gas transmission stations, including compressor stations and processing facilities. The extent of the threat is currently unknown, but specific initiatives to scope and mitigate the threat and attendant risk are included as part of this asset management plan. By the end of 2014, PG&E will have completed its preliminary research of facility documentation to consolidate and review its traceable, verifiable, and complete records. This systemic review of all M&C stations will generate detailed asset lists that will enable the following downstream programs to begin after 2014:

- Engineering Critical Assessment (ECA) Phase 1: Review station assets in an attempt to identify particular safety or compliance risks that require mitigation.
- ECA Phase 2: Mitigation of the risks identified by ECA Phase 1 without the need for hydrostatic testing. These methods will offer viable, yet-low risk alternatives that may include non-destructive or destructive testing, fatigue life calculations, and other evaluations that can substitute for a pressure test.
- Hydrostatic Testing: For risks that remain post-ECA Phase 2 that were unsuccessfully mitigated.

Welding / Fabrication Related
Risks due to construction or fabrication are related to inadequate installation of the station facilities resulting in potential premature equipment failure or operational difficulties. Additional risks are associated with the documentation and construction records not being sufficient or properly maintained to allow correct operation of the assets and/or to demonstrate compliance with regulatory requirements. This impact is similar to the manufacturing record risks and includes the ECA Phase 1, ECA Phase 2, and Hydrostatic Testing projects listed earlier in this subsection.

From a design perspective, during the past few years there has been significant loss of expertise in the station design group with key individuals taking on responsibilities outside of the project design function and many new engineers joining the group. The lack of a formal engineering design manual for Gas Transmission M&C Stations makes it difficult to train new engineers and ensure consistent design practices. Work towards creating a design manual is in

progress and should provide a good basis for training and design consistency. For Gas Distribution stations, there are design standards for district regulator stations, customer HPR sets and customer meter sets. This creates design consistency for new installations. The Gas Distribution field automation team is in the process of creating standardized designs and work execution processes for new SCADA monitoring and control sites. These standardized designs and processes are crucial to ensuring high quality installations.

Equipment
The equipment-related issues may lead to equipment failures that result from age, maintenance, and design which may lead to over-pressure excursions (which may produce failure of downstream assets) or under-pressure excursions (which may result in customer outages). There are potential impacts on safety, operations, reliability and financial performance associated with these threats. The key factors affecting equipment are:

- Age: Typical facility life expectancy for terminals, complex stations, and simple stations is in the order of 40-50 years and there is a large population of assets above this age. This condition may result in additional maintenance, unavailable parts for obsolete equipment, and extended outage time. While maintenance and replacement of parts can extend asset life, the aging of the asset population indicates potential for future problems.
- Design configuration: There are some older stations that were built for one specific use in the system and the functionality of the station has changed without major configuration changes to the system. These stations are in need of redesign or reconfiguration to ensure proper operation control and maintenance.
- Maintenance: There are indications of overdue discretionary maintenance that can result in more rapid component deterioration and wear. There are reports of insufficient trained staff to inspect and maintain all assets. The effect of this situation will result in ineffective application of the maintenance program.
- Low Pressure Distribution Vault Flooding: The potential for equipment (regulator) malfunction due to vault flooding will produce overpressure excursions affecting integrity of downstream assets.

Third-Party / Mechanical Damage
Damages from third parties relate to security surrounding the stations. Typically, the most common type of 3rd party damage is dig-ins. Dig-ins is prevented at facilities by preventing 3rd party access to the facilities. These dig-in occurrences are not common at stations; however, mitigation actions being developed across the system will be reviewed for incorporation into the M&C asset plans. Additional cyber security breaches and vandalism pose additional risks on the system. PG&E has historically implemented mitigative measures to improve physical security at critical gas transmission facilities. Upgrades have been made in compliance with internal PG&E standards based on TSA guidelines. With convergence of information technology and control systems such as SCADA and process control, the threat of third party damage is necessarily expanded to include risk of unauthorized operation along with loss of service and reliability due to cyber security. This risk is currently managed through established IT processes governing design and access of databases and systems critical to operations.

Incorrect Operations
For the M&C Station asset family, the key risks are primarily those created by the effects of incorrect station operation on downstream piping systems. These incorrect station operations include those from both automated and manual operations of station equipment. The two key risk areas are loss of containment in a downstream piping system caused by the failure to properly limit the pressure of gas supplied into that system, and customer outages from a loss of gas supply to a downstream system caused by the flow through the station being shut-off or severely restricted.

There is also considerable work being done in the area of enhancing, simplifying and clarifying M&C Station maintenance and operating standards, and then utilizing these standards as a basis for training. The expertise level of personnel maintaining M&C stations is an identified weak area, especially as more complex monitoring and control equipment is being installed. This was specifically identified as a corrective action area by the Overpressure Events Elimination initiative. In progress enhancements to the standards and training program will significantly strengthen this opportunity area.

Weather Related and Outside Forces
The risks from weather and outside forces are the potential equipment damage during earthquakes resulting in equipment failure and loss of containment or pressure downstream resulting in potential safety issues and/or customer outages on both the transmission and distribution systems.

BTU Heating Value
Providing customers with gas that exceeds the BTU limits established in the Chico areas causing potential appliance malfunctions with potential carbon monoxide production, appliance over-heating, and possible release of unburned gas.

Records Management – Inadequate Records
The risk of not having an effective records management program may result in the failure to construct, operate and maintain a utility system safely and prudently.

C. Asset Family Risks

Table 13 – M&C Risks and Interdependencies

Risk ID	Threat	Risk	Interdependencies with Other Risks
MC004	Incorrect Operations - Simple/Complex or Terminal Stations	The risk of an overpressure event caused by incorrect operation of a local transmission complex station or terminal station may result in failure of downstream assets with loss of containment	N/A
MC032	Weather Related/Outside Forces - Seismic	The risk of failure of a station to perform its pressure control function from flooding or seismic impact of greater than 6.7 magnitude causing downstream under or over-pressure events.	N/A
MC006	Incorrect Operations - Backbone (PLS) Stations	The risk of an overpressure event at complex stations (backbone / PLS stations) caused by incorrect operations may result in damage to downstream assets with loss of containment	N/A
MC003	Incorrect Operations - LoC Simple Stations	The risk of an overpressure event caused by incorrect operation of a local transmission simple station may result in failure of downstream assets with loss of containment	N/A
MC030	Third-Party/Mechanical Damage - Vandalism	The risk of failure of station piping from vandalism/terrorism damage causing may result in loss of containment	N/A
MC001	Incorrect Operations - LoC LP Distribution	The risk of an overpressure event caused by incorrect operation of low pressure distribution assets may result in failure of downstream assets with loss of containment	N/A
MC015	Equipment Related - LoC Complex/Simple Station	The risk of an overpressure event caused by equipment failure in a complex/simple station may result in failure of downstream customer assets with loss of containment	N/A

Risk ID	Threat	Risk	Interdependencies with Other Risks
MC016	Equipment Related - LoC LP Distribution	The risk of an overpressure event caused by equipment failure in low pressure distribution assets may result in failure of downstream assets with loss of containment	N/A
MC012	Welding/Fabrication - Overpressure Event	The risk of an overpressure event caused by design or fabrication issues with high pressure distribution assets may result in failure of downstream assets with loss of containment	N/A
MC030.2	Third-Party/Mechanical Damage - Train Derailment into Antioch terminal	The risk of significant station failure at Antioch terminal due to train derailment may result in loss of station and fatalities	N/A
MC014	Welding/Fabrication - Overpressure Complex Station	The risk of a loss of containment event caused by design or fabrication issues a local transmission complex station may result in fire or explosion at a complex station.	N/A
MC013	Welding/Fabrication - LoC Simple Station	The risk of a loss of containment event caused by design or fabrication issues a local transmission simple station may result in fire or explosion at a simple station.	N/A
MC019	Equipment Related - Backbone (PLS) Stations	The risk of an overpressure event at complex stations (backbone / PLS stations) caused by equipment failure may result in damage to downstream assets with loss of containment	N/A
MC018	Equipment Related - LoC Terminal or Complex/Simple Station	The risk of an overpressure event at a terminal or large complex station or simple/complex stations caused by equipment failure may result in damage to downstream assets with loss of containment	N/A
MC002	MC002 - Incorrect Operations - LoC HP Distribution	The risk of an overpressure event caused by incorrect operation of high pressure distribution assets may result in failure of downstream assets with loss of containment	N/A

Risk ID	Threat	Risk	Interdependencies with Other Risks
MC017	Equipment Related LoC HP Distribution	The risk of an overpressure event caused by equipment failure in high pressure distribution assets may result in failure of downstream assets with loss of containment.	N/A
MC025	External Corrosion	The risk of failure of vaulted station piping from external corrosion causing gas release with potential risk to public or employee safety.	N/A
MC025.1	External Corrosion	The risk of failure of transmission station piping from external corrosion causing gas release with potential risk to public or employee safety.	N/A
MC033	BTU Heating Value	The risk of providing customers with gas that exceeds the BTU limits established in the Chico areas may result in public safety	N/A
MC030.1	Third-Party/Mechanical Damage - Vehicular Damage	The risk of failure of station piping from vehicular damage may result in loss of containment	N/A
MC007	Incorrect Operations - LoS LP Distribution	The risk of an under-pressure event caused by incorrect operation of low pressure distribution assets with relight risks and unburned pilot gas at customer locations may result to loss of supply, downstream pressure cycles, and ignition	N/A
MC021	Equipment Related - LoS LP Distribution	The risk of an under-pressure event caused by equipment failure in low pressure distribution assets with relight risks and unburned pilot gas at customer locations may result to loss of supply, downstream pressure cycles, and ignition	N/A
MC037	Equipment Related Defects - Farm Taps	The risk of an overpressure event caused by equipment failure on farm taps may result in failure of downstream customer assets with loss of containment	N/A
MC029	Internal Corrosion	The risk of failure of station piping from internal corrosion causing loss of containment may result in public safety.	N/A

Risk ID	Threat	Risk	Interdependencies with Other Risks
MC028	Stress Cracking Corrosion	The risk of failure of station piping from stress cracking corrosion causing loss of containment may result in public safety.	N/A
MC009	Incorrect Operations LoS HP Distribution	The risk of an under-pressure event caused by incorrect operation of high pressure distribution assets with relight risks and unburned pilot gas at customer locations may result to loss of supply, downstream pressure cycles, and ignition	N/A
MC022	Equipment Related - LoS HP Distribution	The risk of an under-pressure event caused by equipment failure in high pressure distribution assets with relight risks and unburned pilot gas at customer locations may result to loss of supply, downstream pressure cycles, and ignition	N/A
MC024	Equipment Related - LoS Complex Station	The risk of an under-pressure event at complex station/terminal stations due to equipment failure may result in loss of supply and downstream pressure cycles.	N/A
MC011	Incorrect Operations - LoS Complex/Simple Station	The risk of an underpressure event at a complex/simple station caused by incorrect operations may result in loss of service impacting multiple customer locations	N/A
MC035	Equipment Related - Backbone (PLS) Stations	The risk of an underpressure event at a complex station (backbone / PLS stations) caused by equipment failure may result in loss of service impact to multiple customer locations	N/A
MC023	Equipment Related - LoS Simple Station	The risk of an under-pressure event at simple station due to equipment failure may result in loss of supply and downstream pressure cycles.	N/A
MC026	Manufacturing Related Defects	The risk of a pressure reduction or under-capacity event caused by insufficient station documentation to support MAOP validation with potential for relight risks and unburned pilot gas at customer locations may result in loss of service impacting multiple customer locations.	N/A

Risk ID	Threat	Risk	Interdependencies with Other Risks
MC008	Incorrect Operation - Terminal/Large Complex	The risk of an underpressure event at a terminal or large complex station caused by incorrect operations may result in loss of service impact to multiple customer locations	N/A
MC005	Incorrect Operations - Backbone (PLS) Stations	The risk of an underpressure event at a complex station (backbone / PLS stations) caused by incorrect operations may result in loss of service impact to multiple customer locations	N/A
MC020	Equipment Related - LoS Complex/Simple Station	The risk of an under-pressure event at complex/simple station due to equipment failure may result in loss of supply to a large customer facility.	N/A

D. Stakeholder Roles and Responsibilities Matrix

Stakeholders have been identified for each lifecycle stage. Stakeholders provide perspective and input for risk identification and assessment, and on programs to address risks. The quality of the input depends on the level of engagement by stakeholder groups. Key stakeholders for the Measurement and Control Asset Family are shown below.

Table 14 - Stakeholder Roles and Responsibility Matrix

		Creation / Enhancement						
Stakeholder Group	**Primary Contact**	**Conception**	**Design**	**Procure**	**Construct / Start-up**	**Utilization**	**Maintenance**	**Decommission / Dispose**
Facility Integrity Management & Technical Services	Director	X	X	X	X	X	X	X
Reservoir Engineering	Director	X	X		X	X		X
Compliance	Director	X	X	X	X	X	X	X
Transmission Engineering & Design	Director	X	X	X	X			X
Transmission Project Management	Director	X	X	X	X			X
Backbone Planning	Manager	X	X			X		X
Local Transmission Planning	Sr. Manager	X	X			X		X
Gas Transmission Control Center	Manager	X			X	X	X	X
Gas Control Strategy & Support	Director	X	X					X
Gas Pipeline Operations & Maintenance	Director		X		X		X	X
Wholesale Marketing & Business Development	Director	X						X
General Construction	Sr. Director				X			X
Distribution PMO	Director	X	X	X	X			X

E. Summary of Integrated Programs

Table 15 below summarizes the programs of work contained within this asset management plan that are relevant to and documented in other asset family asset management plans. The table highlights which programs are applicable to multiple asset families and which plan has included forecast costs. This also provides comfort that there is no duplication in forecasted program costs.

