

California Public Utilities Commission
Safety and Enforcement Division
Staff Report

Survey of Natural Gas Leakage Abatement Best Practices

In partial fulfillment of

Senate Bill 1371 (Leno, 2014) &
Order Instituting Rulemaking (OIR) 15-01-008

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Introduction

Methane is a greenhouse gas (GHG) at least 20 times more potent than carbon dioxide. Researchers have identified the oil and natural gas industry as a significant source of methane emissions. In California, Senate Bill (SB) 1371 (Leno, 2014) was signed by Governor Brown on September 21, 2014. This bill seeks to reduce methane emissions from leaks in the gas transmission, distribution and storage utilities in California. While the benefits to the environment are apparent, some may question if the economic cost of the legislative mandate will be too high. In actuality, reducing methane emissions may be a win-win resulting in an improved environment as well as a reduction in costs to the consumer.

The California Public Utilities Commission (CPUC) Safety and Enforcement Division (SED) staff prepared this report to comply with the requirements of SB 1371. The bill adds Article 3 (commencing with Section 975) to Chapter 4.5 of Part 1 of Division 1 of the Public Utilities Code which states, in part:

Not later than January 15, 2015, the commission, in consultation with the Air Resources Board, shall commence a proceeding to adopt rules and procedures for those commission-regulated facilities that are intrastate transmission and distribution lines...¹

Establish and require the use of best practices for leak surveys, patrols, leak survey technology, leak prevention, and leak reduction. The commission shall consider in the development of best practices the quality of materials and equipment.²

In January 2015, the CPUC launched Rulemaking (R.) 15-01-008 in response to SB 1371 to investigate new technologies in gas leak detection in the transmission,

¹ Section 975 (d) at 222. Unless otherwise stated, all statutory references are to the Public Utilities Code.

² Section 975 (e)(4) at 223.

distribution and storage process, specifically optimizing for methane reductions.³ This staff report is written in response to the above statutory requirement and to facilitate record development in R.15-01-008. The purpose of this paper is to identify technologies and practices presently in use around the globe, technologies and practices which are new and/or currently not in use in California, and those which are in various stages of research and development (R&D). We note that this report has identified many different types of leak management technologies and proposes some “best practices”; however, we do not claim to identify ALL technologies or best practices. Leak detection and abatement is an evolving field and there are many technologies currently under development. Consequently, identifying leak management technologies and “best practices” is an ongoing process not ending with the publication of this report and not confined to the work of the Commission. We prepare this report recognizing that all stakeholders, including the utilities and facility operators, have a responsibility to engage in the identification of best practices and an investment in the R&D of new technologies.

In preparing this report, it is not Staff’s intent to suggest that any particular gas leak management technology or practices should necessarily be a requirement subject to further review and evaluation via this instant proceeding. We recognize that there are many variables between the gas transmission, distribution and storage companies including size, location, population density, materials, soil conditions, etc. Thus, the best leak management practice for one company may not be the best for another. We offer this report for consideration by the Commission and parties to R.15-01-008 to inform them of the many gas leak management technologies and practices which may

³ See R.15-01-008 “Order Instituting Rulemaking to Adopt Rules and Procedures Governing Commission-Regulated Natural Gas Pipelines and Facilities to Reduce Natural Gas Leakage Consistent with Senate Bill 1371” issued January 22, 2015.

be used to comply with the impending Commission rules and procedures required by SB 1371.

Background

Methane is a potent greenhouse gas that contributes to global warming. As stated in the report “Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries,” by ICF International (ICF Report):

Methane emissions have an enhanced effect on climate change because methane has a climate forcing effect 25 times greater on a 100 year basis than that of carbon dioxide, the primary greenhouse gas (GHG). Methane’s impact is almost three times greater on a 20 year basis and there is research that may cause both factors to be increased. Recent research also suggests that mitigation of short-term climate forcers such as methane is a critical component of a comprehensive response to climate change.⁴

In an effort to reduce methane emissions from gas utilities in California, Senator Mark Leno introduced and Governor Brown signed into law, SB 1371 Natural Gas Leakage Abatement. As stated in SB 1371:

The California Global Warming Solutions Act of 2006 requires the State Air Resources Board to adopt regulations to require the reporting and verification of emissions of greenhouse gases and to monitor and enforce compliance with the reporting and verification program, and requires the state board to adopt a statewide greenhouse gas emissions limit equivalent to the statewide greenhouse gas emissions level in 1990, to be achieved by 2020.

