California Air Resources Board and California Public Utilities Commission Joint Staff Report-Analysis of the Utilities' June 15, 2018, Natural Gas Leak and Emission Reports

SB 1371 (Leno) Natural Gas: Leakage Abatement

R.15-01-008/D.17-06-015

Ed Charkowicz, CPA, CPUC
Andrew Mrowka, P.E., CARB
Mihail Cucu, P.E., CARB

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Table of Contents

Executive Summary 4

Key Findings: 6

Conclusion: 10

Introduction and Background 13

Purpose of the Natural Gas Leak Abatement Report: 14

Basis for the Annual Gas Leak Abatement Report: 16

Findings and Discussion 16

Leaks and Emissions: 16

System-wide Leak Rate 17

2017 Adjustments to Categorization 18

Utility Emission Summary: 18

Detailed Emissions by Source, Category and Classification 23

Detailed Discussion for Each of the Seven Systems Categories 26

Lessons Learned 39

Conclusion: 40

Appendix A: Methods for Estimating Emissions 42

Appendix B: Definitions 48

Appendix C: Article 3, Section 975 (c) and (e)(6) 50

Appendix D: Conversion of Natural Gas to Carbon Dioxide Equivalents 51

Appendix E: Proposed Changes to Data Request Template 52

Table of Tables

Table 1: Total SB 1371 Sector Emissions, 2015-2017 7
Table 2: Total Emissions by System Category, 2015-2017 7
Table 3: Total Emissions Grouped by Source Classification, 2015-2017 9
Table 4: Population Based Emissions Sources, 2015-2017 10
Table 5: System-wide Emissions – Throughput Categories, 2015-2017 17
Table 6: Emissions by Utility and Independent Storage Provider, 2015-2017 19
Table 7: Detailed Emissions (Category, Source, and Classification) 2015-2017 24
Table 8: Blowdown and Vented Emissions by Systems Category, 2015-2017 26
Table 9: Transmission Pipeline Emissions, 2015-2017 27
Table 10: Transmission M&R Station Emissions, 2015-2017 28
Table 11: Transmission Compressor Station Emissions, 2015-2017 29
Table 12: Distribution Mains and Services (DM&S) Emissions, 2015-2017 30
Table 13: Calculated Emissions Volume by Leak Grade in 2017 33
Table 14: Average Days to Repair by Entity, 2017 33
Table 15: Distribution M&R Stations Emissions, 2015-2017 34
Table 16: Customer Meter Emissions, 2015-2017 34
Table 17: Underground Storage Emissions, 2015-2017 36

Table of Figures

Figure 1: 2017 Emissions by Reporting Entity (Mscf) 20
Figure 2: Emissions Grouped by Source Classification, 2017 25
Figure 3: Distribution Pipeline Emissions by Grade 2015, 2016 and 2017 (Mscf) 32

Executive Summary

This is the fourth annual report compiled jointly by the California Public Utilities Commission (CPUC) and the California Air Resources Board (CARB) (2017 Joint Report) produced in compliance with SB 1371 (Leno – 2014) on natural gas emissions, as ordered by the CPUC Decision Approving Natural Gas Leak Abatement Program Consistent with Senate Bill 1371 (D.17-06-015).

Staff from the CPUC and CARB jointly prepared this annual report, which analyzes and accounts for natural gas emissions from leaks and vented emissions in the natural gas system in California.[1] This report provides the estimated emissions of methane – a potent GHG – from California's transmission, distribution and storage systems and discusses emissions by system categories, source categories and leak grades.[2]

Each March CPUC Staff issue an annual data request that provides reporting templates and associated guidelines to gas utilities and independent storage providers (ISPs) in California (Respondents). Respondents filed their 2017 data and information on June 15, 2018.

Staff used the report filings and any other relevant information to prepare the 2017 Joint Report.[3] Staff made minor adjustments to the categorization of 2015 and 2016 data in order to present comparable category level emissions estimates and trends.

The 2017 Joint Report has been improved and updated as follows:

- The 2017 Joint Report is the first report to analyze data on a three-year basis.
- The chapter "Responses to Data Request Questions #1 and #7" was omitted as this material is included in the 2018 Compliance Plans and Staff refer to the contributing factors of Best Practices, as relevant, throughout the document.
- The Aliso Canyon natural gas storage facility leak was capped in 2016 so there are no emissions to report in the 2017 data.

The information in this report should be used by stakeholders to help determine where emission reductions can be achieved to meet the State's overall goal of reducing

[1] Unless specified as a fugitive leak or vented emission, for the purposes of this report "emissions" include both fugitive leaks, and vented emissions of natural gas.

[2] "System Category" refers to the grouping of assets by function within the natural gas delivery system. "Source Category" refers to grouping emissions based on like source, e.g. pipelines emissions, or M&R station emissions, which was performed in the previous Joint Report. See page 9 of this report for definition of leak grades.

[3] 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*

natural gas emissions 40% by 2030,[4] while maintaining the safe and reliable operation of the regulated gas storage and delivery systems.

Since the beginning of the Natural Gas Leak Abatement (NGLA) reporting process Staff and respondents have identified opportunities for improving reporting methodology, record keeping and emissions factors (EFs). Had these improved emissions data been known or used at the time of the 2015 Baseline NGLA report they would have had a material impact on the level of baseline emissions. The June 2017 Commission decision (D.17-06-015) did not order a process for updating the 2015 Baseline, however, it ordered that:

> "The Natural Gas Leak Abatement Program Annual Reporting Framework contained in Section 5.2 … of this decision is adopted consistent with the process detailed below: The Commission's Safety and Enforcement Division (SED), in consultation with the Air Resources Board (ARB), shall direct the annual report process…"[5]

This is interpreted to include the consideration and evaluation of any changes to 2015 Baseline emissions based on new methods of emissions accounting, better record keeping and information as well as updated factors used for estimating emissions. The discussion within D.17-06-015 further clarifies the roles and responsibilities for managing the emissions reporting processes.

> "…[T]he development of EFs and an official baseline to manage this initiative in the long term is still in flux. Therefore, while, ARB is ultimately responsible for the development of EFs in collaboration with stakeholders, both ARB and CPUC should continue to collaborate to ensure that updates to EFs are completed in a timely fashion consistent with the Commission's annual reporting process. Following this year's example, if changes are required to the annual reporting template, ARB and CPUC staff will conduct a workshop to discuss EFs and ongoing changes to the reporting template. This workshop should take place during the first quarter of each year before SED issues the annual data request at the end of the first quarter."[6]

Therefore, Staff will track the impact of ongoing methodology and accounting changes to evaluate their impact on the 2015 baseline balances.

[4] This goal was established by (SB 1383, Lara 2016).
[5] D.17-06-015: Pg. 157
[6] Ibid, Pg. 39

In addition, there have been items identified for correction in the 2016 emission data based on new information received after the posting of the 2016 Joint Report and thru the 2017 data analysis. The potential changes to 2015 Baseline and 2016 data include the Southern California Gas (SoCalGas) and San Diego Gas & Electric (SDG&E) revision to un-surveyed leaks in their Appendix 4 Mains and Services. The potential decrease is in the range of 150,000 Mscf or 2% to both 2015 and 2016 estimated emissions.

A potentially larger change being considered for future Joint Reports would result from updating the 1996 USEPA/Gas Research Institute (GRI) emission factors (EFs) that are used. The USEPA/GRI EFs are over 20 years old and are not California specific. Recent studies suggest that emissions factors could be significantly lower for distribution mains and services and metering and regulating stations.[7]

CARB is currently evaluating Distribution Mains and Services EFs based on a California specific study completed by the Gas Technology Institute (GTI) study in 2018. CARB is working with utilities to ensure there are no discrepancies between pipeline types (e.g. plastic, protected steel) initially reported and the pipeline type reported upon repair. Once CARB resolves these issues, and fully evaluates any impact of the EFs on their annual gas inventory, then the updated EFs will be promulgated for use for the Joint Report.

Key Findings:

The total emissions estimate for the 2017 calendar year is 6,399 million standard cubic feet (MMscf). This figure is 132 MMscf or 2.1% higher than the emissions volume reported in 2016, but 203 MMscf or 3.1% below the 2015 baseline emissions. The small overall increase from 2016 to 2017 is the result of significant emission increases in some categories being offset by decreases in other categories, see Table 2: Total Emissions by System Category. A detailed analysis of emissions from individual categories will be provided later in this report.

The total natural gas emissions of 6,399 MMscf equates to 2.86 million metric tonnes of carbon dioxide (MMTCO2e) using the Intergovernmental Panel on Climate Change (IPCC) Forth Assessment Report (AR4) 100- year methane Global Warming Potential (GWP) of 25 or 8.25 MMTCO2e, using the 20-year methane GWP of 72.

[7] Washington State University (WSU) conducted a study of M&R stations emissions factors which indicate the current emissions factors are overstated by about 25%.