Table 15 – Programs Relevant to Multiple Asset Families

Programs of Work	Transmission Pipe	Gas Storage	M&C	C&P	Other
Locate & Mark	X	X			
Gas transmission routine pipeline maintenance & monitoring	X	X			
Gas transmission routine pipeline reliability & expense projects	X	X			
Corrosion control	X	X	X	X	
ILI assessments	X	X			
ILI upgrades	X	X			
ILI anomalies rectification	X	X			
ILI inspected by other means	X	X			
ECDA	X	X			
ICDA	X	X			
SCCDA	X	X			
Close Interval Surveys (CIS)	X	X			
Stress corrosion cracking	X	X			
Pressure testing	X	X			
Shallow pipe	X	X			
Class location program	X	X			
Valve automation	X	X	X		

Programs of Work	Transmission Pipe	Gas Storage	M&C	C&P	Other
Public awareness	X	X			
Inoperable & Hard-to-Turn Valves	X	X	X	X	
Preventative maintenance program	X	X	X	X	X
Guidance documents	X	X	X	X	X
Training	X	X	X	X	X
Process safety	X	X	X	X	X
Cyber security	X	X	X	X	X
Physical security	X	X	X	X	
Locate & Mark	X	X			
Gas transmission routine pipeline maintenance & monitoring	X	X			
Gas transmission routine pipeline reliability & expense projects	X	X			
Corrosion control	X	X	X	X	
ILI assessments	X	X			
ILI upgrades	X	X			
ILI anomalies rectification	X	X			
ILI inspected by other means	X	X			
ECDA	X	X			
ICDA	X	X			
SCCDA	X	X			
Close Interval Surveys (CIS)	X	X			
Stress corrosion cracking	X	X			
Pressure testing	X	X			
Shallow pipe	X	X			

Programs of Work	Transmission Pipe	Gas Storage	M&C	C&P	Other
Class location program	X	X			
Valve automation	X	X	X		
Public awareness	X	X			
Inoperable & Hard-to-Turn Valves	X	X	X	X	
Preventative maintenance program	X	X	X	X	X
Guidance documents	X	X	X	X	X
Training	X	X	X	X	X
Process safety	X	X	X	X	X
Cyber security	X	X	X	X	X
Physical security	X	X	X	X	

F. Glossary of Acronyms and Abbreviations

The following is a glossary of acronyms and abbreviations used in this asset management plan and related documents.

Table 16 – Acronyms and Abbreviations

Acronym	Meaning
AC	Atmospheric Corrosion
AF	Asset Family
AFO	Asset Family Owner
AMP	Asset Management Plan
AMR	Automated Meter Reading
ANSI	American National Standards Institute
APD	Abnormal Peak Day
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
Bcf	Billion cubic feet
BHP	Brake Horsepower
BTU	British Thermal Unit
C&P	Compression & Processing
CC&B	Customer Care and Billing
CAP	Corrective Action Program
CCE	Customer Connection Equipment
CCR	California Code of Regulations
CFH	Cubic Feet per Hour
CFR	Code of Federal Regulations
CIS	Close Interval Survey
CM	Corrective Maintenance
CNG	Compressed Natural Gas
CNL	Compensated Neutron
CoF	Consequence of Failure
CP	Cathodic Protection
CPP	Casing Protection Profile
CPUC	California Public Utilities Commission
CSRP	Copper Service Replacement Program
CWD	Cold Winter Day
DCVG	Direct Current Voltage Gradient
DHSV	Downhole Safety Valve
DIMP	Distribution Integrity Management Program
DOGGR	California Division of Oil Gas and Geothermal Resources
DOT	Department of Transportation
ECDA	External Corrosion Direct Assessment
ECA 1	Engineering Critical Analysis Phase 1
ECA 2	Engineering Critical Analysis Phase 2
EORM	Enterprise Operations Risk Management
ERM	Enterprise Risk Management
ERW	Electric Resistance Welded
ESD	Emergency Shut Down
ESZ	Emergency Shut-down Zone
ETS	Electrolysis Test Station
FIMP	Facility Integrity Management Program
FM	Facility Maintenance
FPI	Future Performance Indicator
GC	Gas Chromatograph
GDCC	Gas Distribution Clearance Process
GGE	Gas Gallon Equivalents
GHG	Greenhouse Gas
GIS	Geographic Information System
GMPCP	Gas Meter Performance Control Program
GPRP	Gas Pipeline Replacement Program
GRC	General Rate Case
GRN	Gamma Ray Neutron
GSE	Gas Safety Excellence
GSO	Gas System Operations
GSR	Gas Service Representative
GT	Gas Transmission
GTI	Gas Technology Institute
GT&S	Gas Transmission and Storage
HAZOP	Hazard Operability

Acronym	Meaning
HCA	High Consequence Area
HP	High Pressure
HP	Horsepower
HP-hrs	Horsepower - Hours
HPFI	High Pressure Fuel Injection
HPR	High Pressure Regulator
HST	Hydrotest
I/O	Input/Output
I/W	Injection/Withdrawal
IA	Information Assurance
IC	Internal Corrosion
IC	Internal Corrosion
ICDA	Internal Corrosion Direct Assessment
IGIS	Integrated Gas Information System
IJ	Injection
ILI	In-Line Inspection
IM	Integrity Management
INGAA	Interstate Natural Gas Association of America
IRV	Internal Relief Valve
IT	Information Technology
KPI	Key Performance Indicator
LAUF	Loss And Unaccounted For
LNG	Liquefied Natural Gas
LOB	Line of Business
LoF	Likelihood of Failure
LP	Low Pressure
LR	Linear Feet
LRCV	Line Rupture Control Valve
M&C	Measurement and Control
M&O	Maintenance and Operations
MAME	Meter Asset Management and Engineering
MAOP	Maximum Allowable Operating Pressure
MASCP	Maximum Allowable Surface Casing Pressure
MAT	Major Activity Type
MBTO	Mean Time Between Outages

Acronym	Meaning
MCC	Motor Control Centre
Mcf	Million cubic feet
MIT	Mechanical Integrity Test
ML	Microlog
MMCFD	Millions Cubic Feet per Day
MOC	Management of Change
MOP	Maximum Operating Pressure
MPP	Meter Protection Program
MPR	Material Problem Report
MSA	Meter Set Assembly
MTTR	Mean Time to Failure
MTTR	Mean Time to Repair
MTU	Meter Transmitting Units
MWC	Major Work Category
NDE	Non-Destructive Examination
NFPA	National Fire Protection Association
NOV	Notice of Violation
NOx	Nitrogen Oxides
OBS	Observation
OEM	Original Equipment Manufacturer
OPF	Over-Pressure Frequency
OPP	Over-Pressure Protection
OSHA	Occupational Safety and Health Administration
P&ID	Piping and Instrumentation Diagram
PAP	Public Awareness Plan
PAS55 / ISO 55001	Publically Available Specification 55 / International Standards Organization 55001
PCM	Pipeline Current Matter
PG&E	Pacific Gas and Electric
PHA	Process Hazard Analysis
PHA	Process Hazard Analysis
PHMSA	Pipeline and Hazardous Materials Safety Administration
PIR	Potential Impact Radius
PLC	Programmable Logic Controller
PM	Preventative Maintenance
PLM	Pipeline Maintenance Database

Acronym	Meaning
PMC	Periodic Meter Change
PRCI	Pipeline Research Council International
PS	Portable Supply
PSEP	Pipeline Safety Enhancement Plan
psig	Pounds per Square Inch Gage
PSRS	Project Status Reporting System
PSSR	Pre-Startup Safety Review
RCV	Rupture Control Valves
RMP	Risk Management Procedure
RTU	Remote Terminal Unit
SAP	Enterprise System used for Asset Management and Work Management
SCADA	Supervisory Control and Data Acquisition
SCC	Stress Corrosion Cracking
SCCDA	Stress Corrosion Cracking Direct Assessment
SEDB	System Equipment Database
SLA	Service Level Agreement
SMC	Statistical Meter Control
SME	Subject Matter Expert
SMYS	Specific Minimum Yield Strength

Acronym	Meaning
SP	Spontaneous Potential
STPR	Strength Test Pressure Report
STPR	Strength Test Pressure Report
SWGR	Switchgear
TCS	Turner Cut Station
TIMP	Transmission Integrity Management Program
TOX	Thermal Oxidizers
TPL	Tangible Property List
TSA	Transportation Security Administration
TVC	Traceable, Verifiable, Complete
UPSV	Uphole Safety Valve
USA	Underground Service Alert
USGS	United States Geological Survey
UVIR	UltraViolet InfraRed
VAC	Volts Alternating Current
VFD	Variable Frequency Drives
WD	Withdrawal
WELL	Well Integrity Management Program
WRO	Work Requested by Others

G. Change Log

The following table summarizes revisions since the previous publication of GP-1104: Measurement & Control Asset Management Plan, Revision 3, 7/1/2016.

Table 17 - Asset Management Plan Change Log

Section	Change	Reason for Change	Implication of Change
Entire Asset Management Plan	General update to previous version of Asset Management plan dated July 15, 2015; no major changes to format of document	Provided updated information regarding fleet of M&C assets; condition of M&C assets; risks associated with M&C assets; mitigations associated with risks to M&C assets; strategic objectives and continuous improvement activities associated with M&C assets	Updated Information

H. M&C Station Asset Photographs

Gas Terminal

Complex Station

Complex Station

Simple Station – Below Ground

Simple Station – Above Ground

District Regulator Station – Below Ground

District Regulator Station – Above Ground

Customer Meter Set

I. Station Condition Health Scoring Criteria

The station condition assessment provides a snapshot of station condition and defines a set of metrics and the basis of the metrics. The following topics are addressed in this section:

- Component metrics definitions and data requirements
- Component scoring approach
- M&C station scoring approach

The intent of this discussion is to describe the calculation basis for the metrics and the data required to support the metrics.

A. Component Level Health Metrics

The condition assessment for gas transmission M&C facilities defines the evaluation of health for the components of a station. The condition assessment employs a set of component-level metrics that are utilized to provide an indication of the component health. These metrics are defined in Table 18 below.

Table 18 - Component Condition Health Metrics

Metric No.	Metric	Definition
1	Component Age	Percent of component age vs. expected life of component
2	Obsolete Equipment	Component make and model matches equipment on obsolescence list
3	Problem Equipment	Component make and model matches equipment on problem equipment list
4	Physical Condition	Assessment of component from visual inspection based on site inspection criteria
5	Functional Performance	Assessment of component performance based on review of maintenance and operations history against performance criteria
6	Operational Efficiency	Measure of operational efficiency based on review of maintenance hours spent on component over past three years against efficiency criteria
7	Engineered Maintenance Strategy	Component included in maintenance database (PLM or SAP) with defined maintenance strategy (preventive maintenance or maintenance for cause)
8	Corrective Maintenance Tasks	Number of corrective maintenance tags against equipment with defined maintenance strategy, excluding maintenance for cause strategy
9	Planned Maintenance Tasks Overdue	Occurrence of preventive maintenance tasks overdue greater than 30 days
10	Percent Corrective Maintenance vs. Total Maintenance	Percent of work hours associated with corrective maintenance against the total work hours on the component

The metrics defined in Table 18 have been used in the component condition assessment. However, the use of these metrics to assess component condition requires that the information needed to define these metrics is collected and evaluated on an on-going basis. The data sources for these metrics and the on-going data collection and update activities required to continue to score the components are based on the assumption that the data is available to support calculation of the metrics.

The information for each metric includes:

- Scoring criteria for the metric
- Current information which is the basis for the uploaded information from the critical documents (asset register information) and health scoring information
- Recommended future source for updating this information

Component Age

Scoring Criteria: The component age metric represents the ratio of component age to its intended life expectancy. The metric is measured as shown below in Table 19

Table 19 - Component Age Metric Criteria

Metric	Definition	Metric Score (1=good; 10= poor)				
		1	3	5	7	10
Component Age	Percent of component age vs. expected life of component	0-20%	21-40%	41-60%	61-80%	>80%

Current Information: The information on component age as well as make and model number is not readily available in the various databases, such as PLM, SAP or PSRS. The current quality of this information is low due to uncertainty in the reliability and accuracy of the data. To the extent possible, data with the highest perceived accuracy was used according to the following priority:

- Site inspection information from the Critical Documents project
- PSRS project description records
- PLM or SAP
- Operating Diagrams initial drawing date (proxy for commissioning date)

The information on expected life has been developed based on the experience of various stakeholders and experts for various component types. The expected life definitions have been included for categories of equipment and have not been based on component specific make or model number. Table 20 provides the list of expected life by component for the various components included in the condition assessment.

Table 20 - Component Expected Life

Component	Expected Life (Years)	Component	Expected Life (Years)
Valve - Manual	60	Odorizers	20
Valve – Actuated (all applications)	30	Meters – Orifice	30
Regulator (Pilot)	30	Meters – Turbine	20
Monitor (Pilot)	30	Meters – Rotary	20
Regulator (Spring)	30	Meters - Ultrasonic	20
Monitor (Spring)	30	RTU	15
Valve - Relief	60	Transmitters	15
Piping	60	Civil (Foundations & Supports)	60
Filters	30	Sampling & Measuring Devices	10
Separators	30		

Future Needs: The information for future metric evaluation will come from:

- The equipment asset register
- Annual updates to the table for expected component life to be included in the health scoring database (currently identified as SAP)

This metric can be automatically updated as changes are made to the asset register changing the age of the assets (either existing asset age updated annually or new components added).