This bill would require the commission, giving priority to safety, reliability, and affordability of service, to adopt rules and procedures governing the operation,

⁴ “Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries, page 2-1, prepared for the Environmental Defense Fund” by ICF International, March 2014.

maintenance, repair, and replacement of those commission-regulated gas pipeline facilities that are intrastate transmission and distribution lines to minimize leaks as a hazard to be mitigated pursuant to the Natural Gas Pipeline Safety Act of 2011, consistent with specified federal regulations, and a specified order of the commission, and to reduce emissions of natural gas from those facilities to the maximum extent feasible in order to advance the state's goals in reducing emissions of greenhouse gases pursuant to the California Global Warming Solutions Act of 2006.⁵

Among other requirements, SB 1371 requires the commission to “establish and require the use of best practices for leak surveys, patrols, leak survey technology, leak prevention, and leak reduction.” This report attempts to identify as many of these current best practices as possible.

The Air Resources Board (ARB) is currently developing a regulation to set greenhouse gas emissions limits for the oil and gas industry in California. The goal of the regulation is to obtain the maximum methane emissions reductions possible from new and existing oil and gas operations in a technically feasible and cost effective manner. By adopting a statewide regulation, ARB seeks to limit the administrative burden to local air districts. ARB staff expects to present the proposed regulation to the Board in September 2015.

The draft regulation, *Greenhouse Gas Emission Controls from Crude Oil and Natural Gas Operations*, applies to onshore and offshore crude oil and natural gas production, processing and storage; natural gas underground storage; and natural gas transmission compressor stations. The draft regulation sets emissions limits and control technology requirements for separator and tank systems, circulation tanks for well stimulation treatment, natural gas compressors, pneumatic pumps, and liquids unloading of

⁵ AB 32, Nunez. Air pollution: greenhouse gases: California Global Warming Solutions Act of 2006.

natural gas well operations. Reporting and record keeping requirements are also specified. Local air districts will implement the regulation by incorporating the requirements into their rules.

With the adoption of the rule, fugitives from storage and transmission compressor stations will be covered, thereby limiting mitigation options. However, annual reporting of activity data is still required to ensure the compliance and effectiveness of the rule.

Defining Leaks in the Context of Senate Bill 1371

SB 1371 changes a paradigm that has existed since the beginning of the gas industry: previously, only leaks considered hazardous to persons or property needed to be repaired immediately. Before the passage of SB 1371, intentional, non-hazardous emissions, during the course of normal operations and maintenance were considered harmless. With SB 1371 now in effect, there is a need to create a new category of hazard in addition to “gas leaks hazardous to persons and property”. That new category is “gas leaks hazardous to the environment”.

In effect, all gas leaks are now considered hazardous.

Although not defined in statute, in considering the new paradigm established by SB 1371, we define a leak as any release of methane from the gas system into the atmosphere, whether intentional or unintentional, whether hazardous or non-hazardous.

We note that this definition of leak is NOT in agreement with the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) definition of leak, which states:

A “leak” is defined as an unintentional escape of gas from the pipeline. A non-hazardous release that can be eliminated by lubrication, adjustment, or tightening, is not a leak.⁶

The reason for the difference is that PHMSA regulations are concerned with physical safety, while SB 1371 is concerned with reducing methane emissions. SB 1371 uses the words “leaks and leaking components”. Some examples of leaking components are defective gaskets, seals, valve packing, relief valves, pumps, compressors, etc. We also include gas blow-downs during the course of operations, maintenance and testing (including hydro-testing). Therefore, methane emitted during the course of purging, normal operations, maintenance and testing, whether intentional or unintentional, are also considered leaks.

With this definition in place, we now turn to best practices, methods and technologies to reduce methane emissions. Specific topics and major references include the economic analysis of methane leak reduction, leak grading and repair timelines, leak surveys, leak detection, and leak prevention. In this paper we also introduce “administrative” best practices including information management and training. Major references include recent industry technical reports from ICF International, the U.S. Environmental Protection Agency (EPA), and current utility rules, procedures and “best practices.”