Table 1: Total SB 1371 Sector Emissions, 2015-2017

Sector Emissions	2015 Baseline	2016	2017	2015 Baseline to 2017 Change		2016 to 2017 YOY Change	
				MMscf	%	MMScf	%
Volume of Natural Gas (MMscf)	6,601	6,267	6,399	(202.5)	(3.1%)	132.0	2.1%
Mass Equivalent, 100-Yr GWP, AR 4 (MMTCO2e)	2.96	2.81	2.86	(0.1)	(3.2%)	0.05	2.0%
Mass Equivalent, 20-Yr GWP, AR 4 (MMTCO2e)	8.51	8.08	8.25	(0.3)	(3.0%)	0.17	2.1%

This report further analyses the total emissions by looking at individual categories and sub-categories that comprise the emissions for 2017. Table 2 shows emissions and trends by System Category while Table 3 shows total emissions and trends grouped by Source Classification.

Table 2: Total Emissions by System Category, 2015-2017[8]

System Category	2015 Baseline		2016		2017		2015 Baseline to 2017 Change		2016 - 2017 YOY Change	
	MMscf	%	MMscf	%	MMscf	%	MMscf	%	MMscf	%
Transmission Pipeline	549	8%	433	7%	505	8%	(45)	(8%)	71	16%
Trasmission M&R Station	1,007	15%	983	16%	1,014	16%	7	1%	31	3%
Compressor Station	163	2%	145	2%	157	2%	(6)	(4%)	11	8%
Distribution Mains & Services	1,703	26%	1602	26%	1,420	22%	(282)	(17%)	(182)	(11%)
Distribution M&R Stations	1,348	20%	1319	21%	1,334	21%	(14)	(1%)	15	1%
Customer Meter	1,638	25%	1645	26%	1,656	26%	18	1%	11	1%
Underground Storage	193	3%	139	2%	229	4%	36	19%	90	65%
Unusual Large Leak	-	0%	-	0%	83	1%	83	NA	83	NA
Total	**6,601**	**100%**	**6,267**	**100%**	**6,399**	**100%**	**(203)**	**(3.1%)**	**132**	**2.1%**

The key drivers for the 2% increase in emissions include increased levels of maintenance blowdowns (262 MMscf), vented emissions (107 MMscf), and Unusual Large Leaks (a transmission pipeline rupture and two instances where operators opened the wrong valve) (79 MMscf), which were partially offset by reductions from Distribution Mains & Services (DM&S) pipeline (194 MMscf) and Damages (134 MMscf) leak.

All system categories except DM&S experienced varying degrees of increased emissions.

Transmission Pipeline assets accounted for 8% of the 2017 emissions reflecting an increase of 71 MMscf or 16.4% from 2016. Within this asset category the increase was

[8] For more sub-category details see Table 7: Detailed Emissions by Category, Source, and Classification 2015-2017. In addition, in 2015 and 2016 the Aliso Canyon storage well leak was excluded from Unusual Large Leaks because it was accounted for by other state agencies.

largely due to increased Blowdowns resulting in 218 MMscf, which was significantly offset by decreased All Damages emissions of 144 MMscf.

The Transmission Metering &Regulation (M&R) Station's share of the total 2017 emissions remained at 16%, with a slight YOY increase of 31 MMscf (3%). The Transmission M&R Stations' emission increase was due from a greater level of maintenance related activities resulting in Blowdowns of 33 MMscf.

The Compressors Stations' share of the 2017 total emissions also remained constant at 2%. However, this category saw a small emission increase of 11 MMscf from 2016. The Compressor Station emissions largely increased due to increase survey activity identifying leaks, and efforts across the board to improve asset databases and accounting for all component leaks and emissions.[9] As such, this may not be an actual increase in emissions but an increase in leak detection and quantification.

The 2017 Distribution Mains &Services (DM&S) category decreased emissions from the 2015 Baseline by 282 MMscf or 17%. Emissions decreased by 182 MMscf or 11% from 2016 to 2017 mainly due to a reduction in pipeline leaks of 194 MMscf. While there were many improvements described in the respondent reports, the primary reason for the decrease in the DM&S Pipeline Leaks from 2016 was a change to the calculation of un-surveyed leaks that erroneously included Operations & Maintenance (O&M) leaks. The new information was brought to Staff's attention by Sempra utilities (SoCalGas and SDG&E). This change lowered the leak rate used to estimate un-surveyed leaks that resulted in a significant amount of reported emissions. Staff did not retrospectively change the previous year's pipeline leak emissions. Such a change should be considered for retrospective updating of prior year pipeline leak balances. Staff did not change the prior reported balances in this report because the impacts of all changes should be evaluated with all parties and considered for a one-time baseline adjustment.[10]

The Distribution M&R Stations emissions remained level as did its contribution to the total emissions. There was a slight YOY increase of 15 MMscf or 1% due to utilities' re-categorizing assets within this category and improving the accuracy of records within their asset management systems.

[9] Compressor Station operators surveyed their facilities in Q4 of 2017 in anticipation of new CARB regulations that took effect January 1, 2018

[10] New information that affects prior year reported balances are noted, but not changed because these changes need to be reviewed for their impact on the 2015 Baseline figures.

The emissions from Customer Meters increased from 2015 baseline by 18 MMscf (1.5%) and YOY by 11 MMscf (1%) due to the increase in number of customer meters.

The Underground Storage emissions increased about 90 MMscf (65%) from 139 MMscf to 229 MMscf, primarily due to increases in the Compressor Emissions (23 MMscf) directly related to additional operating hours and the Component Emissions of 69 MMscf (260%). The Component Emissions increased due to increased surveys of facilities, better emissions estimation methods, and updated asset records that added more components to sites' records. As such, this may not be an actual increase, but an increase due to better leak detection and quantification.

Lastly, in 2017 there were three relatively large gas releases that did not fit any of the existing sub-categories; Staff grouped them into the Unusual Large Leaks category for transparency. SoCalGas experienced a transmission pipeline rupture resulting in a fugitive release of 29,500 Mscf.[11] Pacific Gas and Electric (PG&E) experienced two releases on its transmission system due to operators opening the wrong valves that released a total of 53,500 Mscf.

The key drivers of the significant changes can be seen in Table 3: Total Emissions Grouped by Source Classification below, and Table 7: Detailed Emissions (by Category, Source, and Classification) 2015-2017, in the body of the report.

Table 3: Total Emissions Grouped by Source Classification, 2015-2017

Source Classification	2015 Baseline		2016		2017		2015 Baseline to 2017 Change		2016 - 2017 YOY Change	
	MMscf	%	MMscf	%	MMscf	%	MMscf	%	MMscf	%
Population Based Emissions	3,931	60%	3,898	62%	3,926	61%	(5)	(0.1%)	27	0.7%
Graded Pipeline Leaks	1,458	22%	1,401	22%	1,207	19%	(252)	(17%)	(194)	(14%)
Blowdowns	603	9%	373	6%	635	10%	32	5%	262	70%
Vented Emissions	258	4%	135	2%	242	4%	(16)	(6%)	107	80%
All Damages	318	5%	365	6%	227	4%	(91)	(29%)	(138)	(38%)
Other Leaks	33	0.5%	94	2%	79	1%	46	138%	(15)	(16%)
Unusual Large Leaks	0	0%	0	0%	83	1%	83	NA	83	NA
Total Sector Emissions	**6,601**	**100%**	**6,267**	**100%**	**6,399**	**100%**	(202)	(3.1%)	**132**	**2.1%**

[11] Transmission Pipeline Leaks are based on the number of miles of transmission pipeline times an EF, therefore including actual leaks would violate the definition for this type of emission estimate. However, the emission is significant and though infrequent it should be considered in the overall emissions inventory.

Consistent with prior years' the Population Based Emissions makes up the single largest source at 61% of the 2017 total emissions, see Table 4.[12] Population Based Emissions, which are calculated based on the number of units within an asset category multiplied by an EF, show virtually no YOY change.

Table 4: Population Based Emissions Sources, 2015-2017

Population Based Emissions	2015 Baseline		2016		2017		2015 Baseline to 2017		2016 - 2017 YOY Change	
	MMscf	%	MMscf	%	MMscf	%	MMscf	%	MMscf	%
Transmission Pipelines, Pipeline Leaks	5	0.1%	5	0.1%	7	0.1%	2	38%	2	41%
Transmission M&R Stations , Station Leaks & Emissions	942	14%	931	15%	929	15%	(12)	(1%)	(2)	(0%)
Distribution M&R Stations, Station Leaks & Emissions	1,348	20%	1,319	21%	1,334	21%	(14)	(1%)	15	1%
Customer Meters, Meter Leaks	1,636	25%	1,643	26%	1,655	26%	19	1%	12	1%
Total Population Based Emissions	**3,931**	**60%**	**3,898**	**62%**	**3,926**	**61%**	(5)	(0.1%)	**27**	**0.7%**

Table 3 also shows that the largest changes in YOY emissions occurred in Graded Pipeline Leaks, Blowdowns, Vented Emissions, and Damages as follows:

- Pipeline Leaks decreased due to an accounting change made in 2017 filings.[13] If the accounting change were retroactively implemented it would significantly decrease prior year reported Graded Pipeline Emissions. Because of the change in accounting method the as-reported figures for 2015 and 2016 are not comparable to 2017 reported emissions.
- Blowdowns increased due to greater maintenance activity levels even though bundling and cross compression procedures were implemented.
- Vented emissions increased due to higher survey frequency in advance of the 2018 implementation of CARBs oil and gas methane regulation, which covers Transmission Compressor Stations and storage facilities.
- The total number of damage events decreased.