Obsolete Equipment

Scoring Criteria: The obsolete equipment metric represents the identification of equipment as part of components identified as obsolete, where obsolescence refers to a component being out of the market place (original equipment offer or availability of spare parts). The metric is measured as shown below in Table 21.

Table 21 - Obsolete Equipment Metric Criteria

Metric	Definition	Metric Score (1=good; 10= poor)				
		1	3	5	7	10
Obsolete Equipment	Component make and model matches equipment on obsolescence list	Equipment currently available in market (not on the list)	N/A	Equipment with component age metric equal to 10 (not on the list)	N/A	Equipment no longer available; spare parts limited (on the list)

Current Information: The information on equipment obsolescence is based by comparing known equipment make and model information to a list of identified obsolete make and models. Currently, the sources of equipment make and model is often incomplete, unreliable/inaccurate, and not readily accessible. As a temporary mitigation measure, this information was supplemented by the following sources:

- Site inspection information from Critical Documents project
- PSRS project description records

Equipment make and model information may also be available from various regulator and valve maintenance records, but information from these "paper" sources has not yet been obtained.

Furthermore, there is no current formal list of obsolete equipment currently being maintained by the business. As a result, information on obsolete equipment was taken from communications with various staff members (Table 22).

Table 22 - Obsolete Equipment List

Make	Model	Component
LIMITORQUE	SMB	ACTUATOR
SCHAFER	UNKNOWN	ACTUATOR
BRISTOL	UNKNOWN	CONTROLLER
MOORE	50	CONTROLLER

Future Needs: The information for future metric evaluation will come from:

- The equipment asset register (which will include make and model number)
- A centrally maintained database of obsolete equipment

A list of obsolete equipment needs to be defined and updated by the facility engineers (or other identified personnel) on an on-going basis. One recommended consideration is to further develop relationships with major equipment manufacturers and/or suppliers such that PG&E is readily alerted to obsolete equipment. It is also recommended that the obsolete equipment database be stored in a central location and be easily integrated into the Asset Management Information System so the health and condition monitoring systems can be automatically updated when new information is available.

Problem Equipment

Scoring Criteria: The problem equipment metric represents the identification of equipment where undesirable functional or operational issues have been detected which is suspected to be or is a direct result of a manufacturing defect or in-service configuration with system-wide implications. The metric is measured as shown below in Table 23.

Table 23 - Problem Equipment Metric Criteria

Metric	Definition	Metric Score (1=good; 10= poor)				
		1	3	5	7	10
Problem Equipment	Component make and model matches equipment on problem equipment list	No reported issues with equipment (not on list)	N/A	N/A	N/A	System wide issues with equipment (on list)

Current Information: The information on problem equipment is based on comparing known equipment make and model information to a list of identified problem equipment. As was previously mentioned, currently the information on make and model number is often incomplete, unreliable/inaccurate, and not readily accessible. As a temporary mitigation measure, this information was supplemented by the following sources:

- Site inspection information from Critical Documents project
- PSRS project description records

Problem equipment should be identifiable through review of information stored in the Material Problem Report (MPR) computer program. This information can be used to report, evaluate, and document defective material and equipment among other things.

Future Needs: The information for future metric evaluation will come from:

- The equipment asset register
- Utilization of Material Problem Reporting (or similar) as specified under SCM-2106S and integrated into the enterprise Asset Management Information System (e.g., SAP)

A list of problem equipment needs to be defined and updated by the facility engineers (or other identified personnel) on an on-going basis. This information can be updated in the health scoring database and the component metric can be updated automatically based on changes to the problem equipment database.

Physical Condition

Scoring Criteria: The physical condition metric represents an assessment of the physical condition of a component from a visual inspection. The inspection is based on the checklist shown below. The inspection is focused on observable issues with material condition (rust and corrosion), excessive grease or oil, and support configuration (or physical configuration). The metric is measured as shown below in Table 24.

Table 24 - Physical Condition Metric Criteria

Metric	Definition	Metric Score (1=good; 10= poor)				
		1	3	5	7	10
Physical Condition	Assessment of component from annual visual inspection based on site inspection criteria	Condition "good" from inspection document	N.A.	Condition "medium" from inspection document)	N.A.	Condition "poor" from inspection document

Current Information: The information on physical condition is based on the information from the site inspection checklists (visual inspection) performed during the condition assessment and critical document projects as well as on photographs taken of the components during the site visits. The component score is based on the criteria shown below. If a component has a "poor" score for any criteria in the checklist, then it is scored a "10". If there are no "poor" scores, but a "medium" score for any criteria, then it is scored a "5". If there are "poor or medium" scores for all criteria, then the item is scored a "1". A review of available photographs is also performed to assist in determining the score. The photograph review is used to help ensure that consistent scoring is used for this metric. Table 25 below provides information to guide the physical condition metric.

Table 25 - Physical Condition Metric Characteristics

Condition	Characteristic	Description and Explanation
Good	Fully painted	Atmospheric corrosion protection (photo 1)
	Little to some dirt	Able to spot residue leaks, rust, and other physical health characteristics Does not threaten the operation of the equipment (photo 2)
	Minor rust	Little to no rust (photo 3)
	No or minor grease / residue	Periodically cleaning equipment is a good maintenance practice (detect minor issues before they develop into major problems). Studies have also shown that it improves morale and work performance (encourages ownership). (photo 4)
Medium	Some grease or other residue	Grease or other residue generally not wiped off following maintenance or equipment seal(s) have deteriorated. When excessive, tends to mask early warning signs of more significant problems (photo 5)
	Excessive dirt where not buried (e.g., vaulted)	Has potential to inhibit operability Has potential to mask early warning signs of more significant problems (photo 6)
	Some rust	Spotty rust (< 10% of surface area) usually due to chipped/flaking paint (Includes non-pressure containing elements of equipment)
	Chipped/flaking paint	Inadequate corrosion protection Unsightly (photo 7)
	Poor paint job	Typically involves failing to strip equipment surface prior to painting in accordance with PG&E standards. This can lead to disbondment in the future and corrosion/pitting to occur (photo 8)

	Unanchored or missing supports	Support not in contact with piping Support base plate not anchored/fastened to concrete footing (photo 9)
	Combination of issues	Less severe combination of above characteristics which when taken together is determined to be more significant than a 'Good' designation but not so severe as to be designated as 'Poor' (photos 10 & 11)
Poor	Excessive grease or other residue	Visible residue on the ground Potential operability issues (inadequate lubrication) Unsightly (photo 12)
	Excessive rust	Not spotty; broad areas of equipment impacted Higher potential for pitting / integrity failure Unsightly (photo 13)
	Excessive chipping/flaking paint	Not spotty; broad areas of equipment impacted Higher potential for pitting / integrity failure Unsightly (photo 14)
	Flooded vault	Higher potential for corrosion Inhibits inspections (accessibility) Masks early warning signs of more significant problems (photo 15)
Unknown	Underground	Valve is underground and the operator/stem is the only part visible (photo 16)
	Vaulted	Equipment in a vault that could not be opened at the time of visit
	Photo not available	Photo not taken during site inspection or not uploaded to the PG&E U drive at time of assessment
Low Confidence	Underground	Buried equipment that is not visible
	Vaulted	Vaulted equipment that is inaccessible
	Poor photograph	Photograph cannot be evaluated (or poor quality)

Figure 15 - Physical Condition Examples

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Future Needs: The information for future metric evaluation will need to come from information gained in the annual (or defined maintenance period) maintenance inspections. The criteria for assessing the overall condition of a station include review of material conditions, housekeeping, structural supports, and other factors. Details of these requirements can be found in existing standards and procedures including:

- S4446 - Vault Inspection Procedure
- TD-4430P-02 - Gas Transmission Stations Inspection, Testing, and Maintenance Procedures and attachments including
    - Inspection of Piping for Atmospheric and External Corrosion at Transmission Station Facilities
    - Pilot-Operator Regulator Station Maintenance Record
    - Station Monthly Routine Log

The site inspection (visual inspection) checklist or some appropriate equivalent needs to be incorporated into the annual maintenance process. The information needs to be captured at the equipment level so that it is can be readily integrated into the Asset Information Management System to support health and condition assessments and other asset management activities. This metric can then be automatically updated as information on the visual inspections are entered into the appropriate database.

Functional Performance

Scoring Criteria: The functional performance metric represents an indication of current operational performance. The specific criteria for these metrics are different for various equipment categories. However, the score is based on the following general criteria as shown below in Table 26.

Table 26 - Functional Performance Metric Criteria

Metric	Definition	Metric Score (1=good; 10= poor)				
		1	3	5	7	10
Functional Performance	Assessment of component performance based on review of maintenance and operations history over past three years against performance criteria	No performance issues identified	N/A	Minor performance issues identified	N/A	Significant performance degradation

Current Information: The criteria for scoring functional performance are the most subjective of those used in the condition assessment. To the extent information is available, functional performance considers the frequency and impact(s) of the issue(s) documented. Table 27 below includes, but is not limited to, examples of common characteristics of the various levels of work history issues encountered.

Table 27 - Functional Performance Metric Characteristics

Issue(s) Extent	Characteristic(s) / Examples
None	small/minor leak (e.g., on a fitting, active grade 3)
	TLA leaks (tighten, lubrication, or adjustment required to fix; non-reportable)
	equipment degradation problems reported and corrective action taken where sufficient time has passed to determine effectiveness (e.g., issue detected in 2011, no issues reported in 2012)
Minor	at most 1 CM of moderate significance
	Grade 2/2+ leaks, and there has not been sufficient time to determine its effectiveness (e.g., issue detected in 2012 for a 2013 assessment)
	Leaks of unknown Grade or Cause where there has not been sufficient time to determine its effectiveness
	Multiple leaks
Significant	major problem reported with corrective action taken, but not sufficient time to determine its effectiveness (e.g., issue detected in 2012 for a 2013 assessment)
	Repeated major operability issues
	assets (regulators and monitors) were identified as having performance problems during the control assessments and there is no evidence of corrective action taken
	Asset not in use (abandoned in place or inoperable)

For the current assessment, corrective work is only considered to have resolved the problem when documented evidence of the corrective work was found or at least one maintenance cycle had gone by, indicating the problem no longer existed.

Future Needs: The information for future metric evaluation will need to be determined based on one or two specific functional tests of a component. This metric is different for each component type and the specific measures for collecting and evaluating data for this metric still need to be defined during the completion of the condition assessment project.

There are several alternatives available for developing this metric:

- This metric may not be easily automated such that information can be queried from some database and calculated in the metric algorithm. It is possible that this metric will require entry by the responsible facility engineer on an annual basis or when there is some issue raised on the component performance.
- This metric may be based on specific failure codes that can be included in SAP and that are updated based on maintenance, material problem reports, or events.

The final definition of this metric will require future work.

Operational Efficiency

Scoring Criteria: The operational efficiency metric represents the measure of maintenance hours spent on a component from one year to the next. The metric is intended to identify potential component issues through the annual hours spent on maintenance. The metric is measured as shown below in Table 28Table 34.

Table 28 - Operational Efficiency Metric Criteria

Metric	Definition	Metric Score (1=good; 10= poor)				
		1	3	5	7	10
Operational Efficiency	Measure of operational efficiency based on review of maintenance hours spent on component over past three years against efficiency criteria	Similar hours spent each year over 3 year period	N.A.	Hours spent in one year >5 times other years	N.A.	Hours spent in one year >10 times other years

Current Information: The information on maintenance man-hours for this metric is taken from man-hours shown for total maintenance hours identified in PLM or SAP for a given component. The metric is based on using 3 years of total maintenance hours. Key definitions are:

- H_3= PM + CM hours of year health is being assessed (for an evaluation taking place in 2013, this is 2012)
- H_i =PM + CM hours of year i, where i is the number of years prior to the current evaluation year (e.g., for an evaluation taking place in 2013, i = 1 corresponds to 2010, i = 2 corresponds to 2011, and i = 3 corresponds to 2012)
- WT = proxy for current wrench time trend
- OE = operational efficiency score

The equation used to determine this metric is:

If $WT = \begin{bmatrix} \leq 1.5 \\ > 1.5 \; and \leq 2.5 \\ > 2.5 \\ no \; infomration \end{bmatrix}$, then the metric for operational efficiency is $OE = \begin{bmatrix} 1 \\ 5 \\ 10 \\ 1 \end{bmatrix}$

where,

$$WT = \frac{3 \times H_3}{\sum_{i=1}^{3} H_i}$$

Note that the definition for *WT* is the last year (2012 in the example) divided by the average of the 3 years (2010, 2011 and 2012).

The man-hour information is captured by PLM and SAP for work management and this metric can be automatically determined based on this information.

Future Needs: The information for future metric evaluation will come from the total man-hours in SAP. The future information will come from the same source as the current information. The major data issue to be resolved for the future needs is that corrective maintenance must be identified against a specific component and not the station.

Engineered Maintenance Strategy

Scoring Criteria: The component age metric represents the ratio of component age to its intended life expectancy. The metric is measured as shown below in Table 29.

Table 29 - Engineering Maintenance Strategy Metric Criteria

Metric	Definition	Metric Score (1=good; 10= poor)				
		1	3	5	7	10
Engineered Maintenance Strategy	Component included in maintenance database (PLM or SAP) with defined maintenance strategy (preventive maintenance or maintenance for cause)	N/A	Strategy defined and specific equipment tasks included in work management system	N/A	Strategy not defined or included in work management system	N/A

Current Information: The information on the engineered maintenance strategy metric is based on whether the component is included in PLM or SAP; and that a planned maintenance task is included for the component.