⁶ PHMSA Gas Distribution Integrity Management Program Definition

Economic Analysis of Methane Leak Reduction

Under the current ratemaking practice employed in California, gas distribution utilities do not pay for lost gas due to intentional and unintentional leaks; the gas customers do. Lost and unaccounted-for gas is considered a "cost of doing business" and therefore is passed through to customers via rates. Gas distribution utilities have no financial incentive to eliminate traditionally non-hazardous leaks. While we assume that new investments in capital or costs associated with change in operations to reduce methane from gas leaks should be paid for by customers, we do not take any position on what the appropriate cost sharing or level of reasonableness is appropriate between customers and shareholders. Nor do we take a position on the appropriate CPUC procedural venue to resolve. We do compare customer-oriented costs with the current regime, which is mainly a pass-through model to gas customers for gas used or vented by the utility during normal operations and maintenance, and gas that is lost and unaccounted for. With that in mind, the investment in equipment and infrastructure to reduce methane leaks can be very cost effective for the customers. This economic benefit is noted in the following excerpt from the ICF Report:

Methane is an important climate change forcing greenhouse gas (GHG) with a short-term impact many times greater than carbon dioxide. Methane comprised 9% of U.S. greenhouse gas (GHG) emissions in 2011 according to the U.S. EPA Inventory of U.S. Greenhouse Gas Emission and Sinks: 1990-2011⁷, and would comprise a substantially higher portion based on a shorter timescale measurement. Recent research also suggests that mitigation of short-term climate forcings such as methane is a critical component of a comprehensive response to climate change.⁸ Emissions from the oil and gas industry are among the largest anthropogenic sources of U.S. methane emissions. At the same time, there are many ways to reduce emissions of fugitive and vented methane from

⁷ Calculated at a 100 year GWP of 21 – see Section 2.3. of the ICF Report

⁸ Shoemaker, J. et. al., "What Role for Short-Lived Climate Pollutants in Mitigation Policy?", *Science* Vol. 342 13 December 2013.

the oil and gas industry and, because of the value of the gas that is conserved, some of these measures actually save money or have limited net cost.⁹

In Appendix A of this report is an Excel spreadsheet. The first tab of the spreadsheet is titled "Econ. Anal. of CH₄ Reduction". The spreadsheet refers to the ICF Report and contains the cost/benefit of reducing methane leaks from specific components of the entire gas system. For purposes of this report, we focus on the parts of the gas system which are operated by the gas utilities under the jurisdiction of the CPUC, namely gas transmission, storage, distribution and regulated gathering lines as described in 49 CFR 192.8. We do not focus on leaks from the gas system during production, which is under the jurisdiction of the California Air Resources Board (ARB.)

The ICF Report contains data on the total amount of methane leaking from the entire gas system and expresses methane leaks from specific components and equipment as percentages of the total methane leaking from the system. The following table derived from the ICF Report lists some of the most common leaks for gas transmission, storage and distribution systems by component responsible for leakage and percentage of total methane leaked from the gas system. The majority of methane leaked from the gas system does not emanate from "leaks" as they are usually defined, but from gas system equipment and infrastructure. These types of leaks are usually defined by the gas industry as "fugitive emissions". For the purposes of SB 1371, fugitive emissions are now also considered leaks.

⁹ ICF Report, page 1-1

Component Responsible for Leakage	Percentage of Total Methane Leaked from the Gas System¹⁰
Reciprocating Compressors	13%
High Bleed Pneumatic Devices	7%
Local Distribution Company Meters and Regulators	7%
Centrifugal Compressors with wet seals	6%
Gas Engine Exhaust	5%
Intermittent Bleed Pneumatic Devices	5%
Reciprocating Compressor Rod Packing	4%
Pipeline Leaks	2%
Centrifugal Compressors with dry seals	2%
Mains – Plastic	2%
Mains - Cast Iron	2%
Transmission Station Venting	2%
Chemical Injection Pumps	2%
Residential	1%

In April 2009, the California Air Resources Board (ARB) staff conducted a survey of the natural gas transmission and distribution (NG T&D) industry. The information collected was a snapshot of the 2007 activity data, including pipeline length and material, number of compressors stations, types of compressors, number of pneumatic valves, and number of metering and regulating (M&R) stations. In comparing the

¹⁰ The total percentage does not equal 100% because this a list of the most common (not all) sources of methane leaks in gas transmission, distribution and storage areas of the gas system. This list also does not include the most common sources of methane leaked during the production of gas which, as stated in this report, is under the jurisdiction of ARB.

survey data to national data, ARB staff determined that California has different activity data than other states and therefore has a different breakdown of GHG emissions.

