**PREPARED DIRECT TESTIMONY OF GLEN STEVICK**
**ON BEHALF OF**
**THE CITY OF SAN CARLOS**

**R.11.02.019**

**CONFIDENTIAL VERSION**

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# PREPARED TESTIMONY OF GLEN STEVICK
# ON BEHALF OF
# THE CITY OF SAN CARLOS

## I. INTRODUCTION

This testimony is presented on behalf of the City of San Carlos (San Carlos) by Dr. Glen Stevick. A summary of Dr. Stevick's qualifications is attached as Appendix A. This testimony, based on review of available documentation, is intended to identify more detailed safety-related concerns that PG&E needs to address specifically with respect to the safe operation of Line 147.

In compliance with California Public Utilities Commission (CPUC) Decision 11-02-019, Pacific Gas and Electric Company (PG&E) issued its Pipeline Safety Enhancement Plan (PSEP) on August 26, 2011. In this plan, Line 147, which connects between Line 101 on the eastern end and Line 132 on the western end, was hydrostatically tested on 12/1/2011 between MP 0.83 and MP 3.40. A Spike Pressure Test was also conducted.

In my professional opinion, the PSEP, and its supporting testing and analysis, has many deficiencies which are described in this testimony below. An incomplete assessment by Berkeley Engineering And Research (BEAR) indicates that Line 147 might have adequate structural integrity to safely operate as a natural gas transmission transfer line. However, a fracture assessment needs to be completed to determine an allowable operating pressure and the allowable time between requalifications by hydrotest and/or follow-up fatigue and crack growth assessment. The estimate of a 500-year life referred to by Kiefner and Associates does not appear to be based on adequately conservative engineering assumptions. We recommend: (1) the database be further corrected, (2) an appropriate operating pressure be determined based on the consideration of all failure modes including fracture, (3) appropriate remaining life calculations performed and made available to PG&E engineering, and all regulatory bodies and (4) complete fracture testing be performed on materials available from repairs.

In addition to fracture assessment, BEAR needed additional information from PG&E to

properly assess the safety of Line 147. It is important to note that San Carlos and BEAR requested the following information from PG&E:

1. Full calculations, values, models and assumptions from Kiefner's Redacted letter to Sumeet Singh (Singh), of PG&E, dated October 18, 2013 re: current fitness for service of Line 147. Specifically, what calculations Redacted used to select an appropriate operating pressure as outlined in his Task 1. a. of his letter.

2. Documentary evidence, as referenced in Kiefner's Redacted letter to Singh, of PG&E, dated October 18, 2013 re: current fitness for service of Line 147. Redacted states that he reviewed the pipeline features list (PFL) and found that the description of the majority of individual pipes and other components is based on documentary evidence of some type. However, BEAR needs documentary evidence for each segment and asked PG&E to point out the lack of documentary evidence for each segment on Line 147.

3. A copy of the reference in Kiefner's Redacted letter to Singh dated October 18, 2013 re: current fitness for service of Line 147 No: 31, Hart, J.D., SSD, Inc. letter to GTS, Inc., August 17, 2011.

4. Calculations re: Kiefner, letter report dated Oct 18, 2013 (top of page 10): "In all cases the calculated times to failure were in excess of 500 years (an artificial cap we impose to reduce calculation time)."

5. Provide pressure recordings at the minimum time sampling rate (e.g. 20 second per sample or minute by minute) for Line 147 from January 1, 2010 to the present.

6. In the PFL submitted as 147MP0-3.8_08OCT13_RegRel.xls there are approximately 1.94 miles of seamless pipe listed with an install date of 1947. San Carlos asked PG&E to verify that PG&E had seamless pipe in 1947.

7. Provide a PFL that includes all assumed values in the database for Line 147.

To date, San Carlos and BEAR have not received a response to the requested data from PG&E.

BEAR did not find any concrete evidence showing that PG&E hydrotested the entire Line 147. Design safety factors for devices or equipment that: (1) have not been fully proof tested (end-to-end for a pipeline); (2) lack an accurate representative model (knowing what is in the ground and where); or (3) lack representative test data should be 3.0 or greater; which indicates a maximum allowable operating pressure of 220 psi. With an end-to-end proof test, representative fracture and tensile test data, a complete fracture and fatigue analysis and an up-to-date pipeline database, a lower safety factor and higher operating pressure can be justified.