Future Needs: The information for future metric evaluation will come from SAP similar to the current approach. The major data issue to be resolved for the future needs is that components that have only "no maintenance required" need to be included in SAP. This requirement will ensure that all components are accounted for in the strategy and that corrective maintenance against these items can be reviewed for the potential need for planned maintenance.

The information for this metric is captured by SAP for work management and this metric can be automatically determined based on this information.

Corrective Maintenance Tasks

Scoring Criteria: The corrective maintenance task metric represents the number of corrective maintenance tags against a component on a yearly basis. Since the components included here have defined planned maintenance tasks, a corrective maintenance task violates the goal of preventing failure of these components. The metric is measured as shown below in Table 30.

Table 30 - Corrective Maintenance Task Metric Criteria

Metric	Definition	Metric Score (1=good; 10= poor)				
		1	3	5	7	10
Corrective Maintenance Tasks	Number of corrective maintenance tags against equipment with defined maintenance strategy, excluding maintenance for cause strategy	0	N/A	1	N/A	>1

Current Information: The information on corrective maintenance tasks is taken directly from data in PLM and SAP.

Future Needs: The information for future metric evaluation will come directly from data in PLM and SAP similar to the current approach. The major issue is to ensure that all corrective maintenance tasks are identified and captured as corrective maintenance. Current review of data indicates that some corrective maintenance is performed under planned maintenance; that some corrective maintenance is entered against the station and not the component; and that some corrective tasks are performed with no entry into PLM or SAP.

For future metric determination, Table 30 should be used for all components that require a PM task. If a component does not require a defined maintenance task (such that it is a “fix when broke” strategy), then the component should have a default score of “1”.

The information for this metric is captured by SAP for work management and this metric can be automatically determined based on this information.

Planned maintenance Tasks Overdue

Scoring Criteria: The overdue planned maintenance metric represents the occurrence of planned maintenance tasks against a component that are greater than 30 days overdue. The metric is measured as shown below in Table 31.

Table 31 - Overdue Planned Maintenance Metric Criteria

Metric	Definition	Metric Score (1=good; 10= poor)				
		1	3	5	7	10
Percent Planned Maintenance Tasks Overdue	Percent of preventive maintenance tasks overdue greater than 30 days	All on schedule	N/A	N/A	N/A	Maintenance strategy defined and any overdue for past year or Undefined maintenance strategy

Current Information: The information on overdue planned maintenance tasks is taken directly from data in PLM and SAP.

This metric is calculated by using the percent maintenance overdue for the year being evaluated. The following criteria may be used:

- PM task overdue by 30 days: Score "10"
- PM task on time (within 30 days): Score "1"
- If no PM is assigned and is required, then default to Score "10"

Future Needs: The information for future metric evaluation will come directly from data in SAP similar to the current approach. A potential issue is that planned maintenance tasks are generally entered for compliance maintenance only, and not for reliability maintenance. There is a high priority on compliance maintenance so that if other maintenance tasks are not identified, then this metric may not prove to be useful for monitoring schedule compliance. Since schedule compliance is a key maintenance metric, future review of maintenance tasks identified against equipment may be required.

Percent Corrective Maintenance vs. Total Maintenance

Scoring Criteria: The ratio of corrective maintenance man-hours to total maintenance man-hours represents the effectiveness of the maintenance program to prevent equipment failures that require corrective maintenance. The metric is measured as shown below in Table 32.

Table 32 - Percent Corrective Maintenance vs. Total Maintenance Metric Criteria

Metric	Definition	Metric Score (1=good; 10= poor)				
		1	3	5	7	10
Percent Corrective Maintenance vs. Total Maintenance	Percent of work hours associated with corrective maintenance against the total work hours on the component	<30%	N/A	30%-50%	N/A	>50%

Current Information: The information on the ratio of corrective to total maintenance man-hours is based on information taken directly from PLM and SAP.

The future metric may be automated by using the percent corrective maintenance hours to total maintenance hours for the year being evaluated. The following criteria may be used:

- If a PM is defined: Score based on criteria in Table 30.
- If no PM is defined:
  - Score "1" if no CM exists
  - Score "10" if CM exists
- If component is defined to require "no maintenance", then default to Score "1"

The information for this metric is captured by PLM and SAP for work management and this metric can be automatically determined based on this information.

Future Needs: The information for future metric evaluation will come directly from SAP similar to the current approach. The major issue is to ensure that all corrective maintenance tasks are identified and captured as corrective maintenance. Current review of data indicates that some corrective maintenance is performed under planned maintenance; that some corrective maintenance is entered against the station and not the component; and that some corrective tasks are performed with no entry into PLM or SAP.

B. Component Level Health Model

The component level score is based on the ten metrics identified in Section 4.1.1 using the weighting factors in Table 33. The component level score is based on summation of the metric score times the weighting factors:

$$Component\ score = \sum_{i=1}^{10} (metric\ score)_i \times (weighting\ factor)_i$$

The component scoring basis is the same for all components in all station types (M&C and C&P).

Table 33 - Component Metric Weighting Factors

Metric	Metric Weighting Factor
Component Age	10%
Obsolete Equipment	15%
Problem Equipment	15%
Physical Condition	15%
Functional Performance	25%
Operational Efficiency	4%
Engineered Maintenance Strategy	4%
Corrective Maintenance Tasks	4%

Percent Planned Maintenance Tasks Overdue	4%
Percent Corrective Maintenance vs. Total Maintenance	4%

The metric weighting factors reflect the importance of the metric relative to component condition and the current confidence level in the data and data sources. The weighting factors above put 25% on age and obsolescence, 55% on current condition, and 20% on maintenance-related items. Since the data related to maintenance appears to be incomplete in the PLM and SAP systems, the maintenance related items were relied on less heavily. An alternate view shows that the weighting factors are 63% leading indicators and 37% lagging indicators.

In the future, consideration should be given to adjustments to the weighting factors as importance or data confidence changes.

C. M&C Station Level Health Model

The station level score is based on the influence of the components included in the station. Each station component is assigned a component type that is used to tie the component to an equipment class. The weighting factors are then assigned to the equipment class. The current equipment types and classes are shown in Table 34 below.

Table 34 - Equipment Type, Class and Weighting Factor

System	Component Type	Class	Weighting Factor
Control	RTU / PLC	3	0%
	TRANSMITTER	3	0%
Electrical	BATTERY	3	0%
	GENERATOR	3	0%
	UPS	3	0%
Gas	ANALYZER	3	0%
	BOTTLE	3	0%
	DEHYDRATOR	2	50%
	FILTER	2	50%
	METER	2	50%
	METER - INSERTION	2	50%
	METER - ORIFICE	2	50%
	METER - ROTARY	2	50%
	METER - TURBINE	2	50%
	METER -ULTRASONIC	2	50%

	MONITOR	1	100%
	ODORIZER	2	50%
	PIPING	3	0%
	REGULATOR	1	100%
	SAMPLER	3	0%
	SEPARATOR	2	50%
	SUPPRESSOR - NOISE	3	0%
	VALVE	3	0%
	VALVE - ACTUATED	1	100%
	VALVE - RELIEF	2	50%

The station level score is based on component scores based on the following formula:

$$Station\ Score = \left[\frac{\sum(Class\ 1\ Scores) * class\ 1\ weighting\ factor}{No.of\ class\ 1\ comp'ts} + \frac{\sum(Class\ 2\ Scores) * class\ 2\ weighting\ factor}{No.of\ class\ 2\ comp'ts} + \frac{\sum(Class\ 3\ Scores) * class\ 3\ weighting\ factor}{No.of\ class\ 3\ comp'ts}\right] \times 10$$

The station score is normalized to allow for more weighting on the class 1 components, which have an active function to perform. The remaining components are divided into class 2 or secondary components, which support the functionality of the class 1 components; and class 3 or passive components, which typically have no active function.

J. M&C Station Condition Health Target Score Criteria

Category A and B Stations

The station health scores are based on a set of 10 metrics that are weighted for scoring each component in the station. Category 1 and Category 2 components are defined for use in determining the overall station health score. Appendix I provides the details of the component and station level health scoring. Additionally, for each station, the consequence of failure (COF) has been defined for each of 6 risk categories as shown in Appendix L. The station health target is defined based on a target component and station score along with the COF's for health and safety and reliability.

The criteria for defining the station target health scores are:

- For stations with COF of health & safety or reliability of 5 or above (Category 1 targets), the target station score is based on all component metrics being at a score of 2.5 (between best of 1 and medium of 5) with the exception of the age, obsolescence, and engineered maintenance strategy. Since most stations are scored with the age of the facility being identified at the date of station installation due to a lack of component data, the age metric is scored as 10 and the obsolescence metric as 5. Also, the maintenance strategy is either 3 (has a strategy) or 7 (no strategy identified), this metric is set as 3. Based on these scoring criteria, the component score for this scenario is 3.65 (See Table 35 below). If all components (both Category 1 and 2) utilize this score (or are averaged to this score), then the station health target score is 54.8 (See Table 35 below).
- For all other stations with COF for health & safety and reliability less than 5 (Category 2 targets), the target station score for all metrics is based on the same criteria above except that the average score for the components is set to 3.5 (slightly higher score closer to medium) physical condition is 5 and the functional performance is 3. Based on these scoring criteria, the component score for this scenario is 4.36 (See Table 35 below). If all components (both Class 1 and 2) utilize this score, then the station health target score is 65.4 (See Table 35 below).
- There are stations that have only Class 1 components and no Class 2 components. For these stations, the target scores utilize Class 1 station scores only and the target scores are 36.5 for stations with COF of health & safety or reliability at 5 or greater and 43.6 for stations with COF of health & safety and reliability less than 5, respectively.
- There are stations that have only Class 2 components and no Class 1 components. For these stations, the target scores utilize Class 2 station scores only and the target scores are 18.3 for stations with COF of health & safety or reliability at 5 or greater and 21.8 for stations with COF of health & safety and reliability less than 5, respectively.

Table 35 - Initial Target Station Score Recommendations

Target Station Score

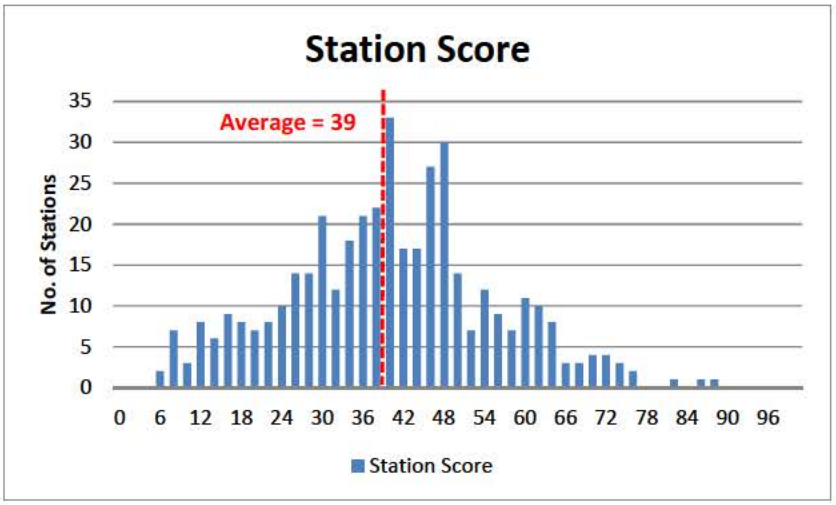
Component Score							
			Category 1 Targets (Note 1)		Category 2 Targets (Note 2)		
No.	Metric	Weighting	Target Score	Metric Score (Wtd)	Target Score	Metric Score (Wtd)	Target Score Basis
1	Age	10%	10	1.00	10	1.00	Many older items since minimum information on component age. Assume equipment old for now until data improves.
2	Obsolescence	15%	5	0.75	5	0.75	Obsolescence score based on default for Age = 10. Again assume for now until data improves.
3	Problem Equipment	15%	2.5	0.38	3.5	0.53	Assume between good and medium.
4	Physical Condition	15%	2.5	0.38	3.5	0.53	Assume between good and medium.
5	Functional Performance	25%	2.5	0.63	3.5	0.88	Assume between good and medium.
6	Operational Efficiency	4%	2.5	0.10	3.5	0.14	Assume between good and medium.
7	Engineered Maintenance Basis	4%	3	0.12	3	0.12	Assume maintenance strategy defined
8	Number of CM's	4%	2.5	0.10	3.5	0.14	Assume between good and medium.
9	Number of PM's Overdue	4%	2.5	0.10	3.5	0.14	Assume between good and medium.
10	Ratio of CM / PM Man-Hours	4%	2.5	0.10	3.5	0.14	Assume between good and medium.
	Component Score	100%		3.65		4.36	Based on scale of 1 (good) to 10 (poor)

Station Score							
			Category 1 Targets (Note 1)		Category 2 Targets (Note 2)		
No.	Component Type	Weighting	Target Score	Metric Score (Wtd)	Target Score	Metric Score (Wtd)	Target Score Basis
1	Category 1	100%	3.65	36.50	4.36	43.60	Assume all category 1 are same component score or the average is the same.
2	Category 2	50%	3.65	18.25	4.36	21.80	Assume all category 2 are same component score or the average is the same.
3	Category 3	0%	3.65	0.00	4.36	0.00	
4	Category 4	0%	4	0.00	4.36	0.00	
	Station Score			54.8		65.4	

Note
1. COF criteria: Score for health & safety or reliability is 5 or above.
2. COF criteria: Score for health & safety and reliability are both 4 or less.

A statistical analysis was performed of the current station scores to determine if these target scores are reasonable and appropriate. The results of the statistical analysis are shown in Figure 16 below.