California also has fewer compressor stations compared to oil and gas producing states. However, it has approximately 200,000 miles of distribution pipelines, which is a relatively larger number in comparison. Consequently, pipelines are estimated at approximately 74% of the 2007 GHG emissions. Based on the survey, M&R stations result in about 16% of the emissions and compressor stations and other sources are the remaining 10%. Additional data will improve this estimate.

In addition to information on the sources of methane leaks, the ICF Report also contains the capital cost of purchasing new equipment to reduce methane leaks, the cost of enhanced inspections and other methods to detect and mitigate leaks, and the avoided cost of lost gas from the leaks.

The report also refers to the EPA Natural Gas STAR reference materials for information on how to locate and quantify leaks:

There are a variety of techniques and types of equipment that can be used to locate and quantify these fugitive emissions. Extensive work has been done by EPA and others to document and describe these techniques, both in the Gas STAR reference materials and in several regulatory analyses.¹¹

EPA Natural Gas STAR references, techniques and equipment are discussed below in a section entitled "Leak Prevention."

Using the economic analysis in the ICF Report can help the parties in this proceeding to determine the cost/benefit of reducing each type of leak and prioritize how funds should be spent.

¹¹ ICF Report at 3-9.

Leak Grading, and Repair Timelines

It is appropriate to summarize current practices of leak grading and repair timelines since any changes made to optimize methane will need to fit into this existing structure. California gas utilities currently use the following leak grading and repair timelines (with slight deviations between companies):

Grade 1 Gas Leaks:

A Grade 1 gas leak, also referred to as a “hazardous leak,” represents an existing or probable hazard to persons or property and requires immediate repair or continuous action until conditions are no longer hazardous.

Grade 2 Gas Leaks:

A Grade 2 leak is non-hazardous to persons or property at the time of detection but still requires a scheduled repair because it presents a probable future hazard. Grade 2 leaks must be repaired within 15 months. These leaks are usually monitored at set intervals to ensure that they do not get worse or become hazardous before they are scheduled for repair. If they become hazardous, they are upgraded to Grade 1 and should be immediately repaired.

Grade 3 Gas Leaks:

A Grade 3 leak is non-hazardous at the time of detection and can reasonably be expected to remain non-hazardous. These leaks are monitored to ensure that they do not get worse or become hazardous. If they get worse or become hazardous, they are upgraded to Grade 2 or Grade 1.

Note: Some smaller California utilities fix all leaks as they are discovered and/or have no open Grade 2 or Grade 3 leaks being monitored.

SB 1371 necessitates changes to the leak grading, and repair timelines because all leaks are now considered hazardous to either people, property or the environment. For example, in the current system a fairly large leak in a remote area may be considered a Grade 3 leak because it is non-hazardous to people or property. Theoretically, it could be allowed to leak indefinitely. With SB 1371 being optimized for methane reduction,

this practice may no longer be appropriate. We offer a suggested update to each grade of leak, below. SB 1371 requires leaks and leak rates to be recorded geographically. We also have highlighted with “XX” variables in which we seek party input. Under this new proposal, we augment the definitions for Grades 1 and 2 leaks and eliminate the Grade 3 category. There may be alternative approaches to this proposal which can be discussed as a topic of conversation at an upcoming workshop.

SB 1371 also suggests that any rules and procedures that may be adopted must not only be guided by SB 1371 “principles” such as “best practices” but also be “technologically feasible” and “cost-effective” and “provide for the repair of leaks as soon as reasonably possible after discovery” – so these factors must be weighed when we consider any options such as the following:¹²

Grade 1 Gas Leaks

A Grade 1 gas leak, also referred to as a “hazardous leak,” represents an existing or probable hazard to persons or property, or leaks in excess of XXX thousand cubic feet (Mcf)/week, and requires immediate repair or continuous temporary leak prevention methods until the leak is permanently repaired. Permanent repairs must be completed within XX days. All leaks, including leak rates, shall be recorded and located geographically on GIS or maps. Leak rates shall be monitored XXX thereafter and recorded geographically on a GIS system or maps until the leak is permanently repaired.

