PACIFIC GAS AND ELECTRIC COMPANY

ENGINEERING & OPERATIONS
GAS TRANSMISSION AND DISTRIBUTION
GAS ENGINEERING
GAS SYSTEM INTEGRITY
Risk Management

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Procedure for Risk Management

Procedure No. RMP-04
Rev. 4
Ground Movement Threat Algorithm

Prepared By: [redacted] Date: 11/19/01

Approved By: [redacted] Date: 11/20/01 (CMW4)

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1.0 PURPOSE

The purpose of this procedure is to provide a guideline for determining the Ground Movement Threat Algorithm for the determination of Likelihood of Failure and Risk for PG&E's Gas Transmission and Distribution's Risk Management Programs (RMP) and Integrity Management Programs.

2.0 SCOPE

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This guideline is applicable to all of PG&E's gas transmission pipeline and distribution facilities and is to be used in conjunction with RMP Procedure 01. The algorithm provided in this procedure is for Natural Gas Pipelines. It is not applicable to regulator, compressor, or underground storage station facilities.

The Integrity Management Group is responsible for managing risk within the scope of this procedure. The Integrity Management Group shall establish and manage the risk of each pipeline facility by utilizing industry and regulatory accepted methodologies appropriate for PG&E's transmission and distribution facilities and shall be in conformance with this procedure. The Integrity Management Program Manager shall be responsible for compliance with this procedure.

3.0 INTRODUCTION

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Gas Transmission: The risk management process is a process of integrating data to calculate risk, developing risk mitigation plans to bring and maintain risk within an acceptable risk profile, and monitoring risk to accommodate changes in the factors which affect risk. The Transmission Integrity Management Program (TIMP) is a program established by PG&E to address the integrity management rules in 49 CFR Part 192 Subpart O. (Procedure RMP-01 provides a procedure for the Risk Management Process.) Procedure RMP-06 provides procedures for compliance with the Transmission Integrity Management Program. This procedure supports the calculation of risk, required by Procedure RMP-01, due to one of the basic threats imposed on gas pipelines, Ground Movement (GM).

As described in RMP-01, Risk is defined as the product of the Likelihood of Failure (LOF) and the Consequence of Failure (COF). [Risk = LOF X COF] A relative risk calculation methodology is used to establish risk for all pipeline segments within the scope of RMP-01. The method used to calculate risk is based on an index model and qualitative scoring approach. Likelihood Of Failure (LOF) is defined as the sum of the following threat categories: External Corrosion (EC), Third Party (TP), Ground Movement (GM) and Design/Materials (DM).

Each threat category is weighted in proportion to PG&E and industry failure experience. GM is weighted at 20%. The weightings on the threat categories will be reviewed and approved annually by the Consequence Steering Committee. For each threat category, the appropriate steering committee will identify the significant factors that influence the threat's likelihood of failure. For each factor, a percentage weighting will be established to identify the factor's relative significance in determining the threat's likelihood of failure within the threat algorithm. Points will be established based on criteria that the

committee feels is significant to determining the threat's likelihood of failure due to each factor and the relative severity of failure (leak-before-break vs. rupture). (Negative points may be assigned where current assessments have been made to confirm pipeline integrity and/or mitigation efforts have eliminated or lowered susceptible to a threat.) Generally, the summation of the percentage weightings for all of the factors within each threat will be 100%. (There may be exceptions to permit the consideration of very unusual conditions.)

For the threat of GM, the scoring is based on direction from the GM Steering Committee. The GM Steering Committee shall meet once each calendar year and shall review this procedure per the requirements of RMP-01.

Gas Distribution: Gas Distribution Integrity Management Plan (DIMP) is a maturing program which will be adjusted to meet the requirements of the planned subpart P of 49 CFR 192. Currently it uses a Subject Matter Expert approach to identify and prioritize risks. That process is detailed in Section 6.2 of this document. 4

4.0 Roles and Responsibility

Specific responsibilities for ensuring compliance with this procedure are as follows:

Title	Reports to:	Responsibilities
Integrity Management Program Manager	Director of Integrity Management and Gas Issues	• Supervise completion of work (schedule/quality) • Monitor compliance to procedure – take corrective actions as necessary. • Assign qualified individuals • Ensure Training of assigned individuals • Assign Steering Committee Chairman, and ensure that meetings are held once each calendar year.
Steering Committee Chairman (Risk Management Engineers)	Integrity Management Program Manager	• Arrange meetings. • Review procedure with committee per RMP-01 • Provides meeting minutes • Ensures action items are completed.
Steering Committee Members (Subject Matter Experts)	Various	• Attend meetings as requested by Steering Committee Chairman. • Provide review and direction to procedure.
Risk Management Engineers	Integrity Management Program Manager	• Perform calculations per procedure.

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5.0 Training and Qualifications

See RMP-06 for qualification requirements. Specific training to ensure compliance with this procedure is as follows:

Position	Type of Training:	How Often
Integrity Management Program Manager	Procedure review of RMP-01 and RMP-04	• Upon initial assignment • Once each calendar year.
Steering Committee Chairman	Procedure review of RMP-01 and RMP-04	• Upon initial assignment • Once each calendar year. • As changes are made to the procedure.
Steering Committee Members (Subject Matter Experts)	RMP-04 and Steering Committee requirements of RMP-01	• Once each calendar year at the time of the steering committee meeting.
Risk Management Engineers	Per RMP-06 Integrity Management Program	• Upon initial assignment • Once each calendar year. • As changes are made to the procedure.