Figure 16 - Target Station Score Recommendations



The statistics indicate that the average score is 39 and the standard deviation is 15. Therefore, the targeted value of 54.8 for the stations with COF for health & safety or reliability at 5 or greater appears

appropriate since this is approximately within 1 standard deviation of the average score. For the score for other stations, the score of 65.4 is slightly below the average plus two standard deviations. This captures about 80% of the population. For stations with Class 1 components only and Class 2 components only, the target scores are based on component and station criteria in Table 35.

Therefore, the target scores are applied as shown in Table 36.

Table 36 - Final Target Station Score Recommendations

Components in Station	COF for H&S or Reliability at 5 or Greater		COF for H&S and Reliability Less Than 5	
	Target Score	No. of Stations	Target Score	No. of Stations
Class 1 & 2 (Cat. X)	54.8	234	65.4	149
Class 1 Only (Cat. XA)	36.5	17	43.6	28
Class 2 Only (Cat. XB)	18.3	8	21.8	29

Note: The Cat. X, Cat. XA, and Cat. XB designations provide the target score category associated with each station in Appendix K. X can be either 1 for H&S or Reliability COF at 5 or greater or 2 for H&S and reliability at 4 or below.

Gas Terminal Stations

The station health scores are based on a set of 10 metrics that are weighted for scoring each component in the station. Category 1 and Category 2 components are defined for use in determining the overall station health score. Appendix I provides the details of the component and station level health scoring. Additionally, for each station, the consequence of failure (COF) has been defined for each of 6 risk categories as shown in Appendix L. The station health target is defined based on a target component and station score along with the COF's for health and safety and reliability.

The gas terminals are identified as having COF for safety and reliability at 6 or above. Therefore, for these gas terminal stations, the target criteria will be established as more limiting. The target station score is based on all component metrics being at a score of 2.5 (between best of 1 and medium of 5) with the exception of the age, obsolescence, and engineered maintenance strategy. Since these stations have a high COF, the age metric is scored as 5 (average) and the obsolescence metric as 1 (no obsolescence). Also, the maintenance strategy is either 3 (has a strategy) or 7 (no strategy identified), this metric is set as 3. Based on these scoring criteria, the component score for this scenario is 2.55 (See Table 37 below). If all components (both Class 1 and 2) utilize this score (or are averaged to this score), then the station health target score is 38.3 (See Table 37 below).

Table 37 - Gas Terminal Score

Gas Terminal Station Score

Component Score					
			Category 1 Targets (Note 1)		
No.	Metric	Weighting	Target Score	Metric Score (Wtd)	Target Score Basis
1	Age	10%	5	0 50	Assume average age
2	Obsolescence	15%	1	0.15	Assume no obsolescence
3	Problem Equipment	15%	2.5	0 38	Assume between good and medium.
4	Physical Condition	15%	2.5	0 38	Assume between good and medium.
5	Functional Performance	25%	2.5	0.63	Assume between good and medium.
6	Operational Efficiency	4%	2.5	0.10	Assume between good and medium.
7	Engineered Maintenance Basis	4%	3	0.12	Assume maintenance strategy defined
8	Number of CM's	4%	2.5	0.10	Assume between good and medium.
9	Number of PM's Overdue	4%	2.5	0.10	Assume between good and medium.
10	Ratio of CM / PM Man-Hours	4%	2.5	0.10	Assume between good and medium.
	Component Score	**100%**		**2.55**	Based on scale of 1 (good) to 10 (poor)

Station Score					
			Category 1 Targets (Note 1)		
No.	Component Type	Weighting	Target Score	Metric Score (Wtd)	Target Score Basis
1	Category 1	100%	2.55	25.50	Assume all category 1 are same component score or the average is the same.
2	Category 2	50%	2.55	12.75	Assume all category 2 are same component score or the average is the same.
3	Category 3	0%	2.55	0.00	
4	Category 4	0%	2.55	0.00	
	Station Score			**38.3**	

The Gas Terminals have both class 1 and 2 components so there is only one target score for these stations.

K. Station Condition Health Scores

The results of the condition assessment are captured in the condition database and provide 10 metric health scores for each component, an overall component health score, and a station level health score. This appendix captures the station level health scores and provide the current condition health score, the target score, the variance to target (negative meaning the current score is higher than the target, which indicates that current health is worse than target). The information here contains the following:

- Table K-1: Category A Station Scores (highest score to lowest; or poorest condition to best)
- Table K-2: Category B Station Scores (highest score to lowest; or poorest condition to best)
- Table K-3: Gas Terminal Scores (highest score to lowest; or poorest condition to best)
- Table K-4: Category A Stations with Negative Variances (and comments on consideration in S1)
- Table K-5: Category B Stations with Negative Variances (and comments on consideration in S1)

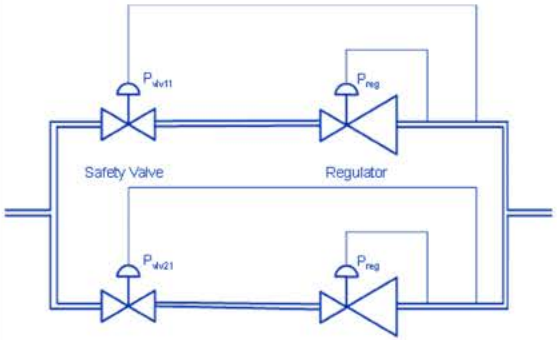
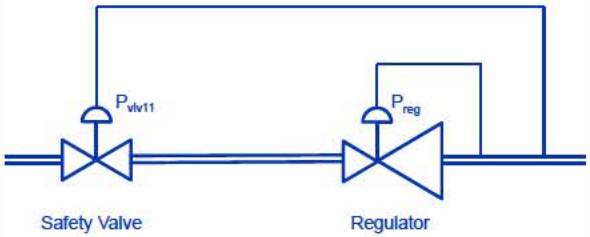
NOTE – Tables K-1 through K-5 are being updated to reflect the current list of transmission stations and the results of the latest S1 reviews. A link will be included in this Appendix when complete. [LATER]

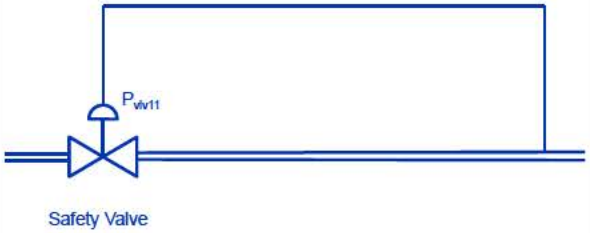
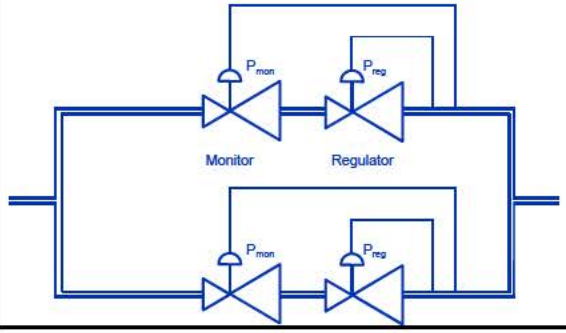
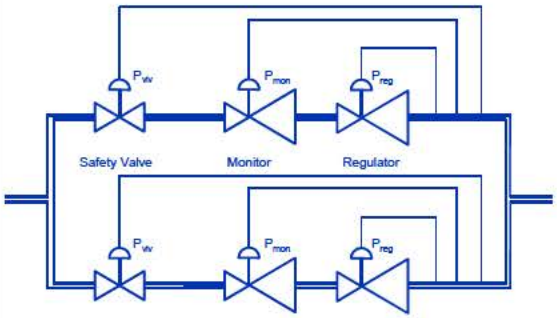
L. M&C Stations Consequence of Failure (COF) Matrix

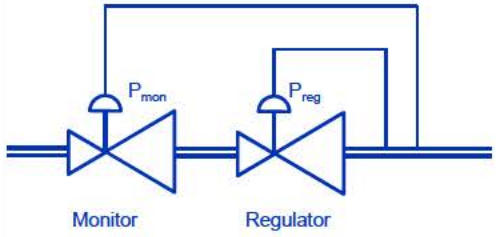
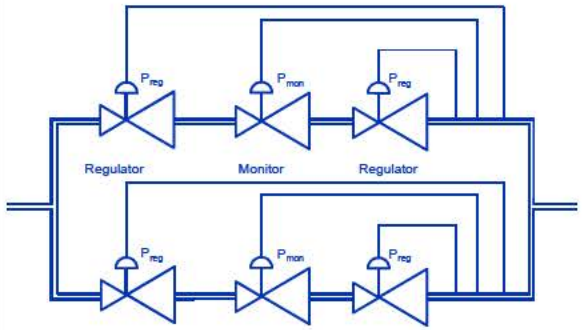
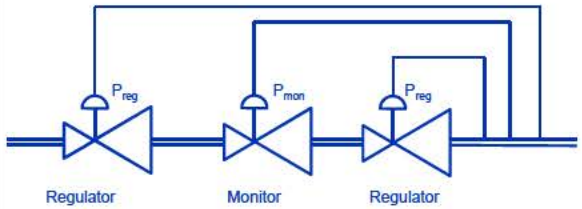
[Consequence of Failure Matrix is being updated to reflect the revised list of transmission stations as well as the current risk scoring criteria. A link to the updated file will be provided [LATER] when update is complete.]

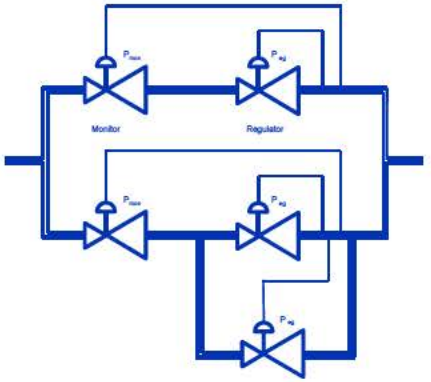
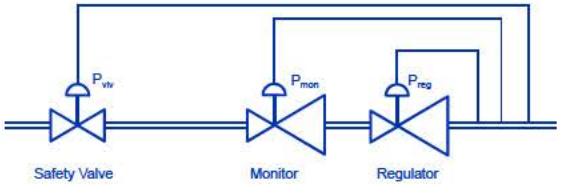
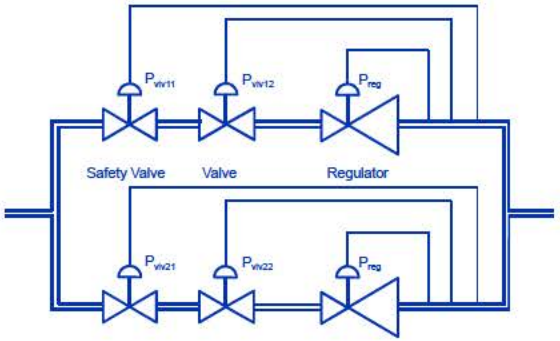
M. M&C Station Groupings for Risk Assessment

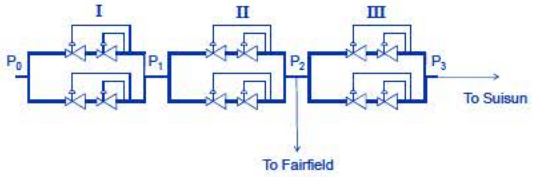
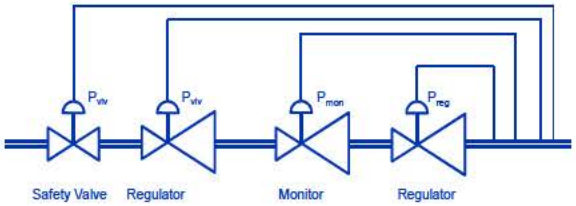
The M&C station groupings were defined to facilitate the station risk assessment. Each station is identified against a station group and the specific models used for the risk analysis are shown below. [Please note that the models are based on the "Risk Register Refresh for 2014 Session D for Measurement and Control Stations" prepared by DNV for PG&E, dated April 8, 2014.] A link to a list of all stations with their defined station grouping will be added to this appendix [LATER] after the model definition.

No.	Station Description	Representative Station	Model
1	Regulator plus relief valve (dual run) - pilot or diaphragm	Penryn	
1A	Regulator plus relief valve (single run) - pilot or diaphragm	[redacted]	

No.	Station Description	Representative Station	Model
2	No regulation (meter, odorizer, dehydrator, or intertie station)	Bunker Field Odorizer	
3	Regulator and monitor (dual run) - pilot or diaphragm	[redacted]	
Incl. as 3	Contains control valve and pilot- or diaphragm-operated	[redacted] Primary	

No.	Station Description	Representative Station	Model
4	Regulator and monitor (single run) - pilot or diaphragm	Wheatland	
5	Three stages of regulation (primary regulator, working monitor, final regulator) (dual run) - pilot or diaphragm	McArthur Road	
5A	Three stages of regulation (primary regulator, working monitor, final regulator) (dual run) - pilot or diaphragm	Roundhill Drive	

No.	Station Description	Representative Station	Model
6	Regulator and monitor (dual run) - control valves	Lomita Park	
6A	Regulator and monitor (single run) - control valves	Kramer Junction Intertie	
7	Regulator plus relief valve (dual run) - control valve	6A/6B Pressure Limiting	

No.	Station Description	Representative Station	Model
8	Regulator and monitor (dual run / multi-stage) - pilot or diaphragm	Suisun-Fairfield	
9	Three regulators (working monitor) (single run) - control valves	Enrico Station	

N. M&C GRC Distribution Station White Paper (DRAFT)

White Paper

Measurement &Control Asset Family
Distribution Regulation Facilities (District Regulation Facilities and Farm Tap Sets)

1. Background

There are several types of facilities that make up the distribution measurement and control asset family. Table 38 below provides the facility types and number of facilities associated with each type.