Grade 2 Gas Leaks

A Grade 2 leak is non-hazardous to persons or property at the time of detection, or leaks less than or equal to XXX Mcf/week. Permanent repairs must be completed within XX days. All leaks, including leak rates, shall be recorded and located geographically on GIS or maps. Leak rates shall be monitored XXX thereafter and recorded geographically on a GIS system or maps until the leak is permanently repaired.

¹² Section 975 (e)(1) at 222.

The allowable leak rates and times to permanent repairs, represented by XX's above may be considered by the CPUC through the rulemaking process (workshops, and formal stakeholder comments, etc.).

The best practice would be to repair all leaks immediately as they are detected however, for utilities with large service areas that may not be practical or cost effective for small leaks. There may be a positive cost/benefit to allow a brief time limit before Grade 2 leaks have to be permanently repaired. Again, these cost/benefit “tradeoffs” will be further evaluated during the CPUC’s rulemaking process.

Leak Surveys

We recommend as part of the updated leak grading and repair that the scope of leak surveys be enlarged. In order to optimize the reduction of methane, the gas utilities should now perform leak surveys of all gas infrastructure and equipment. That means the entire gas system will now have to be leak surveyed and all fugitive emissions / leaks recorded, graded, tracked and repaired. The ICF Report contains an analysis of the cost and effectiveness of the increased inspections of equipment:

The key factors in the analysis are how much time it takes an inspector to survey each facility, how many inspections are required each year, how much reduction can be achieved, and how much time is required for repairs. Research cited by both Colorado and EPA indicates that more frequent inspections result in greater reductions, summarized as approximately:

- Annual inspection = 40% reduction
- Quarterly inspection = 60% reduction
- Monthly inspection = 80% reduction¹³

¹³ ICF Report at pages 3-10.

Where leaks result from intentional venting, leaking seals, packing, etc. new methods and equipment may be needed to reduce or eliminate the leaks. New methods and equipment are discussed in the "Leak Prevention" section, below.

We expect an increase in leak surveys in the near term, to record, re-grade and repair as many leaks as possible to comply with the rules and procedures resulting from SB 1371. Finding and repairing many gas leaks in a short amount of time may require new methods to perform this task efficiently. One promising method is the use of extremely sensitive mobile leak survey technology combined with using multiple leak repair crews simultaneously to fix all of the leaks in an area in a short amount of time. One such mobile technology in use today by Pacific Gas & Electric (PG&E) is from the Picarro Corporation. The technical name for the Picarro technology is "Cavity Ring-Down Spectroscopy" (see Appendix A "Leak Detection" tab for details). It can detect methane concentrations as low as 1 part per billion (ppb), which is 1000 times more sensitive than many traditional gas detection instruments. The technology allows PG&E to detect gas leaks from 600 feet away; the technology in practice has enabled PG&E to find more leaks in a shorter amount of time.

PG&E has conducted three pilot projects using Picarro technology and sensitive hand held gas detection devices to pinpoint all of the gas leaks within an area. PG&E schedules a date when leak repair crews can be brought to a defined geographic area to fix all of the leaks at once. PG&E calls this the "Super Crew" method. Due to the amount of equipment concentrated in a small area, this method usually requires advanced notifications sent to residents and building occupants. While employing a Super Crew creates a short-term inconvenience, it eliminates the need for individual service calls to repair individual leaks. PG&E estimates that surveying and bundling leak repair work in this way results in a cost savings of approximately 50% compared to

using the traditional leak survey and leak repair methods. In addition, using Picarro technology has allowed the company to complete many more leak surveys than before. Using this technology, PG&E has been able to survey 500 services/ hour vs. 10-11 services/ hour and locate 32 leaks per hour vs. 0.4 leaks/ hour using prior methods.¹⁴ In addition to the benefit of a more rapid reduction in methane escaping to the environment, the leak survey labor cost savings and the methane cost savings can be used to offset new costs, lessening the need for new recovery from customers.

Leak Detection

Gas leak detection is an area where rapid technological advances are being made. We include in this report a list of technologies currently in use, or in R&D, in the U.S. and several different foreign countries. These technologies are listed on the third tab of Appendix A titled "Gas Leak Detection". This is a rapidly evolving field, and any new rules or practices which the CPUC may adopt should be nimble enough to account for technological advancements and refined best practices.