On October 15, 2012, a gas leak occurred at MP 2.29, which is near the intersection of Redacted in San Carlos. Excavation for repairs revealed that the pipe

was different from what PG&E has listed in its database, either its GIS or its PFL. A redacted email string, dated Nov 17, 2012 to Mr. Sumeet Singh, states: "we now believe this is 1929 pipe . . . It is thin wall pipe and now we have found external corrosion on it . . . we now have visual confirmation that this is A.O. Smith Type 1 seamed pipe."[1] Redacted, a PG&E consultant concludes that the pipe is a "first-generation A.O. Smith pipe that had been reconditioned."[2] Anamet, Inc. performed a metallurgical evaluation and stated in their August 19, 2013 report that based on information provided by PG&E, the weld "appears to be an A.O. Smith type weld."[3] Later, PG&E asked Anamet to redact this information, because it was "not traceable, verifiable and complete."[4]

At this time, after PG&E has spent millions of dollars on an updated database, it is still not clear from the record what kind of pipe is in the ground at, and nearby, MP 2.29. Safe and well maintained gas pipelines rely on (a) accurate data of infrastructure characteristics; (b) correct mathematical calculations to assess risk of an aging pipeline system; and (c) transparency so that engineers and scientists inside PG&E and regulatory bodies can find problems before accidents occur. The calculations performed by Kiefner and Associates[5] have not been produced and it does not appear PG&E had a Pipeline Engineering Manager available to handle the pipeline repair at MP 2.29.[6]

## II. OVERVIEW

### *A. PG&E Data of Pipeline Characteristics*

In August 2011, PG&E filed the PSEP which requires pipeline data to prioritize maintenance and capital improvement through a decision tree (DT). The accuracy and

1 GasPipelineSafetyOIR_DR_ED_005Q02Atch45_Redacted; see Appendix B, footnote 1.

2 0215-1305 Final Letter L147 FFS _Rev2 (3) Kiefner Report, see Appendix B, footnote 2.

3 Anamet, Inc. Laboratory Certificate, No: 5004.9237, August 19, 2013; see Appendix B, footnote 3.

4 GasPipelineSafetyOIR_DR_DRA_091-Q05; see Appendix B, footnote 4.

5 0215-1305 Final Letter L147 FFS _Rev2 (3) Kiefner Report; see Appendix B, footnote 5.

6 GasPipelineSafetyOIR_DR_DRA_087-Q28Atch02_CONF, email between Todd Arnett and others, it is stated that there is no Pipeline Engineering Manager [to handle the pipeline repair at MP 2.29], and "hopefully we can do it democratically." See Appendix B, footnote 6.

effectiveness is highly dependent on the accuracy and completeness of the data used. At the time PG&E was using an old database which was to be replaced by a newer version. The two databases were not connected and PG&E planned to verify accuracy on a project-by-project basis.

By May 2012, PG&E was proceeding with its Records Verification and MAOP Validation Project Phase 3. The new database version incorporates macros that flag inconsistent entries. For example, if a data entry operator enters a pipe seam type that was not available when the pipe section was manufactured, an error screen appears alerting the data entry person of that fact. If fields have been populated with parameters within acceptable ranges, the error checking macros do not make competing suggestions. When out-of-range errors do occur, the user is alerted and may obtain expert input.

The error checking macros are an improvement, but may mask the difference between known records and those that are "assumed" rationally or otherwise. In PG&E's Procedure for the Resolution of Unknown Pipeline Features, PRUPF,[7] macros help data entry when features are not known. The example given, on page 10, explains that if a pipe section might have been purchased in 1945, the assumption is that it could have been manufactured any time in the previous ten-year time span. Given this, the system then prompts the operator to a limited, time period appropriate choice for longitudinal seam type, which are LW, SMLS or ERW. The data entry person is then to choose the more conservative choice, which would be LW, "because of its lower E [efficiency]."

PG&E states that an independent audit firm tested a sample in the PFL and provides a spreadsheet of that sample.[8] This begs the question: what did the independent audit conclude? How does an audit detect the fact that data is entered incorrectly, as was the case for Line 147? An email dated November 17, 2012 between PG&E employees point to the problems that persist in the database: "no peer review, the QC engineer is the same as the FVE." Also, if data is filled

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7 Utility Procedure: TD04199P-01, 10/09/2013 Rev: 0; see Appendix B, footnote 7.