Conclusion:

The major findings from the 2017 data are:

- Blowdown emissions increased significantly YOY from 2016 by 262 MMscf or 70% but they were only 32 MMscf or 5% greater than 2015 Baseline Blowdowns. In 2016 utilities did not experience a significant change in maintenance activity from 2015 while at the same time implemented work bundling and pressure

[12] The Population Based Emissions is comprised of Transmission and Distribution M&R Stations (35.4%), Customer Meter Sub-Assemblies (25.9%), and Transmission Pipeline Leaks (0.1%).

[13] The number of Pipeline Leaks and related emissions decreased after a realization that O&M leaks were being included in the un-surveyed leak calculation.

reduction BPs that reduced Blowdown emissions. In 2017, work bundling and cross-pressurization to reduce line pressures prior to performing work were still in use, but a significant increase in transmission system maintenance activity resulted in an increase of 218 MMscf. Transmission Blowdowns were the largest contributor to the aggregated Blowdowns source of emissions. These types of YOY fluctuations need to be expected and factored into any expected emissions reductions planning. (See Table 8: Blowdown and Vented Emissions by System Category, 2015-2017.)

- The method used to calculate un-surveyed DM&S - Pipeline Leaks was changed to exclude O&M discovered leaks, which overstated the amount of un-surveyed leaks and associated emissions. The change resulted in a decrease in un-surveyed leaks for most distribution companies, however, Sempra utilities realized the greatest impact. The change in method was due to new information from Sempra (SoCalGas and SDG&E) that a considerable portion of the leaks that had been previously classified as survey were O&M source leaks. While the sum of leaks did not change, there was a considerable change in the count of un-surveyed leaks due to the proportional allocation of Survey leaks factored in the calculation of un-surveyed leaks. In addition, the total sub-category of DM&S – Pipeline Leaks is not comparable to prior years, since virtually all the decrease in 2017 emissions is based on this change and not due to any other factor.
- The 2017 total increase of 2% from 2016 emissions was primarily a result of increases in Blowdowns of 262 MMscf, Vented Emissions of 108 MMscf (largely driven by the increase in the combined Underground Storage's Compressor Emissions of 23 MMscf and Component Emissions of 69 MMscf), where these were partially offset by decreases in Graded Pipeline Leaks of 194 MMscf, and All Damages 138 MMscf. (See Table 3: Total Emissions Grouped by Source Classification, 2015 – 2017)
- CARBs new survey regulations for Underground Storage and Compressor facilities, which went into effect January 1, 2018 increased reported items leaking and associated emissions in 2017 as entities proactively initiated survey protocols in advance of the January 1, 2018 implementation date. However, we believe the quarterly surveys will identify leaks that in the past may not have been identified because of the new reporting requirements. In addition, the long-term impact

will be the early detection and abatement of leaks and unnecessary vented emissions at these facilities.

- PG&E described efforts aimed at verifying component assets at its facilities to update and the implementation of a new asset accounting system. These efforts better identified components within their compressor and storage facilities, which directly affect emissions based on the count of different types of components, thus resulted in additional emissions in Compressor Stations and Underground Storage.
- In 2017 PG&E was able to identify the pipe material of DM&S - Pipeline Leaks, which improved its estimates of un-surveyed leaks by material type. Staff has not evaluated whether the method for obtaining the pipe material can be obtained for their prior year filings, and if so, what impact that may have on previously reported emissions.

Introduction and Background

On September 14, 2014, Governor Jerry Brown signed into law SB 1371 that required reporting and verification of emissions of greenhouse gases (GHGs). The bill also requires gas corporations to file a report summarizing utility leak management practices, a list of new natural gas leaks by grade, a list of open leaks that are being monitored or are scheduled to be repaired, and a best estimate of gas loss due to leaks. In accordance with SB 1371, the California Public Utilities Commission (CPUC) and California Air Resources Board (ARB)prepared this annual report, which analyzes and accounts for natural gas from leaks and vented emissions from natural gas transmission, distribution and storage in California.[14]

SB 1371 also requires the adoption of rules and procedures to minimize natural gas leakage from Commission regulated natural gas pipeline facilities consistent with Pub. Util. Code § 961(d), § 192.703(c) of Subpart M of Title 49 of the Code of Federal Regulation, the Commission's General Order (GO) 112-F, and the state's goal of reducing GHG emissions.

In January 2015, the Commission opened an Order Instituting Rulemaking (R.) 15-01-008 (OIR) to implement the provisions of SB 1371.

On June 15, 2017, the Commission in D.17-06-015 (Gas Leak Decision) approved the Natural Gas Leak Abatement (NGLA) Program consistent with SB 1371. This decision established Best Practices (BPs) and reporting requirements for the NGLA Program to be developed by the CPUC in consultation with CARB.[15] The decision implements the following to support the state's goal of reducing natural gas emissions by 40% by 2030:

1. Annual reporting for tracking natural gas emissions;
2. Twenty-six mandatory BPs for minimizing natural gas emissions pertaining to policies and procedures, recordkeeping, training, experienced trained personnel, leak detection, leak repair, and leak prevention;
3. Biennial Compliance Plan (CP) incorporated into the respondents' annual Gas Safety Plans, beginning in March 2018; and

[14] Unless specified as a fugitive leak or vented emission, for the purposes of this report "emissions" include both fugitive leaks, and vented emissions of natural gas.

[15] Leno, Chapter 525, Statutes of 2014; Pub. Util. Code §§ 975, 977, 978

4. Cost recovery process to facilitate Commission review and approval of incremental expenditures to implement BPs, Pilot Programs and Research & Development.

In the Gas Leak Decision, the Commission affirms that the 2015 baseline emissions estimates will provide the starting point to measure future natural gas emissions reductions.[16] The rulemaking remains open to address implementation issues in a second phase.

In addition, SB 32, which sets a 40% GHG reduction target for 2030, was passed and signed into law in 2006.[17] This additional legislation directs CARB to develop plans to reduce statewide natural gas emissions, which it did in the Short-Lived Climate Pollutants strategy (SB 605 (Lara, Chapter 523, Statutes of 2014).

Methane is a very potent GHG, with an impact many times greater than carbon dioxide. To-date the NGLA reports have been consistent with both the US EPA and CARB by reporting GHG using the 100-year horizon, which estimates the impact of methane to be 25 times greater than CO2 over 100 years. According to the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4), methane is 25 times more potent than CO2 over a 100-year time horizon and 72 times more potent than CO2 over a 20-year time horizon. Although the more recent IPCC Fifth Assessment Report (AR5) estimates a global warming potential (GWP) value 86 times higher than CO2 over a 20-year span, the AR4 values are used for consistency with prior Reports.

Purpose of the Natural Gas Leak Abatement Report:

The report estimates emissions from the gas storage and delivery systems in aggregate, by entity, by system categories, by source classification and by grade. The information should be used to help determine where emission reductions can be achieved while maintaining the safe and reliable operation of commission-regulated gas pipelines and other facilities. The metrics used to compile this report provide operators, the Commission, and the public with information about the type, number, and severity of emissions and the quantity of gas emitted to the atmosphere over time.

This report provides a summary of the 2017 emissions inventory reports submitted by the respondents on June 15, 2018, and differs from prior year reports due to the following:

[16] http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=190740714, Finding of Fact #13, pg. 145.
[17] California Global Warming Solutions Act of 2006: emissions limit. SB32, Pavley, Reg. Sess. 2015-2016. (2016).

- The 2017 Joint Report includes year-over-year (YOY) comparisons to 2016 and the 2015 Baseline emissions and shows a three-year emissions trend.
- Respondents already submitted material on BPs in their CPs. While previous Joint Reports included a chapter on "Responses to Data Request Questions #1 and #7," this content is included in the CPs and only the information on what methods and programs employed in 2017 for leak abatement are referenced in the 2017 Joint Report.
- There were no emissions attributed to the Aliso Canyon natural gas storage facility leak for calendar year 2017, since the duration of the leak event spanned 2015 and, these emissions were noted within the body of both the 2015 and 2016 Joint Reports.
- For both Compressor Stations and Underground Storage facilities the subcategories Compressor Leaks and Component Leaks have been combined across all years. This was done to address comments from respondents that it is problematic to try to differentiate compressor leaks and components as in many cases they are integral systems.

Even though the system categories of emissions are the same as in 2015 and 2016, continued efforts to standardize the data submissions by respondents has improved the consistency and integrity of the data. Also, in keeping with prior reports, the data request continued to require the use of 1996 GRI emissions factors (EFs) for this year's report consistent with prior years reports.[18] The report includes general discussions of changes to operational practices, new methods for leak and emission detection and mitigation programs. Lastly, improvements to data capture (e.g. verification of asset inventory, integrating system databases, et al), and methodology for estimating emissions (e.g. calculating emissions for all blowdowns not just those above a specific threshold), may provide greater accuracy in future reporting cycles.

Among the ISPs, notably, Lodi Gas Storage (LGS) had a significant increase in 2017 as compared to the two previous years, which was caused by two relatively large leaks on a transmission line that were quickly repaired.