There is no one single "best practice" standard for leak detection – the context of the operator, business situation, geographic location, cost,¹⁵ are all variables. We do list a variety of best available options with the hope that the operator can explore options to

¹⁴ PG&E presentation to the American Gas Association (AGA), October 5, 2014.

¹⁵ Many of the cost fields on the attached Excel spreadsheet are blank. There are two main reasons for this. The first is that some of the technologies mentioned are still in the R&D phase and are not commercially available yet. The second reason is that many vendors prefer to be contacted by prospective customers to discuss the customer's specific needs before quoting a price. Where the author was able to determine an approximate cost for a device or technology, it was entered on the spreadsheet. The reader should keep in mind however, that the exact cost can change and can only be accurately determined by discussing customer needs with a vendor.

best fit their business situations and to meet the impending rules that the CPUC will be adopting to comply with SB 1371.

SED found leak detection devices, both already in use and in the R&D phase, which we highlight for further consideration by California gas companies. One such “device” isn’t a device at all; it is a dog. Traditionally, dogs have been trained to find and detect explosive materials, drugs and even people. With proper training, as has been done for at least the past 30 years, dogs can be used to find gas leaks. Canines’ sense of smell is sensitive enough to detect gas in the parts per billion (ppb) range, which is on par with the most sensitive gas detection devices in use, or in R&D, today. According to the vendors and research,¹⁶ employing dogs to detect gas leaks can be very cost effective, have a very high accuracy rate and work relatively fast, capable of covering up to five miles per day. Dogs are currently being used to find gas leaks in Texas, Canada and in parts of Europe. At least three companies located in Florida, Canada and Sweden supply these services. We single out detector dogs in this report because we feel that they are a resource which may have been overlooked in California in favor of “high-tech” solutions. However, due to their extremely sensitive sense of smell and relatively rapid speed, we feel that they too deserve consideration by the gas companies.

¹⁶ “Using canines to inspect for leaks in buried pipelines” by Phil Hopkins, Presented at the 1st Australasian International Welding, Inspection and NDT Conference, iWIN2013. WTIA, Perth, Australia. 10-14th March 2013. Contact Info: E-Mail: p.hopkins@penspen.com, Penspen Limited Unit 7-8, Terrace Level, St Peter's Wharf, St Peter's Basin, Newcastle upon Tyne NE6 1TZ. UK.)

Leak Prevention

The first step toward the goal of eliminating methane leaks is to determine how most of the methane is currently escaping from the gas system. This understanding should help gas operators re-prioritize new preventative maintenance and inform the scope of modifications needed for their gas system.

To see where the largest methane leaks in the gas system are, we again refer to the ICF Report:

Table 3-2 summarizes the largest emitting source categories in the projected 2018 emissions for the oil and gas sectors by major source category. Due to the lack of specific data on the emission sources for offshore oil and gas production, the study focused on onshore production and offshore emissions are excluded from this list. The top 22 source categories account for 80% of the total 2018 onshore methane emissions of 404 Bcf and the remaining 100+ categories account for 1% or less of the total emissions each. Although these source categories were not included in this analysis due to their small size, there are demonstrated methane reduction technologies that can provide cost-effective reductions for many of them.¹⁷

¹⁷ ICF Report at page, 3-6.

Table 3-2 - Highest Emitting Onshore Methane Source Categories in 2018

Source	2018 Emissions (BCF)	Percent of Total	Cumulative Bcf	Cumulative %
Reciprocating Compressor Fugitives	53.8	13%	53.8	13%
High Bleed Pneumatic Devices	28.7	7%	82.5	20%
LDC Meters and Regulators	28.7	7%	111.2	28%
Centrifugal Compressors (wet seals)	24.0	6%	135.3	33%
Gas Engine Exhaust	22.2	5%	157.5	39%
Well Fugitives	20.8	5%	178.3	44%
Reciprocating Compressor Rod Packing	17.6	4%	195.9	48%
Liquids Unloading -Wells w/ Plunger Lifts	13.2	3%	209.1	52%
Intermittent Bleed Pneumatic Devices	13.0	3%	222.1	55%
Kimray Pumps	11.5	3%	233.6	58%
Oil Tanks	11.5	3%	245.1	61%
Flares	9.0	2%	254.1	63%
Stranded Gas Venting from Oil Wells	8.4	2%	262.5	65%
Intermittent Bleed Pneumatic Devices -Dump Valves	7.7	2%	270.2	67%
Oil Well Completions -with Fracturing	6.9	2%	277.1	69%
Pipeline Leaks (All)	6.7	2%	283.8	70%
Pipeline Venting (Transmission)	6.6	2%	290.4	72%
Centrifugal Compressors (dry seals)	6.4	2%	296.8	73%
Mains – Plastic	6.3	2%	303.2	75%
Mains -Cast Iron	6.3	2%	309.4	77%
Transmission Station Venting	6.2	2%	315.7	78%
Chemical Injection Pumps	5.9	1%	321.6	80%
Residential	5.6	1%	327.2	81%
Gathering and Boosting Stations	5.6	1%	332.8	82%