Table 38 - Distribution Regulation Facility Types

Facility Type		Number of Facilities[2]
District Regulator Stations (designed to H-14) (High Pressure / Low Pressure)	A pressure regulator station, including both single and multiple stages of pressure regulation that controls pressure to a distribution main serving more than one service line. The regulator station contains, as a minimum, pressure regulating valve(s) and an over-pressure protection device, such as a monitor, relief valve, or automatic shut-off device. Stations are designed to Standard H-14.	1539 (1322 / 217)
District Regulator Stations (designed to H-10)	A pressure regulator that reduces pressure from the transmission system to distribution system and that typically serves many customers. Facilities are designed to Standard H-10. HPR-type district regulator stations using 3/4" spring-operated regulators only.	868
HPR Farm Tap Sets (designed to H-10)	A pressure regulator that reduces pressure from the transmission system to a distribution service line and typically serves only one or two customers. Facilities are designed to Standard H-10. Farm tap regulator sets using 3/4" spring-operated regulators only.	2433

Note that for simplicity, the term "HPR" will be used to represent both Farm Tap sets and HPR-Type District Regulators built to H-10. Sample distribution regulator stations are shown in Figure 17 and Figure 18 for district regulator stations (above ground) and distribution regulator stations (below ground), respectively

[2] District Regulator and Farm Tap Sets counts based on data included in SAP as of 4/16/2015. Various operations and system needs will result in changes to the overall counts over time as facilities are removed, design basis changes, etc.

Figure 17 - District Regulator Station (above ground)

Figure 18 - District Regulator Station (below ground)

2. Asset Management Strategy

The overall asset management strategy for these facilities includes several programs to manage the life cycle and reliability of the facilities and equipment, including:

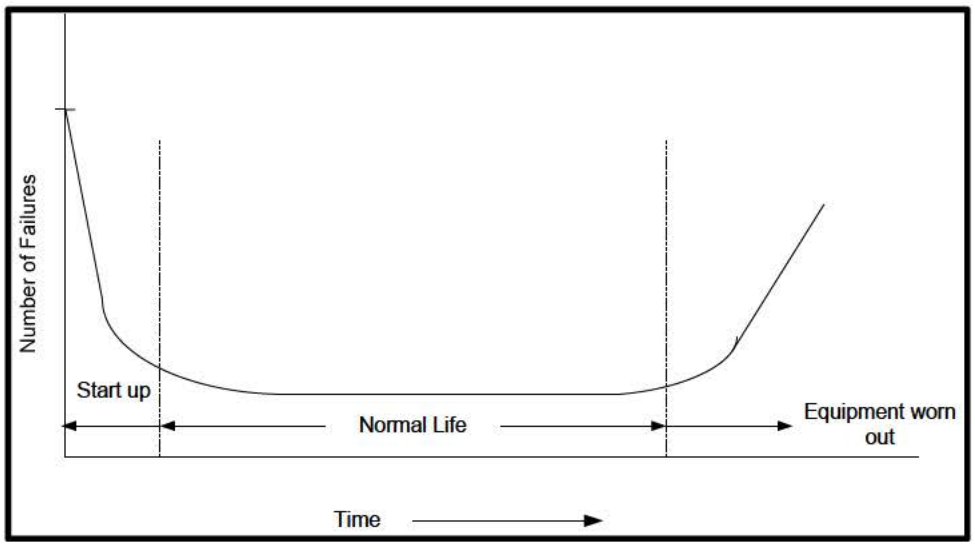
- Maintenance programs to effectively inspect and maintain equipment and to monitor the health of the equipment
- Targeted equipment replacement programs for equipment identified as obsolete or problem equipment
- Rebuild of facilities to maintain health of the overall facilities, to address operational and safety needs, and to ensure a rational turnover rate of the distribution facility fleet.

The basis for the distribution regulation asset strategy is described in the remainder of this white paper.

Equipment or Component Level

The equipment or component level strategy is focused on the maintenance and upkeep of the equipment to achieve the expected life (or obsolescence) of the various equipment items. It involves maintenance through the life cycle and replacement when the expected life (or obsolescence) is reached. Equipment becomes obsolete through normal wear with age, when vendors no longer support the equipment, and when equipment performance deteriorates. Equipment aging is typically illustrated in a "bathtub curve" as shown in the Figure 19.

Figure 19 - Equipment Life Cycle



As equipment starts up (or breaks in), the probability of failure may be high due to installation problems during its initial operation. For district regulator and farm tap set assets, this startup period is very limited and the probability of failure is low. After this break-in period, the probability of failure is relatively low for an extended period of time. Normal maintenance activities are defined to ensure that the equipment remains in operable condition. Following this expected life, the probability of failure increases sharply with time. As the equipment ages and becomes obsolete, the lack of readily available spare parts impacts the ability for normal maintenance to prevent malfunction or mis-operation. The risk of equipment malfunction or mis-operation increases greatly.

Management of the regulation assets during the normal life consists of defined maintenance and parts replacement. Therefore, obsolescence management of equipment is included as a risk mitigation measure to address identified threats and risks. Obsolescence management specifically addresses the threat of equipment failure. When equipment is identified as obsolete, appropriate programs will be identified to address these issues and the replacement of these components.

PG&E continually evaluates equipment for issues related to obsolescence, condition and performance through its maintenance and asset management program. A pilot condition assessment of 83 facilities provides additional insight for the asset management program. Through these assessments, PG&E expects to identify obsolete and problem equipment for replacement on a regular basis.

Facility Level

At the facility level, the types of equipment can be grouped into equipment that has:

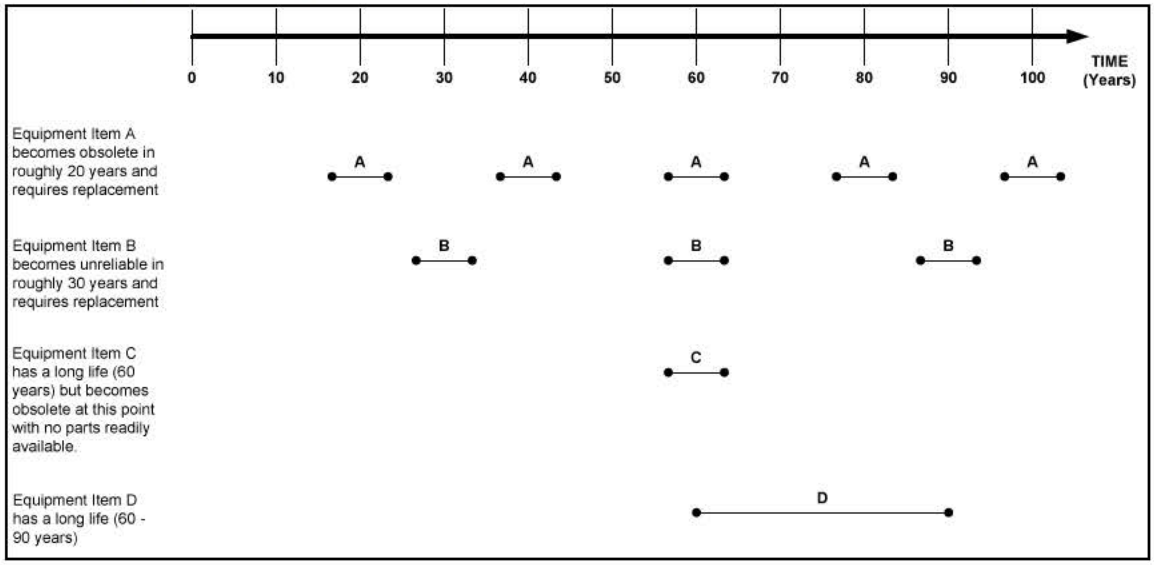
- A defined useful life in which experience indicates that the equipment has a finite life and requires replacement based on either a time-based replacement or a condition-based replacement interval.

- A very long and indeterminate life cycle in which experience indicates minimal threats to the equipment and replacement is based on economic or condition-based criteria.

Typically, for a facility, the accessible components (valves, actuators, filters, meters), whether above ground or in vaults, have defined life cycles ranging from 10 to 30 years and can be individually replaced during the life of the facility. The inaccessible buried components (valves and piping) have very long life cycles and can be replaced or inspected during major facility rebuilds.

For the facilities in the M&C Asset Family, there will be various replacement intervals for each specific equipment item. The goal is to manage the facility so that the health of the facility remains good and that work is integrated to allow for efficient and cost effective equipment replacement at the facility. A program is being developed through the maintenance mobile platform to collect specific aging and life cycle data for the equipment items in each facility. The example below (Figure 20) shows how this strategy may play out for a set of equipment items at a facility. Items A, B and C have different replacement intervals based on time-based or condition-based strategies. Therefore, effective asset management at the facility includes determining when and how to replace equipment. An example is presented below using appropriate life expectancy for various types of equipment typical of a district regulator station or HPR. If Item A represents a meter with an expected life of 20 years prior to obsolescence, this item can be replaced and not require replacement of other items. If Item B represents a pilot-operated regulator, it may have a 30 year life. At some point equipment obsolescence and compatibility becomes an issue. If Item C represents a manual valve, then this may require replacement at 60 years based on lack of replacement parts and obsolescence. Therefore, a strategy may be to replace these items together at 60 years along with other equipment that has reached its useful life. If Item D represents piping, a decision is required whether to replace at this time or wait until a later time based on inspection. This decision will be both economic and condition-based, such as its current condition, configuration issues with the facility, or ease of replacement along with other facility equipment.

Figure 20 - Typical Facility Asset Management



This example provides a basis for specific facility asset management and the specific time frames and decisions must be made on the equipment performance and maintenance data. The facility rebuild may include the following scenarios:

- Major facility rebuild of regulators, meters, valves, filters and other equipment based on equipment obsolescence, functional fit and facility condition, excluding replacement of buried piping. However, the buried piping will be available for inspection and a condition assessment can be performed to validate continued use of this asset.
- Major facility rebuild of regulators, meters, valves, filters and other equipment based on equipment obsolescence, functional fit and facility condition, including replacement of buried piping. An economic analysis may determine that replacement of the piping with the facility rebuild is appropriate from a cost-effectiveness standpoint.

The information currently being gathered as part of the maintenance, condition assessment, and asset management programs can provide the basis for a more condition-based strategy. The health score for the pilot condition assessment includes a set of ten (10) metrics that provide a good basis for identifying the equipment health. This approach is the same as currently being utilized for gas transmission stations. The key is that appropriate data must be available to provide for a solid evaluation and assessment.

Asset condition is based on available data that is currently being collected on an equipment basis from the maintenance program databases so that each facility can be evaluated based on the condition of the assets at the facility relative to their expected life. Considerations that will factor into determination of equipment condition include:

- Equipment age
- Equipment obsolescence
- Physical condition
- Functional performance
- Maintenance-related metrics

- Defined maintenance strategy
- Number of corrective maintenance tags
- Schedule compliance for preventative maintenance tasks
- Percent of corrective maintenance man-hours over total maintenance man-hours

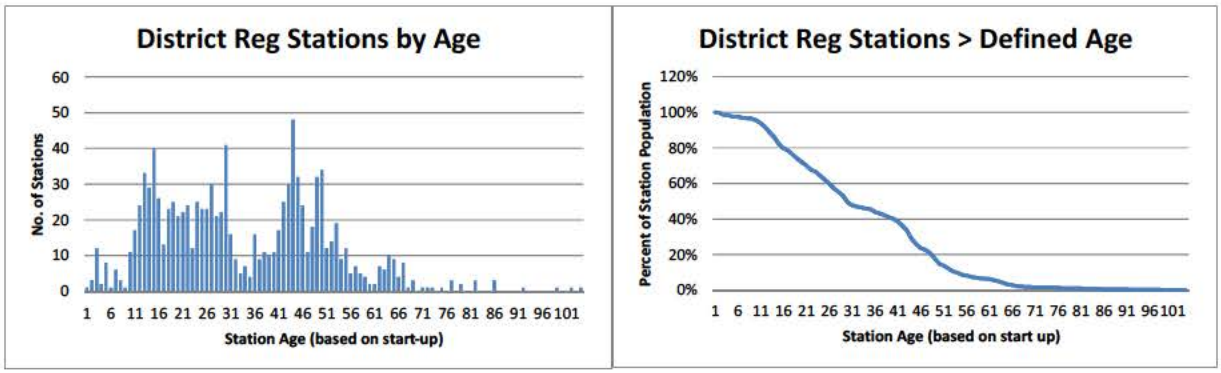
Based on the overall asset condition, specific actions can be defined from continuation of normal maintenance to targeted projects (component replacements) to facility rebuild.

Fleet-Level

Managing at a fleet level requires that obsolescence is managed so that there is not a build-up of obsolescence requiring many facility rebuilds over a short period of time. Over the past years, there have been about 10 - 15 facility rebuilds annually for the district regulator facilities (H-14 type). These facility rebuilds for the most part have consisted of replacement of equipment, piping and vaults. There has also been action taken on about 2300 HPRs (H-10 type) since 2011 (about 600 on average each year) that includes removal (and connection of service to an existing main) or rebuild.

For district regulator facilities (H-14 type), the current facility turnover rate is approximately 90+ years. The current age of the facilities based on facility start (or commissioning) date are shown in Figure 21 below. The first graph shows the number of facilities by age and the second graph shows the percent of facilities greater than a specified age.