[18] See Appendix 9 of the Data Request for specific EFs recommended by each System Category. http://www.cpuc.ca.gov/General.aspx?id=8829

Basis for the Annual Gas Leak Abatement Report:

On March 31, 2018, Staff issued a data request to CPUC jurisdictional utilities and independent storage providers (ISPs) in California to collect the information required by Article 3, Section 975 (c) and (e)(6), using templates jointly developed by CPUC and CARB. (See Appendix C for detailed wording.)

The data were tabulated into the following seven systems categories (which included subgroupings by type):

1. Transmission Pipelines (leaks, damages, blowdowns, components, and odorizers);
2. Transmission Metering and Regulation (M&R) stations (station leaks and emissions, and blowdowns);
3. Compressor stations (compressor leaks and emissions, blowdowns, components leak and emissions, and storage tanks);
4. Distribution Pipeline Mains and Services (leaks, damages, and blowdowns);
5. Distribution M&R stations (station leaks and emissions, and blowdowns);
6. Customer Meters (leaks, and venting); and
7. Underground Storage Facilities (leaks, compressors leaks and emissions, blowdowns, and component leaks and emissions. Dehydrators are omitted in 2016).

The respondents provided contextual information and explanations for their data to help CARB and CPUC Staff understand the composition of the emissions, emission sources and related calculations underlying the emission estimates. The respondents summarized the data and provided their system-wide leak information. Appendix A explains methods used to estimate emissions.

CARB and CPUC Staff jointly analyzed the data and requested supplementary information for clarification as necessary. The "Lessons Learned" section of this report identifies insights Staff acquired about potential improvements to the process and opportunities to enhance future data requests.

Findings and Discussion

Leaks and Emissions:

Based on the gas company data, this sector emitted approximately 6,399 MMscf in 2017, which equates to 2.86 MMTCO2e using the Intergovernmental Panel on Climate Change (IPCC) Forth Assessment Report (AR4) 100- year methane Global

Warming Potential (GWP) of 25, or 8.25 MMTCO2e using the 20-year methane GWP of 72 (see Table 1). This is a 2.1% YOY increase from 2016 estimated emissions of 6,267 MMscf or 2.81 MMTCO2e.[19] The 2017 emissions, however, are 3% lower than the 2015 Baseline of 2.96 MMTCO2e.

System-wide Leak Rate

The System-wide Leak Rate is an important metric that could show the correlation with reductions in emissions or reductions in throughput. SB 1371 requires the establishment and annual monitoring of a System-wide Leak Rate for the transmission and distribution system.[20] [21]

The 2015 System-wide Leak Rate was 0.32%, slightly less than the 2016 system wide leak rate of 0.33%, where lower throughput levels decreased less than the 2016 emissions. The 2017 system wide leak rate of 0.32% is the same as the 2015 Baseline and slightly less than 2016. See the following Table 5: System Wide Emissions – Throughput Categories, 2015-2017.

Table 5: System-wide Emissions – Throughput Categories, 2015-2017

Throughput Category	Natural Gas Volume (MMscf)		
	2015	2016	2017
Total Storage Annual Volume of Injections to Storage	199,522	116,579	155,272
Total Storage Annual Volume of Gas Used by the Gas Department	NA	NA	1,933
Total Transmission Annual Volume of Gas Used by the Gas Department	7,717	6,107	5,875
Total Transmission Volume of Annual Gas transported to or for Customers in state	1,832,676	1,736,336	1,842,669
Total Transmission Volume of Annual Gas transported to or for Customers out of state	16,775	18,002	11,241
Total Distribution Annual Volume of Gas Used by the Gas Department	261	156	315
Total Throughput	**2,056,950**	**1,877,179**	**2,017,306**
Total Emissions	**6,601**	**6,267**	**6,399**
System-wide Leak Rate (Emissions/Throughput)	**0.32%**	**0.33%**	**0.32%**

The total throughput showed an increase in 2017 compared to 2016 with more gas injected into storage and a greater transmission volume of annual gas transported to customers in the State. In 2017 Staff added throughput from "Total Storage Annual

[19] Total Natural Gas emissions reported to the CPUC/CARB for the 2016 annual report without Aliso Canyon come to 6,267 MMscf which translates to 118,026 metric tonnes of methane. See Appendix D for calculations.

[20] For the purposes of SB 1371, the definitions of "leak" and "gas -loss" and the formula for calculating a "system-wide gas leak rate" were defined in a different manner than elsewhere. For the purposes of calculating the System-Wide Leak Rate, a "leak" was defined as any breach, whether intentional or unintentional, whether hazardous or non-hazardous, of the pressure boundary of the gas system that allows natural gas to leak into the atmosphere. Any vented or fugitive emission to the atmosphere is considered a "leak". See Appendix B.

[21] Refer to Appendix C for PUC Code Section 975(e)(6), Article 3

Volume of Gas Used by the Gas Department" of 1,933 MMscf in the total, but this amount is negligible with very little if any impact on the overall leak rate.[22]

2017 Adjustments to Categorization

This report reflects a few minor categorization adjustments to the data reported for 2017.

- The 2017 reporting templates for Customer Meters a new tab for "All Damages" was added.
- The 2017 templates for Transmission Compressor Stations and Underground Storage combined Compressor Leaks and Component Leaks into one Compressor and Component Leaks tab. The purpose is to simplify the process of differentiating the leaks and capturing all the component leaks in one spreadsheet. In the Joint Report the prior year values for each of these subcategories were combined to be comparable to the 2017 reported values.
- SoCalGas was the only utility to report Distribution M&R Stations - Component Emissions and Component Leaks of 17.5 and 14.8 Mscf respectively. Entities were asked to provide this for informational purposes that may help lead the way to reporting these category leaks on an actual basis. However, since these emissions are encapsulated within the existing EFs used for reporting M&R station emissions these are omitted to prevent duplication of emissions.
- SoCalGas also reported Distribution Mains and Services - Component Leaks of 142.2 Mscf. The component leaks are differentiated from pipeline leaks and to facilitate greater transparency, they are being reported on their own line in this report's Table 7.
- SoCalGas also reported 22.8 Mscf for Distribution M&R Stations - All Damages. To facilitate greater transparency and differentiate these leaks appropriately, they are being reported on their own line in this report's Table 7.

Utility Emission Summary:

In 2017, the overall emissions increased 2% over the 2016 total, but were still 3% below the 2015 Baseline. The following Table 6 shows each respondent's 2015 Baseline to 2017, and the 2016 – 2017 YOY change. PG&E's is the state's largest emitter of SB1371 type emissions and YOY reported emissions increased by 153,128 Mscf or about 5%,

[22] This category refers to natural gas that may be used by the utility itself, such as providing fuel to start-up a compressor or run an HVAC system for an occupied building at the storage site.

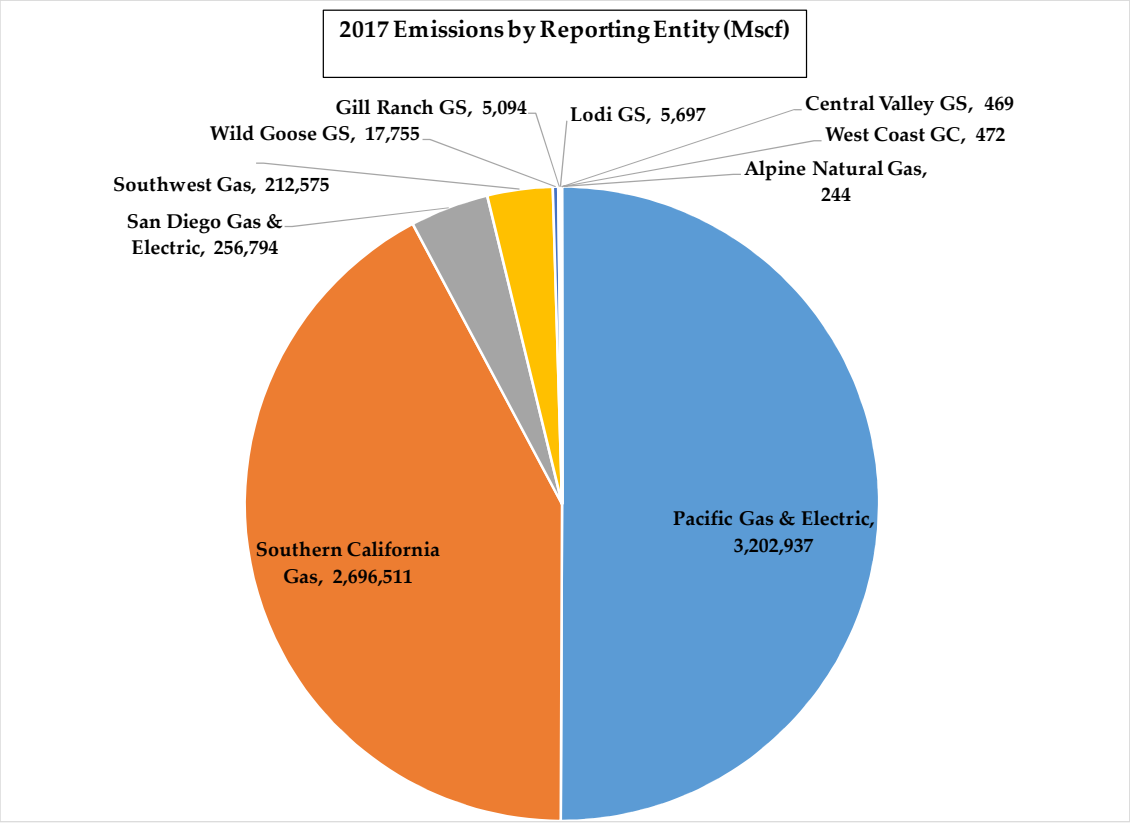
which was primarily driven by the increases from Blowdowns and Component Emissions. However, these emissions are offset by the decreases from All Damages and DM&S Pipeline Leaks. Four ISPs also reported increases in their emissions, three of which are cumulatively about 9,997 Mscf, where the other ISP's increase was minor at 24 Mscf. The remaining entities show YOY emissions decreases of 25,965 Mscf (9%), 4,749 Mscf (2%), 509 Mscf (0.02%) and 1 Mscf (0.4%) for SDG&E, Southwest Gas (SWG), SoCalGas and Alpine Natural Gas (ANG) respectively.