According to the above table, equipment leaks are by far the greatest source of methane emissions from the gas system, with compressor related leaks accounting for 25% of all methane leaked into the atmosphere. More than 22% of total methane leaks are related to oil and gas production, which is beyond the scope of SB 1371.

The ICF Report and the EPA Report complement one another. The economic analysis report by ICF approaches the methane leaks from the gas system on a macro scale, analyzing the environmental impact of the leaks, identifying the sources and analyzing the cost of eliminating the leaks. It also identifies the equipment that leak the largest amount of methane and describes in detail the corrective actions to eliminate or

reduce the leaks. For example, as mentioned earlier, compressor related leaks are the largest source of leaks. The economic analysis report by ICF describes the problematic issues with compressors and the corrective actions needed to reduce the leaks. Using information found in the EPA Report such as labor rates and equipment cost, ICF calculates the time required to recover the investment to replace or repair equipment to reduce or eliminate the largest gas leaks. The report's analysis also recalculates this payback time using various prices of natural gas. The economic analysis report by ICF addresses the corrective actions needed to mitigate, cost-effectively, approximately 80% of the methane leaks from the gas system.

The EPA Natural Gas STAR Program

The second tab of Appendix A contains a link to the EPA Natural Gas STAR program (EPA Report). The EPA Report identifies additional specific corrective actions to reduce methane leaks from almost 100% of the sources of gas leaks. The EPA Report examines practices such as replacing methane-driven pumps with electric motor-driven pumps, replacing pneumatic controls with mechanical controls, changing compressor seals from wet seals to dry seals, better inspection and maintenance practices for various types of equipment, ways to reduce equipment start-ups to reduce methane emissions, flexible liners for gas mains, ways to reduce gas venting and much more. The EPA Report describes a method used by Open Grid Europe which uses a mobile compressor truck to pump down and transfer methane from gas lines instead of venting them to the atmosphere. The EPA Report also includes the investment capital required for repairs or new equipment, along with an analysis of the time needed to recover the investment at various prices of natural gas.

The EPA also hosts regional workshops to help gas companies learn how to reduce methane emissions. As the EPA Report states:

The Natural Gas STAR Program hosts regional Technology Transfer Workshops for each sector of the natural gas industry. These workshops provide a forum for oil and natural gas companies to receive and share detailed information about current cost-effective technologies and practices to reduce methane emissions in their specific sector. Technical presentations provide current information about the emission reducing technologies and practices covered at the Technology Transfer Workshops.¹⁸

Almost all of the corrective actions described in both the ICF and the EPA reports require only one to three years, sometimes less, to save enough gas to recover the investment in new equipment or modifications necessary to eliminate or mitigate gas leaks.¹⁹ The savings from the corrective actions only account for the dollar value of the natural gas lost and do not monetize the benefit to the environment.

Gas Leak Prevention

The fourth tab of Appendix A lists the technologies and practices mainly used to prevent transmission and distribution piping leaks as opposed to leaks due to equipment, operation and maintenance. The information in this tab includes new pipe lining techniques, advanced pipe inspection devices and an acoustic warning system to alert pipeline owners when there is third-party activity near their pipeline.

¹⁸ EPA Report at: <http://www.epa.gov/gasstar/workshops/index.html>

¹⁹ This is for \$3/Mcf natural gas which, in recent history, is inexpensive gas. If gas prices rise higher, the payback time is even less.

Information Management

The fifth tab of Appendix A is titled, "Information Management". It contains information on some of the latest hand-held devices used by leak surveyors to record leak information by GPS coordinates and to aid them on their surveying route. The devices can be programmed to contain information such as on-the-job dangers at particular residences (e.g. dogs), the location of gas services, statistics, templates for recording the material condition of the gas services, reporting and grading leaks and more. The information can then be uploaded to the utility's main leak tracking program and used to generate work orders to repair leaks. Using devices such as this reduce transcription errors and incomplete or illegible records.