8 GasPipelineSafetyOIR_DR_DRA_087-Q20Atch01; see Appendix B, footnote 8.

out based on assumptions, this has to be indicated in a "rationale column," which was not done.[9]

Data for Line 147 show that pipe was seamless in some sections, unknown long seam in other sections, or double-sided arc welded in yet other sections. In July 2013, PG&E informed the CPUC that Line 147 actually had single-sided submerged arc welds, SSAW, similar to those that proved fatal in the Line 132 explosion in San Bruno. According to the latest PFL available for review, there are 3,514 feet of this type of pipe with unknown specifications. The installation dates are listed at 1947 and 1957. The segments in question are in the 103 and 108 ranges. These segments are in a Class 3 location at the eastern end of Brittan Avenue.

The PFL also lists pipe that was installed in 1947 as seamless. There are 1.94 miles of pipe with unlikely 1947 and seamless designations. An unreliable database makes a safe operating assessment difficult and unnecessarily raises suspicions.

The information that Line 147 at the leak location was not seamless was provided to CPUC nine months after PG&E technicians discovered the leak. PG&E determined that the pipe at the leak location was probably 1929 vintage A.O. Smith pipe. PG&E also stated that segment 109 had a High Frequency ERW weld.[10] Again, the information provided to CPUC is conflicting: was it a SSAW weld or an ERW weld?

Key characteristics of the entire Line 147 will determine at which pressure the pipe can be operated safely. Without knowing the accuracy of the pipeline database data, it becomes difficult to determine an accurate safe operating pressure.

The old database reveals that some segments in Line 147 were installed pre-1960. In particular, Segments 107 through 110.9, between MP 1.48 and MP 3.28, were installed in 1947, 1953 or 1957. Segment 109, where the leak occurred, was installed in 1957. This entire section was listed as seamless which was almost certainly in error given the dates of installation. The new database should pick up this type of error.

When checking the latest version of the PFL, there are still pre-1960s installed sections on Line 147 that are listed as Seamless. These facts call into question PG&E's ability to manage a

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9 GasPipelineSafetyOIR_DR_TURN_034-Q02Atch03_CONF; see Appendix B, footnote 9.
10 GasPipelineSafetyOIR_DR_DRA_087-Q26; see Appendix B, footnote 10.

database for which it has allocated over $200 million in upgrades, improvements, and automation. PG&E maintains that in the absence of verifiable data, it likes to err on the side of conservatism, but this needs to be true in all cases.

***B. Fitness for Service***

According to a letter from Redacted of Kiefner &Associates to Mr. Sumeet Singh of PG&E, dated October 18, 2013, Redacted concludes that the hydrostatic pressure test conducted in 2011 confirmed the fitness for service of the pipeline for its MAOP of 400 psig. Line 147 was tested in October, 2011 to a minimum spike test pressure of 669 psig followed by a minimum 8-hour hold pressure of 607 psig. Review of the hydrotest procedure, which included a dead weight pressure tester to verify pressure levels, indicates these tests can be relied upon to estimate maximum flaw sizes in the pipeline.

Redacted suggests, that there is no evidence that fitness for service of Line 147 has degraded since the 2011 tests. External corrosion is said to be prevented by coating and cathodic protection. PG&E conducted close interval surveys of 500 ft. of Line 147 in 2013 after the leak at MP 2.29 and identified no concerns. Nondestructive examination (NOE) by ultrasonic and radio graphic testing of the drip at MP 0.52 suggests there is no internal corrosion. PG&E asserts that cathodic protection levels continue to be maintained at levels effective for prevention of corrosion.

Line 147 also has a span across a ditch and a miter bend in a buried section of the pipeline just beyond the span at MP 0.52. PG&E had structural analysis performed on this part of pipeline[1] found that the pipeline met applicable allowable stress levels. Kiefner reanalyzed the span considering a pipe specification corresponding to first-generation A. O. Smith line pipe and arrived at the same conclusion. Details of these assessments should be provided for peer review.

***C. Fracture Assessment of Line 147***

In a PG&E internal email [redacted] the following statement was made: "*this 1929 pipe was recently tested to just 1.5 times the MAOP in 2011. It is thin wall pipe and now we have found external corrosion on it.... Are we sitting on a San Bruno situation? With fatigue crack*

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*growth over many years? Is the pipe cracked and near failure*" [11]

Anamet received a section of 20-inch diameter pipe that had a PLIDCO weld cap permanent repair and an A. O. Smith longitudinal seam weld. The PLIDCO cap covered a leak that was discovered in 2012. This section also contained a longitudinal weld. The section of pipe was received by Anamet in two halves along the longitudinal axis. One half labeled sample A contained the PLIDCO cap. The other half of the section received by Anamet had a longitudinal weld and is figure 5a from their report. Anamet stated the appearance of the longitudinal seam was typical of A.O. Smith welds. Anamet assessed the metallurgical condition of the pipe wall under the PLIDCO cap and performed Charpy impact testing of the A. O. Smith weld and unaffected base metal.