Table 6: Emissions by Utility and Independent Storage Provider, 2015-2017

Entity	2015 Baseline		2016		2017		2015 Baseline to 2017 Change		2016 - 2017 YOY Change	
	Mscf	%	Mscf	%	Mscf	%	Mscf	%	Mscf	%
Pacific Gas & Electric	3,294,368	50%	3,049,809	49%	3,202,937	50%	(91,431)	(3%)	153,128	5%
Southern California Gas	2,779,853	42%	2,697,020	43%	2,696,511	42%	(83,342)	(3%)	(509)	(0.02%)
San Diego Gas & Electric	282,041	4%	282,759	5%	256,794	4%	(25,247)	(9%)	(25,965)	(9%)
Southwest Gas	214,309	3%	217,324	3%	212,575	3%	(1,734)	(1%)	(4,749)	(2%)
Wild Goose GS	24,003	0.36%	13,301	0.21%	17,755	0.28%	(6,248)	(26%)	4,454	33%
Gill Ranch GS	3,636	0.06%	3,772	0.06%	5,094	0.08%	1,458	40%	1,322	35%
Lodi GS	1,638	0.02%	1,476	0.02%	5,697	0.09%	4,059	248%	4,221	286%
Central Valley GS	806	0.01%	445	0.01%	469	0.01%	(337)	(42%)	24	5%
West Coast GC	509	0.01%	391	0.01%	472	0.01%	(37)	(7%)	81	21%
Alpine Natural Gas	6	0.00%	245	0.00%	244	0.00%	238	4,257%	(1)	(0.4%)
Total	**6,601,169**	**100%**	**6,266,544**	**100%**	**6,398,549**	**100%**	**(202,620)**	**(3%)**	**132,005**	**2%**

Table 6 shows that the top four utilities make up approximately 99.5% of the emissions inventory and the six other utilities and ISPs make up the remaining 0.5% of the total emissions.

Figure 1: 2017 Emissions by Reporting Entity (Mscf)



The top three utilities all describe continuing improvement in and completing updates of programming software in 2017 to better record and analyze the data in their system. Staff appreciates the improved accuracy and additional details provided in the Appendix 8 YOY explanations. Though these efforts culminating in 2017 should facilitate more accurate results from surveys mandated by CARB's 2018 oil and gas regulations. An interesting observation is that both PG&E and Sempra through better data management facilities and queries implemented to respond to SB1371 reporting requirements, which are over and above those used for their historical reporting purposes, enable them to disaggregate data and include additional components and assets not previously reported, that increased the accounted for emissions. [23]

[23] "The level of details about pipeline components currently being requested have not historically been required by regulation to be tracked and therefore this level of detail cannot be readily queried from enterprise systems, which has limited reporting capabilities… The fact that the system was designed historically using equipment that was designed to vent natural gas as a normal mode of operation is not considered to be an unacceptable practice." – Sempra Comments on the Revised Draft Report.

PG&E noted in their NGLA report that while there was a net increase in emissions YOY, it made substantial improvements that impact emission accounting and reductions in several categories as noted below:

- Actively tracked and recorded blowdown events of 50 cubic feet or more. This was done on various blowdowns from the following sources: Transmission Pipeline, Transmission Compressor Station, and Underground Storage facilities.
- Used a new maintenance solution tool Asset Maintenance – Backbone and Stations (AMBBS), to implement more stringent and granular record keeping of Transmission M&R Station Blowdowns.
- Analyzed more robust data of Transmission M&R Station Components, Transmission Compressor Station and Underground Storage facility Component Emissions. This resulted in a larger number of reported devices and increased emissions.
- Included start-up gas emissions for Compressor Station and Underground Storage facility compressors.
- More actively tracked where leaks occurred on transmission pipeline by recording the specific leaking components.
- Provided a refined definition of the four types of Transmission M&R Stations: Farm Tap Regulator Set, Large Volume Customer Regulator (LVCR) Set, Transmission to Transmission Interconnect, and Transmission to Transmission Intra-connect (Appendix 2).
- Conducted a project to document the farm tap regulator sets used during 2017.
- Proactively conducted a comprehensive leak survey pursuant to the requirements of the CARB Oil and Gas regulation. Even though it became effective January 1, 2018, PG&E initiated efforts in the fourth quarter of 2017. They used gas measurement technology on a component-by-component basis at Compressor Station and Underground Storage facility component leaks. This resulted in greater number of reported leaks and more emissions.
- Modified the survey cycle of underground pipeline. Where previously PG&E surveyed some pipe materials on a 5-year-cycle, in 2017 all pipelines have been surveyed either on an annual, 3-year-cycle, or 4-year-cycle. This is in line with the BPs and CP reporting.

- Finally, PG&E used more accurate GIS mapping data to obtain the pipe material of distribution mains and services leaks instead of reporting them as unknown material.

In the process of reviewing the DM&S pipeline data and methodology, Staff, SoCalGas and SDG&E evaluated the calculation inputs and found that many of the leaks that had been classified as survey leaks were O&M leaks, which when included in the leak rate calculation overstate the amount of un-surveyed leaks and emissions. By removing the O&M leaks from the survey leak rate calculation the pipeline leaks were significantly reduced.[24]

Sempra utilities' 2015 and 2016 inventories would decrease from a retroactive application of this change to the un-surveyed leak calculation. If the decrease was reflected in the prior years' emissions, then the current year change would show a small net increase due to the increased compressor emissions, and transmission system maintenance blowdown activities in 2017.

Both Sempra utilities (SDG&E and SoCalGas) implemented other programs and practices that are described in their respective Q1 Attachment to its filing. The most significant efforts undertaken in 2017 are listed below:

- SoCalGas ramped up its leak repair efforts in the summer of 2016, which ultimately led to repairing 4,663 Grade 3 leaks in calendar year 2017.
- Both SDG&E and SoCalGas increased their investment for media campaigns to promote the practice of calling 811 before digging for individuals. The increased awareness campaign is believed to have reduced the total number of excavation damages in 2017 from 2016.
- Both became members of the Gold Shovel Standard and required all company prime contractors to enroll in the Gold Shovel Standard in 2017.
- Both reduced line pressures before blowdowns, which avoided an estimated 81 Mscf and 59,000 Mscf of emissions for SDG&E and SoCalGas respectively.
- SoCalGas increased the frequency of compressor rod packing replacement by installing 19 packing replacements and 28 packing replacements at storage facilities. The increase in replacement frequency has the potential to reduce emissions by 41,000 Mscf.

[24] The 2015 and 2016 data could also be revised in this manner but was not because a change of this magnitude should be reviewed by stakeholders and all impacts to the 2015 Baseline considered holistically. Therefore, Staff will track the impact of ongoing methodology and accounting changes to evaluate their impact on the 2015 Baseline balances, which will be included in the winter workshop for stakeholder evaluation and discussion.

- Both conducted research projects in 2017 in the following areas: EFs, leak detection, leak quantification, damage prevention, blowdowns and pipeline safety & integration.
- Both began transitioning the leak survey cycle on pre-1986 Aldyl-A mains and services (previously on a 5-year survey cycles) to annual leak survey. SDG&E replaced approximately 41 miles of poor performing early vintage plastic pipe, which should result in about 50 Mscf of emission reduction per year. SoCalGas replaced 131 miles of non-state-of-the-art pipe, including 54 miles of early vintage plastic pipe and 77 miles of unprotected steel. The pipe replacement resulted in an estimated annual reduction of 700 Mscf.
- Both added Bluetooth adapters to leak detection equipment for walking leak surveys in 2017. The adapters are intended to better match leaks to the GPS location that improves electronic tracking, verification, data entry errors, and reduces paperwork.

Southwest Gas (SWG) reduced emissions approximately2%. Most of the emissions remained constant across all categories. SWG does not have many leaks on its pipeline network and surveys its distribution system over a 3-year cycle, while some portions of its system are surveyed annually (e.g. business districts and PVC pipe), and SWG has not experienced large YOY fluctuations in emissions.

Detailed Emissions by Source, Category and Classification

The next section discusses the emissions by system categories, emission source, and source classification. Table 7 provides a comprehensive and detailed emission inventory for 2015, 2016, and 2017 calendar years.