This tab also contains information on two of the main information management systems in use today, Maximo by IBM and SAP Enterprise Asset Management. These systems are used to track leak information, schedule work and generate work orders. In order to effectively manage the new definitions of gas leaks proposed above, robust information management systems are critical. to enable information to flow accurately and efficiently between the field and work planners, engineering, management and other affected departments.

Training

Training is extremely important for operator safety and the proper use of any of the technologies and devices described in this report. Accurate gas leak detection and measurement can only be obtained if the operator understands the limitations of the technology and devices that he/she is using. There are variables which can affect the accuracy of measurements such as wind speed, distance from the leak, obstructions,

fog, rain, reflective backgrounds, etc. In addition, some of the instruments require more frequent calibration than others and some use highly pressurized flammable gas, which can be dangerous. For these reasons, gas companies should formalize and document training programs for the operators of these devices. The training programs should include the following elements:

- Scheduled training for all operators;
- Qualification testing to ensure that operators are able to
 - operate the equipment properly and safely,
 - calibrate equipment, if necessary,
 - demonstrate that they can detect measure and record gas leaks accurately;
- Requalification training should occur at least annually;
- Requalification training should also occur before an operator can use any equipment that he/she has not used within the past 60 days;
- All training records should be retained for a period of time in accordance with GO 112 and any applicable CFRs.

Records

An appropriate record retention policy will be determined in consultation with the California Air Resources Board and stakeholders during the course of this proceeding.

Recommendations

Based on the preliminary staff observations made throughout this report, SED staff offers the following recommendations to meet the requirements of SB 1371 and preliminary scoping memo objectives:²⁰

1. The Commission should ensure that financial incentives are properly aligned for both customers and shareholders in the gas transmission, distribution and storage (GTD&S) corporations to eliminate **both** intentional and unintentional methane leaks from the gas system. After assessing ratemaking implications of potential performance based incentives, the Commission should consider the appropriate procedural venue to implement them (e.g., General Rate Case, Gas Cost Incentive Mechanism).
2. The Commission, in cooperation with the parties to R.15-01-008, should develop a new methane leak grading system which meets the intent of SB 1371. Staff proposes updated definitions for Grades 1 and 2 leaks, and eliminating Grade 3. Staff suggests hosting a workshop to determine if there are alternatives to this approach and to build consensus regarding any preferred alternative.
3. The Commission should evaluate the operations, maintenance, and repair practices to determine whether existing (and newly proposed) practices are effective at reducing methane leaks.²¹

²⁰ R.15-01-008 at 12. Final scoping memo objectives will be determined following a Prehearing Conference for this proceeding at a later date.

²¹ Section 975 (e)(3).

4. The Commission should consider how to best have the GTD&S corporations to enlarge the scope of their leak surveys and procedures to include their entire gas system including all equipment and facilities.
5. The Commission should consider how to best encourage the GTD&S corporations to invest in the leak detection equipment for their business and to continually search for best practices in leak detection and prevention.
6. The Commission should consider how the GTD&S corporations should implement training programs as described in this report to ensure that personnel are proficient in the use of leak survey equipment and are periodically re-tested and re-qualified to use it.
7. The Commission should consider how the GTD&S corporations should develop capital improvement plans to upgrade their systems with equipment and modifications which have been identified as best practices for the prevention of methane leaks. These expenditures should be considered in the GTD&S General Rate Case or separate application.
8. The Commission should establish the specific requirements for the annual reports required by SB 1371.

Conclusion

In this report, staff provides references to an economic analysis of methane emission reductions conducted by ICF International. The report also includes references to best leak prevention equipment and methods researched by the EPA and references to some of the newest equipment in the field of gas leak detection. The report also describes a framework for a new leak grading system which would comply

with SB 1371. The reports claim that methane leak reduction is both beneficial to the environment and cost effective to the ratepayer. If an effective methane reduction program is implemented, the ratepayer may no longer be required to pay for methane which leaks from the gas system and the gas system should be safer due to the identification and elimination of more gas leaks. The short one-to-three-year payback time to the ratepayer for most of the new equipment and modifications needed by the utilities appears promising.