Figure 21 - District Regulator Facility Aging (H-14 Type)



There are two types of facilities built to the H-10 design; including those identified as district regulator station facilities (stations are subject to annual maintenance requirements) and farm tap sets, which are not defined as station facilities (farm tap sets do not require annual maintenance, but are subject to atmospheric corrosion inspections every 3 years). The current age of these assets are shown in Figure 22 and Figure 23 for district regulator station facilities and farm tap sets, respectively.

Figure 22 - District Regulator HPR Aging (H-10 type)

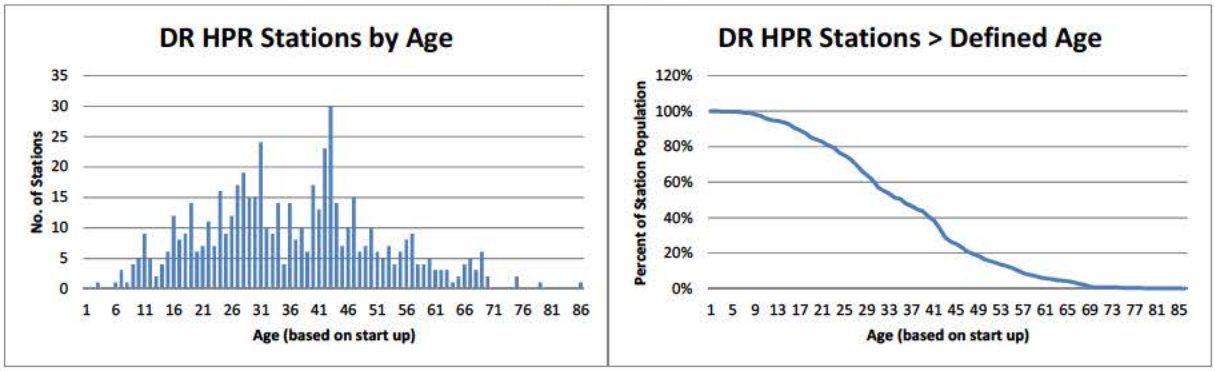
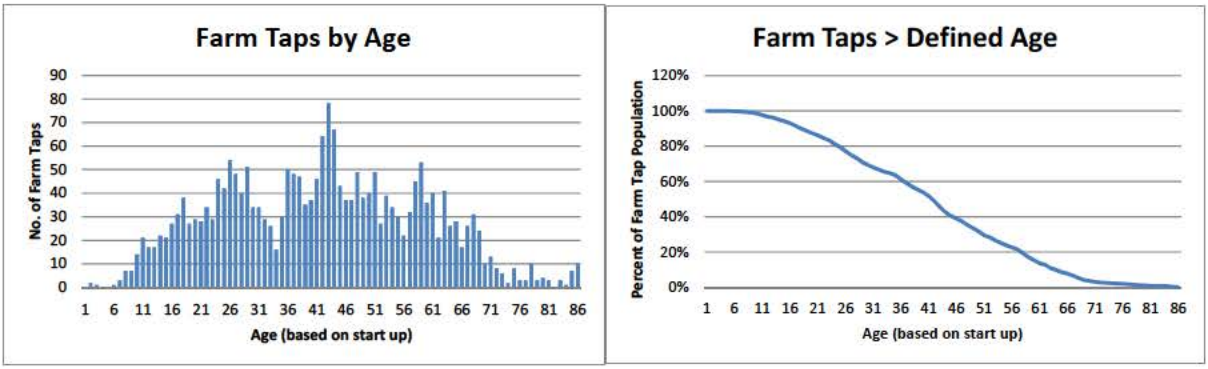


Figure 23 - HPR Farm Tap Aging (H-10 type)

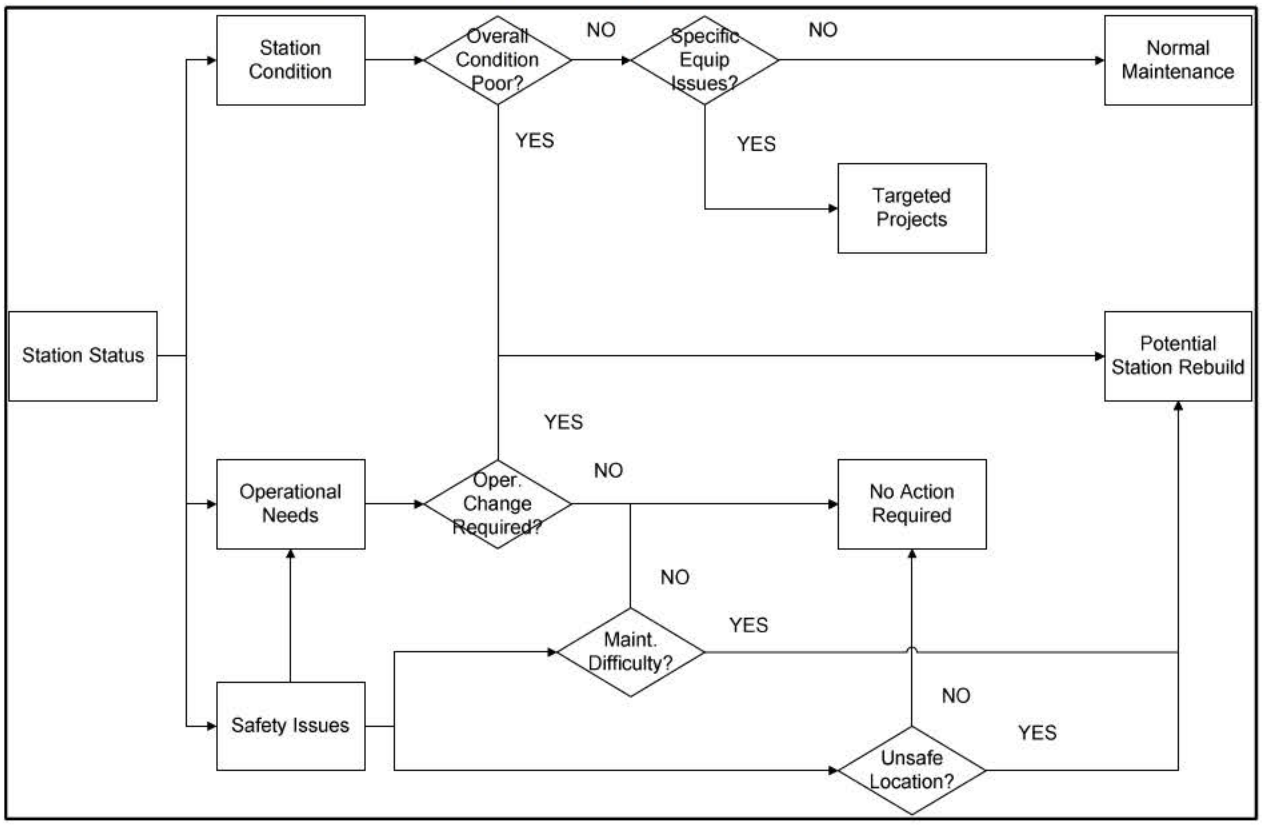


Management at the fleet level requires rebuild or replacement of facilities to ensure that the fleet age does not reach a stage where a significant number of rebuild actions are required.

Asset Strategy Decision Tree

The decision for action for the district regulator facility (H-14 type) is based on condition and safety concerns. Also, when the HPR program is completed, then these assets would utilize this decision tree. The high-level decision tree for actions at a facility is shown in Figure 24.

Figure 24 - District Regulator Facility (H-14 Type) Decision Tree



Based on the overall asset condition, specific actions can be defined from continuation of normal maintenance to targeted projects (component replacements) to facility rebuild. Other factors that influence action at a facility include:

- Operation needs or changes at a facility due to its function in the overall hydraulic independent system
- Potential safety concerns related to location of the facility (e.g. street) or difficulty in performing maintenance

When these factors are evaluated, a specific action at a facility is determined. Based on this overall asset management strategy, specific discussion of the facility targeted projects and rebuild programs is provided in Section 4.

3. Recommended Programs and Pace – District Regulator Station Facilities (H-14 Type)

The facility rebuild projects are intended to address facility equipment aging, obsolescence, and operational needs. The projects are intended to be a complete rebuild of the facility to ensure replacement of older and obsolete equipment and piping, to upgrade configuration to meet current system needs, and to address any outstanding issues with facility operations and maintenance. The scope of each specific facility rebuild will depend on a review of the condition of all facility components, as well as operational and safety issues.

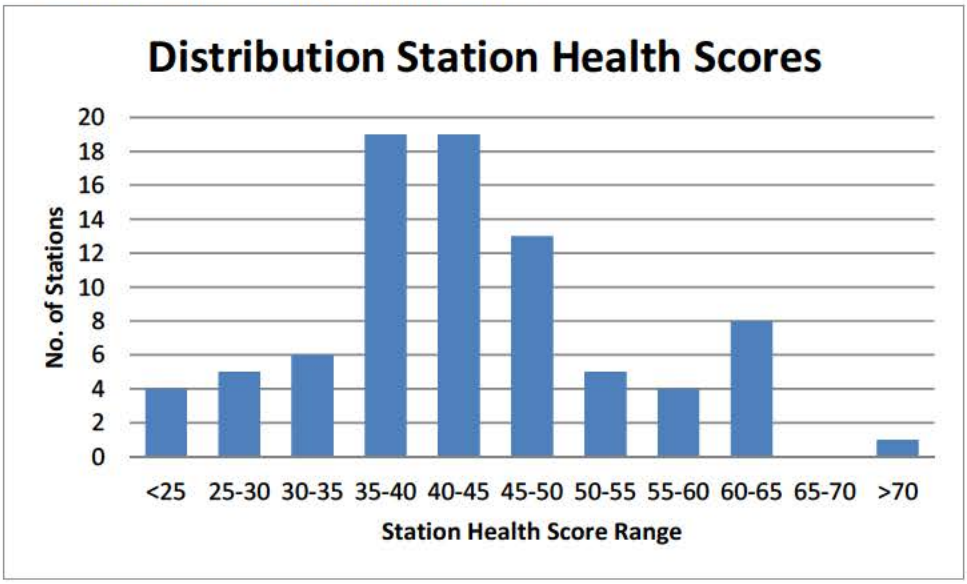
The initial pace of facility rebuilds can be targeted based on overall age distribution. However, the final determination of need for a facility rebuild will depend on a review of the condition of all facility components, as well as operational and safety issues.

As indicated previously, at the current rate of facility rebuilds, the facility turnover rate is approximately 90+ years at the historic average rebuild rate, and about 80 years based on 20 facilities per year (pace planned for 2015 – 2016) for the 1322 H-14 type facilities. While aging is not typically used to define asset replacement in the gas industry, it is utilized throughout the utility industry to provide a basis for retrofits and rebuilds of systems and plants.

Several studies have been conducted at PG&E over the past year that provide insight into establishing a basis for the facility rebuild program.

- A pilot condition assessment of 83 facilities (about 5% of district regulator stations) provides input into the overall condition of the assets. The district regulator station facility score distribution is shown in Figure 25 (with higher score indicating poorer condition). The health scoring system is based on scoring each individual station component on 10 metrics (with the individual metrics ranging from 1 indicating good to 10 indicating poor). The overall station score is determined based on an algorithm that places a weighting factor on the scores of the various component types. This distribution on condition scores is similar to the overall transmission assessment facility scores as shown in the 2014 M&C Asset Management Plan.

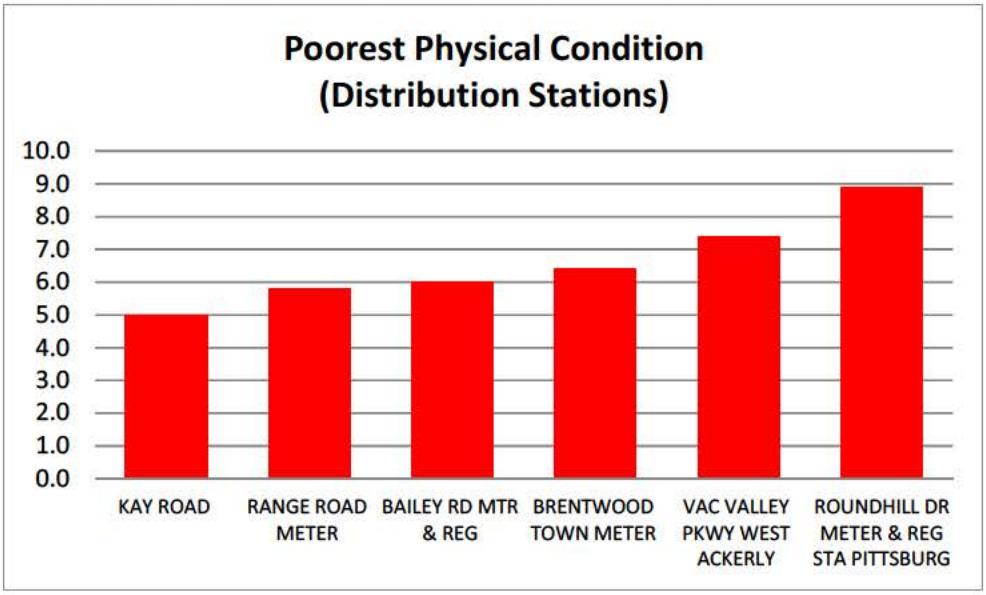
Figure 25 - Distribution Facility Health Scores



- Additionally, a key observation from the original transmission condition assessment was the physical condition of the facilities. This specifically led to the observation that vaulted facilities required additional attention. Since most of the distribution facilities are vaulted, the average of the physical condition metric scores for each component in a station is provided to compare the distribution facilities to the overall assessment results. Figure 26 provides the physical condition results for the distribution stations from the pilot with average score greater than 5. Based on the pilot assessment, about 7% of the

stations evaluated have high average physical condition scores (average component score greater than 5 on scale of 1 to 10, with 10 being poorest condition).