Table 7 summarizes information from the templates, where some common items may be combined or regrouped. Because the reporting templates also include items reported for informal purposes, Table 7 does not report all line item categories as-reported in the templates. For example, in the M&R Station template the Component Leaks are included in the EF used to report M&R Station emissions, and therefore, not included separately to prevent duplication in the emissions inventory. For the line items in the Transmission Compressor template, Compressor Leaks and Component Leaks have been combined in the table.

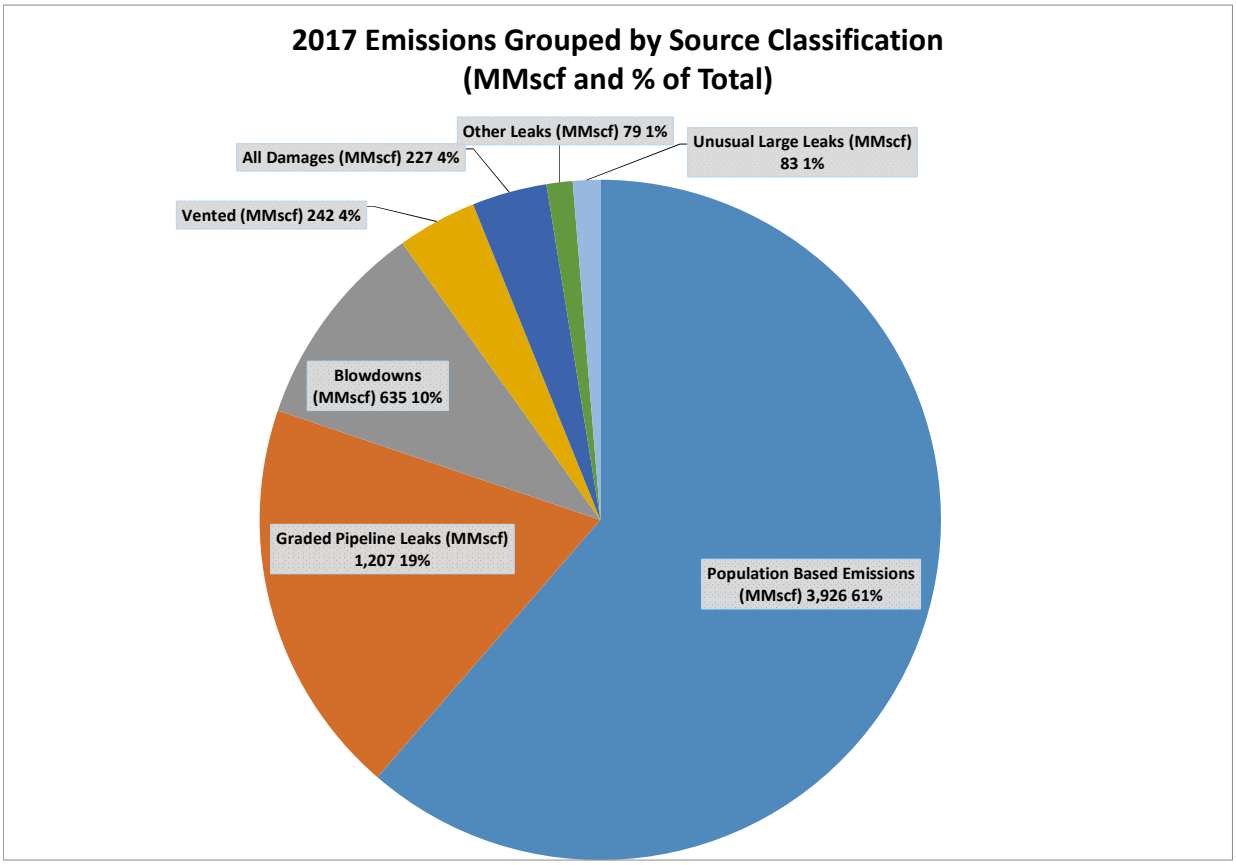
In addition, the Customer Meter template, All Damages are combined with the DM&S – All Damages because not all reporting entities distinguish between the two

sources. This reporting is consistent with how these damages were reported in 2016. Until all respondents can separate out these different types of damages they will be reported as a combined number.

Table 7: Detailed Emissions (Category, Source, and Classification) 2015-2017

System Category	Emission Source	Source Classification	2015 Baseline	2016	2017	2015 Baseline to 2017 Change		2016 - 2017 YOY Change	
			Mscf	Mscf	Mscf	Mscf	%	Mscf	%
Transmission Pipelines	Pipeline Leaks	Population Based	5,238	5,118	7,239	2,001	38%	2,121	41%
	All Damages	Damages	81,793	164,729	16,671	(65,122)	(80%)	(148,058)	(90%)
	Blowdowns	Blowdown	455,056	246,946	465,417	10,362	2%	218,472	88%
	Component Emissions	Vented	4,592	14,237	12,756	8,164	178%	(1,481)	(10%)
	Odorizers	Vented	2,570	2,398	2,496	(75)	(3%)	97	4%
Transmission M&R Stations	Station Leaks & Emissions	Population Based	941,622	931,280	929,454	(12,168)	(1%)	(1,826)	(0%)
	Blowdowns	Blowdown	65,583	51,775	84,936	19,353	30%	33,161	64%
	Component Emissions	Vented	21	-	-	(21)	(100%)	-	-
Trasmission Compressor Stations	Compressor Emissions	Vented	106,257	52,101	65,659	(40,598)	(38%)	13,559	26%
	Blowdowns	Blowdown	31,088	44,510	50,008	18,920	61%	5,497	12%
	Component Emissions	Vented	7,186	11,695	15,360	8,174	114%	3,665	31%
	Compressor and Component Leaks	Other Leaks	18,153	26,575	25,139	6,987	38%	(1,436)	(5%)
	Storage Tank Leaks & Emissions	Other Leaks	3	10,279	395	391	11,858%	(9,885)	(96%)
Distribution Mains & Services	Pipeline Leaks	Pipeline Leaks	1,458,399	1,400,613	1,206,882	(251,517)	(17%)	(193,731)	(14%)
	All Damages	Damages	236,145	200,604	210,561	(25,585)	(11%)	9,957	5%
	Blowdowns	Blowdown	5,046	810	2,847	(2,199)	(44%)	2,037	251%
	Component Emissions	Vented	3,281	-	-	(3,281)	(100%)	0	-
	Component Leaks	Other Leaks	-	-	142	142	-	142	-
Distribution M&R Stations	Station Leaks & Emissions	Population Based	1,347,773	1,319,005	1,333,905	(13,868)	(1%)	14,900	1%
	Blowdowns	Blowdown	295	331	382	87	29%	51	15%
	All Damages	Damages	-	-	23	23	-	23	-
Customer Meters	Meter Leaks	Population Based	1,635,910	1,643,029	1,654,910	19,000	1%	11,881	1%
	Vented Emissions	Vented	2,363	1,968	1,576	(788)	(33%)	(392)	(20%)
Underground Storage	Storage Leaks & Emissions	Other Leaks	15,016	15,630	7,577	(7,439)	(50%)	(8,053)	(52%)
	Compressor Emissions	Vented	96,313	25,163	48,266	(48,047)	(50%)	23,104	92%
	Blowdowns	Blowdown	46,358	28,927	31,405	(14,953)	(32%)	2,478	9%
	Component Emissions	Vented	14,947	26,953	95,747	80,800	541%	68,794	255%
	Compressor and Component Leaks	Other Leaks	-	41,859	45,786	45,786		3,927	9%
	Dehydrator Vent Emissions	Vented	20,163	11	12	(20,151)	(100%)	1	13%
Unusual Large Leaks	Unusual Large Leaks	Unusual Large Leaks	-	-	83,000	83,000	-	83,000	-
Total			**6,601,169**	**6,266,544**	**6,398,549**	**202,620**	**3%**	**132,005**	**2%**

Figure 2: Emissions Grouped by Source Classification, 2017



The Population Based Leaks make up 61% of the total 2017 emissions as shown in Figure 2.[25] Similar to 2016, the 2017 Graded Pipeline Leak emissions make up about a fifth of total emissions and had the largest numerical reduction from 2016 with 194 MMscf or 14%.[26] Though Blowdowns and Vented emissions make up 10% and 4% of 2017 total emissions they accounted for the greatest amount of YOY increases of 262 and 107 MMscf respectively.[27] The All Damages classification made up 4% of 2017 emissions but had the largest percentage reduction from 2016 levels at 37% or 137 MMscf.[28] Other Leaks and Unusual Large Leaks make up the remaining emissions with each at 1% of the 2017 total emissions.

[25] See Table 3: Total Emissions by Source Classification, 2015 – 2017.
[26] Ibid
[27] Ibid
[28] Ibid

Table 8 shows more granular detail of the components that make up Blowdowns and Vented Emissions. Both classifications experienced significant increases from 2016 but were not significantly different than 2015 baseline emissions.