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6.0 GROUND MOVEMENT THREAT ALGORITHM

6.1 Gas Transmission: Ground Movement (GM) algorithm shall be calculated per the direction of the GM Steering Committee. The committee has determined that the factors in A through H of this section are significant to estimate the Likelihood of Failure (LOF) of a gas pipeline due to *ground movement* damage. The GM contribution to LOF shall be the summation of assigned points times the assigned weighting for the following factors:

A) Crossings* (30% Weighting): Points will be awarded as follows:

Criteria	Points	Contrib.
Major Water Crossing Present**	40	12
Seismic Fault Line Present***	60	18
No Major Water or Fault Not Present	0	0

* Points for each factor are additive.

** A Major Water Crossing is defined as waterway identified by the Office of Pipeline Safety (OPS) as being a Commercially Navigable Waterway".

*** Seismic Fault Line Present is defined as either a Historic or Holocene type fault crossing.

B) Unstable Soil (Susceptibility to either slope instability or liquefaction) (15% Weighting): Points will be awarded as follows:

Criteria	Points	Contrib.
Known Soil Instability or Landslide	120	18
Moderate-High Slope Instability	100	15
Liquefaction*	100	15
None	0	0

* Liquefaction shall be considered for areas defined as Moderate-High or Known Liquefaction within GIS and pipelines installed prior to 1947.

C) Seismic Area* (15% Weighting): Points awarded as follows:

Criteria	Points	Contrib.
Seismic Ground Acceleration** ≥ 0.5g	150	22.5
Seismic Ground Acceleration ≥ 0.2g to 0.49g	100	15
Seismic Ground Acceleration < 0.2g	0	0

* Seismic Area shall be considered only if it is in an area of unstable soil. For the purpose of this factor, unstable soil shall be defined as an area of Moderate-High Soil Instability within GIS or areas of Moderate-High or Known Liquefaction within GIS.

** Seismic Ground Acceleration is the peak ground acceleration values to 10% probability of exceedance in 50 years (or 475-year return period). 4

D) Erosion Area* (10% Weighting): Points awarded as follows:

Criteria	Points	Contrib.
Pipe segment within 100 meters of identified erosion area	100	10
Not in erosion area	0	0

* Erosion Area's are reported by the Gas Transmission Erosion Project Manager and also include levee crossings less than 60 feet deep that are susceptible to failure are recorded into GIS on an ongoing basis.

E) Ground Movement Mitigation (5% Weighting): Points awarded as follows:

Criteria	Points	Contrib.
EXTENSIVE Ground Movement mitigation performed*	-360	-18
Some Ground Movement Mitigation**	-240	-12
None	0	0

* "Extensive Ground Movement Mitigation" efforts are projects whose scope substantially removed the ground movement threat of pipeline failure. This information is reported to the RMP on a case-by-case basis by the appropriate Pipeline Engineer and is documented in the RMP files.

** "Some Ground Movement Mitigation" efforts are projects whose scope removed some, but not all of the ground movement issues related to a threat to the pipeline. This information is reported to the RMP on a case-by-case basis by the appropriate Pipeline Engineer and is documented in the RMP files

F) Girth Weld Condition (20% Weighting): Points awarded as follows:

Criteria	Points	Contrib.
Pre 1947 Girth Welds within area of ground acceleration ≥ 0.5g	120	24
Pre 1947 Girth Welds within area of ground acceleration ≥ 0.2g to < 0.5g	80	16
All Other	0	0

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6.2 Gas Distribution:

PG&E's Distribution Integrity Management Plan (DIMP) (RMP-15) addresses each of the GPTC Appendix G-192-8 guide's seven major components. These components are as follows:

A. Knowledge of the distribution system – design, maintenance and operation
B. Threat Identification process
C. Risk evaluation and ranking of threats
D. Implement measures to manage risks
E. Measure and monitor results
F. Periodic evaluation of program for improvements
G. Reports to government agencies

Ground Movement (GM) (i.e. Natural Forces) threat algorithms for Gas Distribution are developed following the guidelines in RMP-15 and they are described as follows:

A) Knowledge of the system – PG&E's records and data bases that define the distribution system and what type of information they provide are described in Table 1.3 of RMP-15.

B) How Threats are identified – The GM threats to the distribution system are identified by Subject Matter Experts (SME). The pool used to select the members will include Gas Engineers at PG&E, Gas Planners at PG&E, experts from the PG&E Geosciences Department, members of the PG&E System Integrity Group and other industry experts inside and outside of PG&E.

C) Risk Evaluation and ranking of threats – Identification is performed by the SME team who then rank the Likelihood and Consequence of each threat with H, M or L. A value is then assigned to each of the ranks such as: H = 3, M = 2 and L = 1. The value of the Likelihood (L) X Consequence (C) of each SME's judgment will be calculated and then the average of all SMEs' risk values will be calculated as the relative risk value, R.

The relative risk values of the threat, $R = 1/n \, (\sum (Li \times Ci)) \quad (i = 1 \text{ to } n)$

n: Total number of SMEs.

In the table below, the consequence of the threat is that it will not be able to safely and reliably perform it's intended function. For example, in the event of an

earthquake, a higher ranking indicates a concern that activating a shutdown zone will limit the damage and loss of service to that zone.

Summary Table of Relative Risk Value (R) Per SMEs ballot results

Consequence / Threat	Shutdown Zones	Steel Pipe	Plastic Pipe	Cast Iron Pipe	Dist. Reg. Station	Customer Meter Set	Connection - Fittings	House Lines
Landslides	7.2	3.5	4.0	5.0	3.3	1.8	3.2	2.0
Liquefaction	7.2	2.2	2.7	5.5	2.8	3.5	2.3	3.0
Fault Crossing	7.2	6.2	5.0	6.0	7.0	4.0	4.5	4.0
Shaking	7.2	2.0	2.0	4.3	4.0	4.5	3.5	3.8

D) Implement Measure to Manage Risk – These risk rankings will be used to identify and implement measures to manage the risk.

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