Figure 26 - Distribution Facility Physical Condition Scores



- A survey is being conducted to solicit input on facilities requiring attention. The survey of the various divisions indicates the following:
    - There is a wide range of district regulator station and HPR conditions over the various divisions relative to both physical condition of the assets as well as safety concerns.
    - Safety concerns are primarily focused on accessibility of the facility relative to its location or ability to enter and work at the various locations. The surveys indicate that 1-2% of the facilities may have safety concerns related to the accessibility issues. These issues have developed over time as growth has occurred in the vicinity of these facilities (such as roads, etc.).
    - Conditions of facilities are primarily focused on existence of obsolete equipment (such as Fisher 399 valves) that requires replacement and on the physical condition (rust, etc.) of vaulted facilities. The surveys indicate 5 -10% of facilities with physical condition issues. [Also, the transmission assessment identified concerns with vaulted facilities that flood and about 80% of the district regulator station facilities are vaulted.]
    - There is a need for facility upgrades related to the SCADA program where some facilities may be too small to incorporate SCADA.

Facility Rebuilds

Based on discussion of the various asset life expectancies as discussed in Section 2, it is reasonable to manage a pool of assets to a replacement age of 60 years as a targeted pace. The 60-year age is based on the expectations of equipment obsolescence and multiple equipment replacements throughout this life cycle. The on-going management of the assets ensures that a large asset population requiring refurbishment does not build up over time, which would require significant work in a short period of time. Therefore, the frequency of facility rebuilds is based on maintaining an overall turnover rate of assets of 60 years. For the district regulator station facilities, this translates into replacing about 27 stations per year to maintain a 60-year turnover. However, in reviewing the existing data from Figure 4, there are 8% of stations over 55 years in age (about 128 stations) and there are additional stations expected to have potential safety and operational issues (approximately 15 – 30 stations for safety concerns based on initial feedback from the survey). Therefore, it is recommended that 110 - 120 stations be considered for rebuild over this next rate case period consistent with the ability to execute these projects.

Targeted Replacement

For targeted projects, the pilot assessment is reviewed for facilities that have components with high scores for component functional performance and physical condition. These results indicate that 20 stations out of the 83 stations in the pilot program have components with high functional performance or physical condition scores (high scores mean poor condition/performance). Since this is about 25% of the total population, this indicates that there may be 400 stations in the total population that have the potential for targeted actions. There are also projects required to address obsolete equipment types. Based on prioritizing the work at these stations, it is recommended that the pace of work be established to address specific needed actions at these stations. Therefore, it is recommended to address approximately 400 targeted projects over the rate case period consistent with the ability to execute this work.

4. Recommended Programs and Pace – HPR (H-10 Type)

The approach for the HPRs (H-10 type) is different than the strategy applied to the district regulator (H-14 types) station facilities. The strategy for addressing HPRs includes the following options:

1. Removal of the HPR (one or more) and connection to an existing main
2. Replace in kind (rebuild the HPR to current H-10 Standard)
3. Replacement of the HPR with a district regulator station facility

PG&E evaluates the alternatives based on location of HPR, location of the main, and potential future system configuration to evaluate an HPR and determine a cost effective approach to continued safe and reliable operation. This approach ensures that HPR's are replaced or rebuilt consistent with system needs to serve these customers. The HPR program has existed for several years and Figure 27 shows how the HPR were dispositioned. The alternative method used most often during the initial period was removal of the HPRs. Figure 28 shows how the removed HPR's were addressed and dispositioned.

Figure 27 - HPR Actions

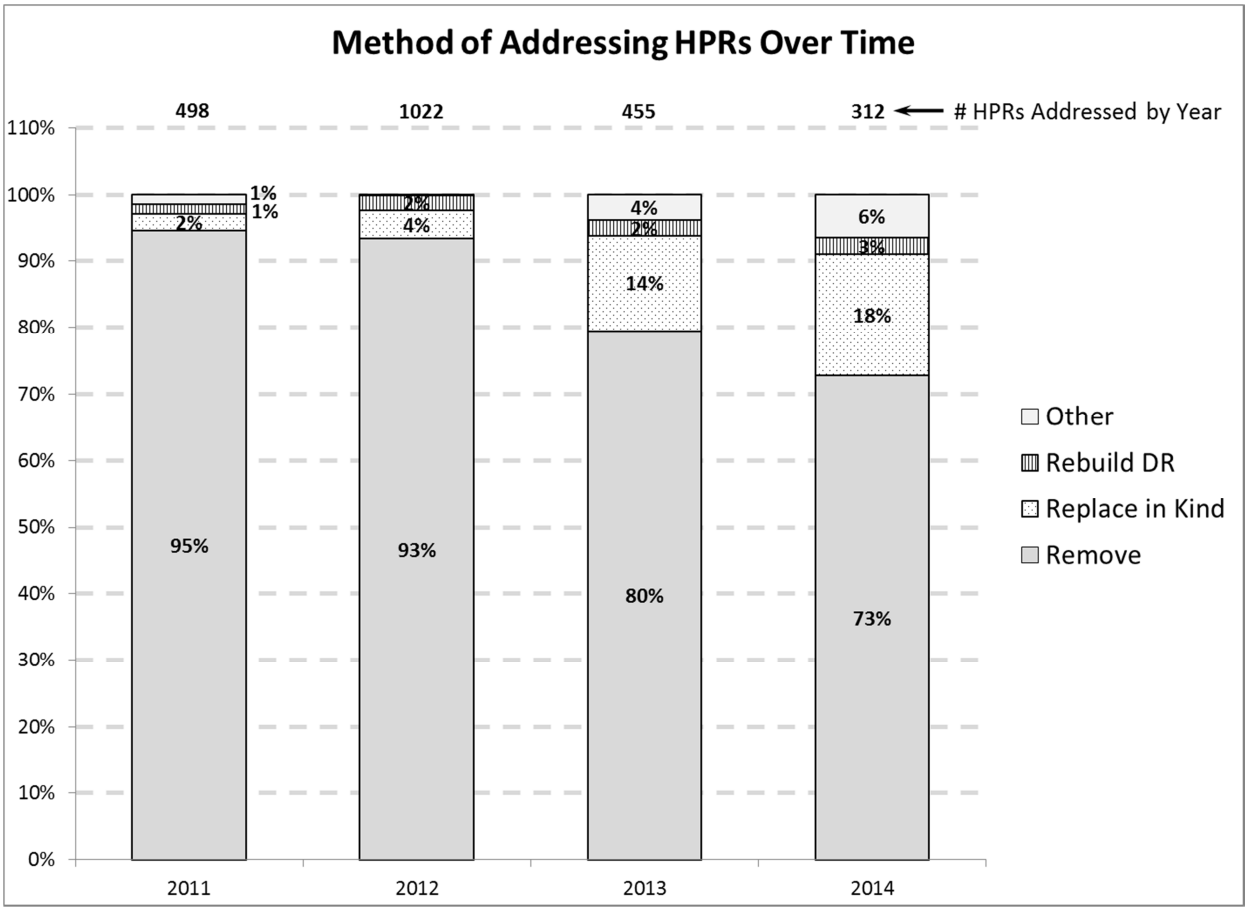
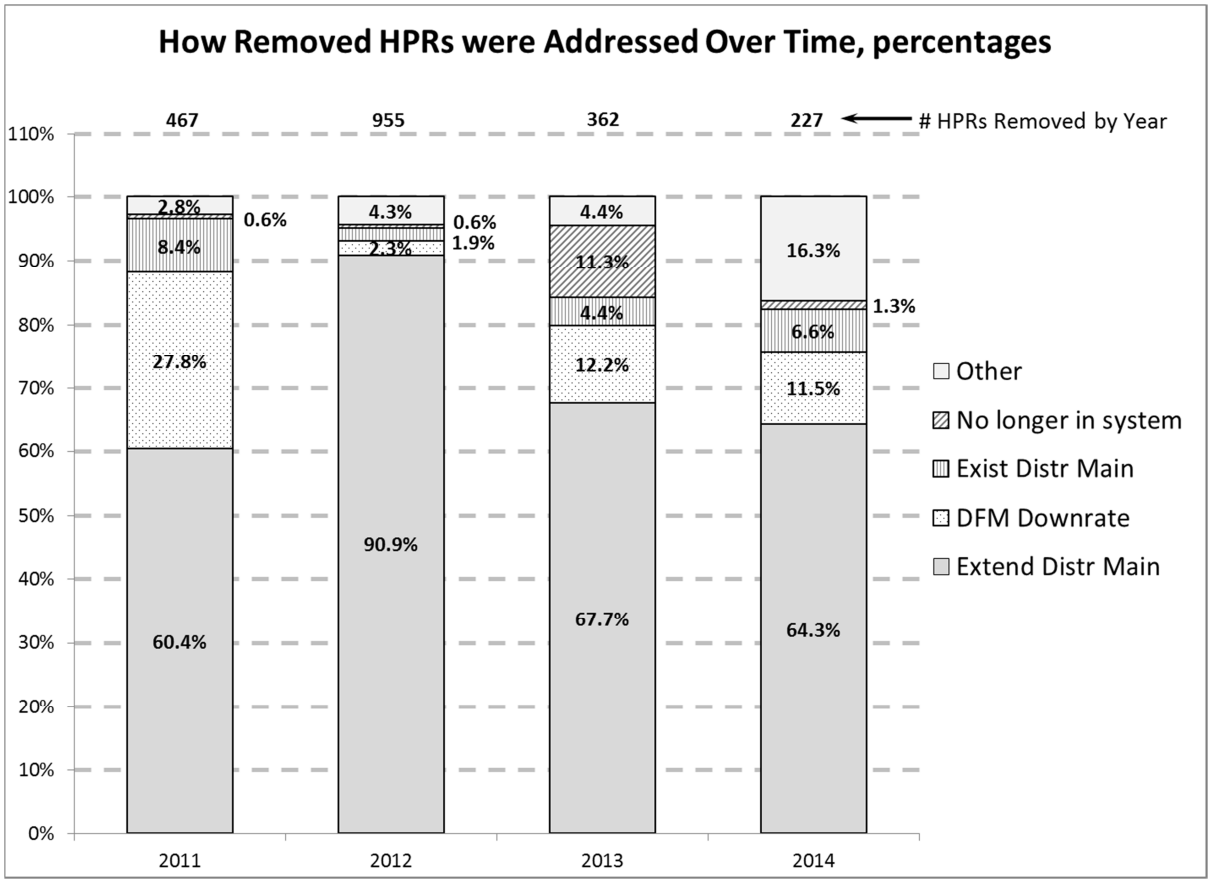


Figure 28 - HPRs Removed and Subsequent Disposition



It should be noted that of the three methods for addressing HPR's, the cost of removal and addition or extension of distribution mains has the most variable scope and cost since the length of main added or extended will vary widely depending on the location of the HPR.

Since the HPR's have not been subject to frequent maintenance, it is important to evaluate these for action is a reasonable timeframe. Recent performance has indicated that depending on the complexity of the action identified, PG&E has performed about 500 HPR actions per year. This rate of addressing HPR's appears reasonable and will allow for completion of the remaining HPR reviews within the next 5 – 6 years. Therefore, a pace of HPR action of approximately 500 stations per year is recommended subject to changes needed to meet specific HPR actions (and their complexity) and the availability of resources to support the required strategies for the specific HPR's.

O. Gas Quality Monitoring

The M&C Asset family is also responsible for gas quality monitoring. PG&E monitors the quality of gas at all regular entry points into its system. The taps between PG&E and SoCalGas and Southwest Gas are not monitored for quality because: the flow rates are relatively small; the flows can be infrequent; the flows are often from PG&E toward SoCalGas or Southwest Gas; and the gas is from a transmission line which has already been monitored for quality. For the large interconnects, such as Transwestern, El Paso, Kern River Daggett, and the storage fields (third party and PG&E-owned and operated except Pleasant Creek), PG&E utilizes gas chromatographs (GCs) to continually monitor the gas composition for heating value determination. These GCs also measure the carbon dioxide concentration. In the case of the Gas Transmission Northwest (GTN) and Ruby interties, PG&E utilizes the GC data provided by these suppliers as measured at the interconnects. For the California production and the Pleasant Creek Storage Field, the supply gas is collected continuously using a time-weighted sampler which allows PG&E to calculate the heating value and the average carbon dioxide concentration at the delivery points.
Moisture and Hydrogen Sulfide (H_2S) analyses are handled somewhat differently as described below. Some analyses are performed at the entry points to PG&E and some are done downstream within the PG&E system.

PG&E collectively measures the moisture content of the Transwestern, El Paso, Kern River Daggett, and Questar supplies at the Hinkley Compressor Station discharge on both Lines 300A and 300B. PG&E continually monitors the moisture level of the GTN gas at the Burney Compressor Station on both Lines 400 and 401. These on-line moisture analyzers were all installed in 2007. PG&E chose to install the monitors at these locations rather than at the various entry points in order to minimize the number of analyzers required and because these analyzer locations were relatively close to the various delivery points for these large suppliers.

PG&E continuously monitors the H_2S level of gas in Lines 300A and 300B at the Topock plant discharge and at the Hinkley Compressor Station suction, and at the Burney Compressor Station on Lines 400 and 401. The monitors used by PG&E are Medor sulfur chromatographs. PG&E chose to install the monitors at these locations rather than at all of the actual entry points in order to minimize the number of analyzers required while still allowing for sufficient data to measure the H_2S levels in these supplies.