Table 8: Blowdown and Vented Emissions by Systems Category, 2015-2017

System Category	2015 Baseline [Mscf]	2016 [Mscf]	2017 [Mscf]	2015 Baseline to 2017 Change		2016 - 2017 YOY Change	
				Mscf	%	Mscf	%
Blowdowns							
Transmission Pipeline	455,056	246,946	465,417	10,362	2%	218,472	88%
Transmission M&R Stations	65,583	51,775	84,936	19,353	30%	33,161	64%
Transmission Compressor Stations	31,088	44,510	50,008	18,920	61%	5,497	12%
Distribution Mains and Services	5,046	810	2,847	(2,199)	(44%)	2,037	251%
Distribution M&R Stations	295	331	382	87	29%	50	15%
Underground Storage	46,358	28,927	31,405	(14,953)	(32%)	2,478	9%
Total-Blowdown:	**603,424**	**373,299**	**634,994**	**31,570**	**5%**	**261,695**	**70%**
Vented Emissions							
Transmission Pipelines, Components	4,592	14,237	12,756	8,164	178%	(1,481)	(10%)
Transmission Pipelines, Odorizers	2,570	2,398	2,496	(75)	(3%)	97	4%
Transmission M&R Stations , Components	21	-	-	(21)	(100%)	-	N/A
Trasmission Compressors Stations, Compressors	106,257	52,101	65,659	(40,598)	(38%)	13,559	26%
Trasmission Compressors Stations, Components	7,186	11,695	15,360	8,174	114%	3,665	31%
Distribution Mains & Services, Components	3,281	-	-	(3,281)	(100%)	-	N/A
Customer Meters, Vented	2,363	1,968	1,576	(788)	(33%)	(392)	(20%)
Underground Storage, Compressors	96,313	25,163	48,266	(48,047)	(50%)	23,104	92%
Underground Storage, Components	14,947	26,595	95,747	80,800	541%	69,152	260%
Underground Storage, Dehydrator Vent	20,163	11	12	(20,151)	(100%)	1	13%
Total-Vented Emissions:	**257,693**	**134,167**	**241,871**	**(15,822)**	**(6%)**	**107,704**	**80%**

Detailed Discussion for Each of the Seven Systems Categories

Transmission Pipeline:

PG&E, SoCalGas, SDG&E, Lodi Gas Storage (LGS), and Central Valley Gas Storage (CVGS) reported Transmission Pipeline Emissions; the transmission system category has shown considerable variability in emissions over the past three years. The increase in total emissions from 433,427 Mscf in 2016 to 527,240 was primarily due to 187,813 Mscf in increased blowdown activity that was offset by a 143,558 Mscf in reductions from All Damages. Blowdowns are cyclical in nature where we expect variability due to maintenance activity levels. The reductions within All Damages are also expected to fluctuate year-to-year depending on the severity and number of damages that occur in any given year.

Table 9: Transmission Pipeline Emissions, 2015-2017

Source	2015 Baseline		2016		2017		2016 - 2017 YOY Change	
	Mscf	%	Mscf	%	Mscf	%	Mscf	%
Pipeline Leaks	5,238	1%	5,118	1%	7,239	1%	2,121	41%
All Damages	81,793	15%	164,729	38%	16,671	3%	(148,058)	(90%)
Blowdowns	455,056	83%	246,946	57%	465,417	92%	218,472	88%
Component Emissions	4,592	1%	14,237	3%	12,756	3%	(1,481)	(10%)
Odorizers	2,570	0%	2,398	1%	2,496	0%	97	4%
Total	**549,248**	**100%**	**433,427**	**100%**	**504,579**	**100%**	**71,151**	**16%**

- The emissions in the Transmission Pipeline Leaks category changed from around 5,100 Mscf in both 2015 and 2016 to 7,239 Mscf in 2017. Typically, emissions for this category have remained constant because the emissions are based on the miles of transmission pipeline, which does not vary much YOY. However, due to two large leaks at LGS, with a total emission of 2,128 Mscf, there was an increase both for the category as well as for LGS, which previously had no transmission pipeline emissions. LGS's actual leaks were added to this line item category because their transmission pipeline is de minimis, and the leaks though large for LGS, are not unusual as transmission pipeline leaks go. It was included here to capture in the actual leaks in the emissions inventory.[29]
- In 2017 All Damages had significantly fewer damage events resulting in a decrease of
  148,058 Mscf from 2016 levels to 16,671 Mscf. The largest YOY decrease occurred within PG&E's transmission pipeline system with a decline of 150,058 Mscf, due to smaller damages in 2017 compared to 2016. The 2016 damages from third parties in the All Damages category showed an increase in emissions from 81,793 Mscf in 2015 to 164,729 Mscf in 2016 due to an increased number of events and longer average time to repair.
- Blowdown emissions increased 218,471 Mscf from 2016 to 465,417 Mscf in 2017, attributed to PG&E blowing down segments of pipelines while conducting a greater number of hydrostatic tests for pipeline integrity and safety. While PG&E increased 2017 Blowdown emissions by 168,862 Mscf from 2016, they noted that their bundling practices and pipeline evacuation protocols diverted approximately 72% of the

[29] The definition of what constitutes an Unusual Large Leak will be tabled at the winter workshop for updating and improving reporting mechanisms and templates.

blowdown emissions through drafting and cross compression. Conversely, in 2016 Blowdown emissions decreased 208,110 Mscf from 455,055 Mscf in 2015 to 246,949 Mscf due to bundling maintenance projects and lower activity levels. Emissions returned to 2015 levels in 2017 to 434,759 Mscf.

- The changes in 2017 Component Emissions were the result of better utility field verification, documentation management and information systems improvements decreasing 1,481 Mscf from 2016 levels to 12,756 Mscf in 2017. This contrasts with the significant increase in Component Emissions in 2016 of 9,645 Mscf from 4,592 Mscf in 2015 to 14,237 Mscf to 2016. The 2016 increase was largely due to re-categorization of assets that were included in other categories or omitted from 2015.
- The Odorizer emissions remained constant across the three years averaging about 2,900 Mscf.

Transmission M&R Stations:

PG&E, SoCalGas, SDG&E, and SWG reported total Transmission M&R Station Emissions of 1,016,362 Mscf in 2017, with station leaks and emissions based on the number of M&R stations multiplied by an EF to obtain the emission estimate. As noted in Table 10 below, Blowdowns increase by 64% YOY by 33,161 Mscf, which is 3% of the total 1,016,362 Mscf Transmission M&R Station Emissions. The Blowdown emissions make up the largest discretionary emissions in this category and were driven by increased maintenance activity.

Table 10: Transmission M&R Station Emissions, 2015-2017

Source	2015 Baseline		2016		2017		2016 - 2017 YOY Change	
	Mscf	%	Mscf	%	Mscf	%	Mscf	%
Station Leaks & Emissions	941,622	93%	931,280	95%	929,454	92%	(1,826)	(0.2%)
Blowdowns	65,583	7%	51,775	5%	84,936	8%	33,161	64%
Component Emissions	21	0%	0	0%	0	0%	0	0%
Total	**1,007,226**	**100%**	**983,055**	**100%**	**1,014,390**	**100%**	**31,335**	**3%**

In 2017 SoCalGas and PG&E took inventory of their M&R station assets and updated their respective systems. SoCalGas field verification of high pressure taps resulted in 1,458 additional tap facilities, that had a commensurate increase in emissions of 20,897 Mscf. PG&E effort resulted in recateogorizing 47 Large Volume Customer Regulators (LVCRs) from M&R station assets to Large Volume Customer

Meters/Regulators captured in the templates for Customer Meter Sub-Assemblies - Appendix 6. Based on their field verficiation PG&E updated its count of intraconnects, interconnects and farm tap regulators that overall resulted in a decrease of 24,278 Mscf.

These offseting changes resulted in relatively constant Transmission M&R Station leaks and Emissions averaging 934,100 Mscf over 3-years.

The Blowdown emissions increased due to an increase in activity by both SoCalGas and PG&E. In addition, PG&E utilized a new maintenance solution tool, which implements more stringent and granular recordkeeping of maintenance events.

Transmission Compressors:

PG&E, SoCalGas, SDG&E, and Gill Ranch Gas Storage (GRGS) reported 2017 total Transmission Compressor Station Emissions of 156,561 Mscf, which is an 8% increase from 2016 emissions of 145,160 Mscf, but 4% lower than 2015 baseline levels of 162,687 Mscf (see Table 11 below).

Table 11: Transmission Compressor Station Emissions, 2015-2017

Source	2015 Baseline		2016		2017		2016 - 2017 YOY Change	
	Mscf	%	Mscf	%	Mscf	%	Mscf	%
Compressor Emissions	106,257	65%	52,101	36%	65,659	42%	13,559	26%
Blowdowns	31,088	19%	44,510	31%	50,008	32%	5,497	12%
Component Emissions	7,186	4%	11,695	8%	15,360	10%	3,665	31%
Compressor and Component Leaks	18,153	11%	26,575	18%	25,139	16%	(1,436)	(5%)
Storage Tank Leaks & Emissions	3	0%	10,279	7%	395	0%	(9,885)	(96%)
Total	**162,687**	**100%**	**145,160**	**100%**	**156,561**	**100%**	**11,401**	**8%**

The sub-category Compressor Emissions increased 13,559 Mscf from 52,101 Mscf in 2016 to 65,659 Mscf in 2017. SoCalGas increased operating hours, and PG&E included four compressors at Santa Rosa (2) and Bethany (2) that were previously omitted from the emissions inventory.