Anamet gives the following conclusions about leak paths under the PLIDCO cap: (1) metallography revealed a leak path was likely present under the PLIDCO cap between an external weld crater crack and liquation cracks in the underlying weld heat affected base metal; (2) no evidence of crack growth during service or hydro testing was detected; (3) a dye penetrant test and a pressure test with 40-psig compressed air failed to detect a leak path in the region covered by the PLIDCO cap; (4) radiography, performed by PG&E, revealed a crack indication under the PLIDCO cap, which was confirmed with metallography; and (5) several shallow hemispherical pits consistent with corrosion were present on the outside surface of the sample adjacent to surface welds.

Anamet provided the data for their Charpy notch (Charpy) testing in Table 3 of their October 19, 2013 report. They state the results are typical for line pipe steel without providing comparisons. The Charpy results indicate a very brittle material at the temperatures and strain rates tested. Charpy testing at a wider range of temperatures would allow temperature shifting to account for the dynamic nature of a Charpy test and hopefully show the material to be ductile at slower loading rates.

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11 GasPipelineSafetyOIR_DR_ED_005Q02Atch45_Redacted; see Appendix B, footnote 11.

Exponent conducted a metallurgical investigation of the leak following the work by Anamet Laboratories. Exponent's analysis helped determine the cause of the leak and why the leak was not detected during hydro testing. Their analysis included visual, fractographic, metallographic, and chemical analysis of the associated welds/piping. Exponent concluded in their report that: (a) the subject leak discovered in PG&E Line 147 occurred in a weld repair of the pipe body and was not associated with either a longitudinal seam or girth weld; (b) the cracks associated with the subject leak occurred during the weld repair; (c) no evidence of progressive crack growth during service was observed at the leak site, and (d) the leak path was small, full of oxide, and provided a tortuous path that limited the amount of water that could escape during hydro testing.

These conclusions seem reasonable for the sample tested of this leak under this cap. The leak was caused by a faulty "repair weld" performed at an unknown time. For this particular weld repair, the leak did not appear to grow following the repair.

Design safety factors for devices or equipment that: (1) have not been fully proof tested (end-to-end for a pipeline), (2) lack an accurate representative model (knowing what is in the ground and where), or (3) lack representative test data should be 3.0 or greater. Starting with a proof test of 667 psi that was not necessarily applied to the entire line and attached components indicates a maximum allowable operating pressure of 220 psi. With an end-to-end proof test, representative fracture and tensile test data, a complete fracture and fatigue analysis and an up-to-date pipeline database, a lower safety factor and higher operating pressure can be justified.

Hydro testing an entire pipeline and attached components to twice operating pressure is generally sufficient to assure that crack growth induced by pressure cycles and/or corrosion in a natural gas pipeline will not produce a failure for decades. This is of course dependent on the corrosion rates, frequency and magnitude of the pressure cycles and fracture toughness of the pipe material. These factors have not been adequately assessed by testing and calculation to support a particular operating pressure or allowable time between reassessments. BEAR is in the process of performing a fracture and crack growth assessment to determine an appropriate operating pressure and reassessment time.

## III. SAFETY CONSIDERATION OF LINE 147

Based on the information I have reviewed, it is apparent that PG&E has yet to compile or retain the information necessary to safely operate a natural gas transmission line such as Line 147. PG&E continues to cause its engineers to make decisions based on incomplete and/or inaccurate information and thereby potentially put the public at great risk. Fortunately, there have been no incidents resulting in significant harm and the gas leak that was found on October 15, 2012 did not cause any injuries or property damage.

PG&E has had 12 months since the October 2012 leak to satisfy concerns about the accuracy of its database, but chose to wait months before informing the CPUC of what was discovered. Now, as we approach winter months with increasing demand for natural gas, PG&E would like to have a quick answer and get permission to increase the pressure on Line 147.

PG&E's consultants at Kiefner and Associates have not provided their analysis for review and appear to have made overly optimistic assumptions in estimating the remaining life of the pipeline. Line 147 can almost certainly be operated safely with proper assessment and tracking of pressure cycles and reevaluations when required. BEAR is in the process of performing a more realistic assessment.