The Blowdowns increased 5,497 Mscf from 44,510 Mscf in 2016 to 50,008 Mscf in 2017 due to increases from PG&E and GRGS, while SoCalGas and SDG&E had YOY decreases.

The Component Emissions and Component Leaks increased in the fourth quarter of 2017 due to comprehensive leak surveys required by CARB's new Oil and Gas Rule.

Storage Tank Leaks and Emission increased from 3 Mscf in 2015 to 10,279 Mscf in 2016 and then decreased back to 395 Mscf in 2017. The increase in 2016 was due to 2

LNG storage tank leaks detected by PG&E at one facility in 2016. The leaks were promptly repaired and comprised 10,277 Mscf, virtually all the 10,279 Mscf total.

Distribution Mains and Services (DM&S):

PG&E, SoCalGas, SDG&E, SWG, West Coast Gas Company (WCGC) and ANG reported total DM&S Emissions of 1,420,432 Mscf in 2017, which is a total decrease of 181,595 Mscf or a 11% reduction from 2016's total of 1,602,027 Mscf (see Table 12).

Table 12: Distribution Mains and Services (DM&S) Emissions, 2015-2017

Source	2015 Baseline		2016		2017		2016 - 2017 YOY Change	
	Mscf	%	Mscf	%	Mscf	%	Mscf	%
Pipeline Leaks	1,458,399	86%	1,400,613	87%	1,206,882	85%	(193,731)	(14%)
All Damages	236,145	14%	200,604	13%	210,561	15%	9,957	5%
Blowdowns	5,046	0%	810	0%	2,847	0%	2,037	251%
Component Emissions	3,281	0%	0	0%	0	0%	NA	NA
Component Leaks	0	0%	0	0%	142	0%	142	NA
Total	**1,702,871**	**100%**	**1,602,027**	**100%**	**1,420,432**	**100%**	**(181,595)**	**(11%)**

The emissions from DM&S Pipeline Leaks showed a significant decrease of 193,731 Mscf (14%) from 2016 to 2017. While there was a change in the calculation of the un-surveyed leaks, the primary reason for the decreased emissions is due to Sempra providing new information that it had included O&M leaks with survey leaks in the calculation of the leak rate. The leak rate is used to calculate the leaks in un-surveyed areas. Before excluding the O&M leaks from leak rate calculation the resultant emissions for SoCalGas's graded DM&S Pipeline Leaks totaled 908,257 Mscf, and after excluding the O&M leaks from the calculation the total graded leaks decreased 210,200 Mscf to 698,058 Mscf. All things being equal this change to the inputs used to calculate the un-surveyed leaks is the primary driver to the YOY decrease in the graded DM&S Pipeline Leaks. SDG&E's saw a decrease of 25,842 Mscf for the same reason.

Allocating the leaks to O&M instead of classifying them as detected through survey results in a much lower number of leaks attributed to un-surveyed areas and the corresponding emissions from un-surveyed leaks decreases, because the formula should use only survey leaks as a factor to estimate the un-surveyed leaks, and not O&M leaks.

Though Sempra noted that they have information to change the leak ratio retroactively for both 2015 and 2016, Staff did not change prior year DM&S Pipeline Leaks emissions. Because no change was retroactively applied to 2015 and 2016 the current YOY decrease from 2016 to 2017 is merely an accounting change and not comparable to prior levels.[30]

PG&E's ratio of leaks discovered by survey to leaks discovered by O&M was not affected by the updated definition. Rather, PG&E noted a reduction of 19,000 Mscf from 2016 to 2017, due to moving from a 5-year survey cycle to a 4-year survey cycle that resulted in a decrease in the estimated number of unknown leaks. A noted improvement by PG&E's data collection and reporting systems occurred in 2017, such that PG&E used GIS mapping data to better record the material types of reported leaks. The more granular data and better identification of pipeline material types reduced their reliance on composite EFs for estimating unknown materials making the estimate of emissions from DM&S pipelines more accurate.

The All Damages category showed an increase from 200,604 Mscf in 2016 to 210,561 Mscf in 2017 for a 9,957 Mscf increase (5%).

While the Blowdowns showed a large YOY percentage increase of 251%, overall these represent relatively small emission totals of 810 Mscf in 2016 and 2,847 Mscf in 2017 for a 2,037 Mscf YOY increase. SoCalGas noted that the majority of their 871 Mscf YOY increase was due to two high pressure leak repairs, one of which included repairing a leaking main line valve.

There were 3,281 Mscf of Component Emissions reported in 2015, none in 2016 and 2017. In 2017 only SoCalGas reportedComponent Leaks of 142 Mscf in 2017, the first time these leaks were captured and reported in the templates.

Detailed Discussion of DM&S Leaks and Emissions:

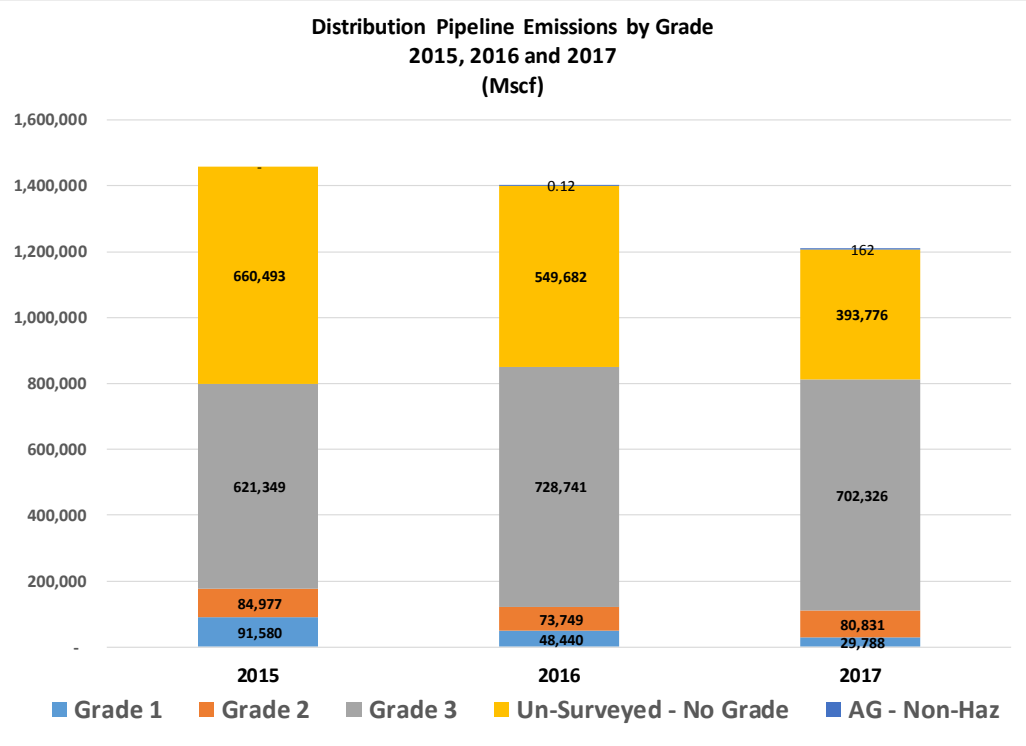
The data provided by respondents include leak discovery date, repair date, leak grade, pipeline classification as either main or service, pipeline material, method of discovery, and emissions calculation. Respondents also provided other parameters for

[30] Staff is accumulating all the current year reporting changes that could have retroactive baseline impacts. These accounting and reporting changes are slated for review within a workshop in order to determine the potential retroactive impact on the 2015 baseline for Commission consideration.

informational purposes that were not used in any calculations, such as zip code location of leak, pipe size, pressure, and scheduled date of repair.

Figure 3 is a graphical representation of the volume of emissions from each of the leak Grades 1 – 3, Un-surveyed Leaks, and Above Ground (AG) Non-Hazardous leaks. Un-surveyed leaks are estimated based on respondent's leak rate, and as such, we do not try to proportionately allocate the un-surveyed leaks by the proportion of Graded leaks found in respondent's service territory. The AG-Non-Hazardous leaks make up a very small portion of DM&S Pipeline Leaks and are barely noticeable at the top of the columns for 2016 and 2017.

Figure 3: Distribution Pipeline Emissions by Grade 2015, 2016 and 2017 (Mscf)



As shown in both Figure 3 and Table 13, Grade 3 leaks make up most of the DM&S leak emissions. A significant amount of the Grade 3 leaks carryover from previous years. The data shows that approximately twice the volume of gas was emitted from carryover Grade 3 leaks compared with new grade 3 leaks discovered in 2017. While the estimated un-surveyed leaks cannot be graded, these leaks make up one third of the inventory by volume. Finally, the above ground pipeline leaks account for only a negligible portion of the total.

Table 13: Calculated Emissions Volume by Leak Grade in 2017

Leak Grade	Natural Gas Volume (Mscf)			Total	
	Carried Over from 2016	Discovered in 2017	Estimated Unsurveyed	Mscf	%
Grade 1	149	29,639	0	29,788	2%
Grade 2	10,310	70,521	0	80,831	7%
Grade 3	442,512	259,814	0	702,326	58%
Unsurveyed - No grade	0	0	393,776	393,776	33%
Above Ground - Hazardous	0	0	0	0	0%
Above Ground - Non-Hazardous	57	105	0	162	0%
Total	**453,027**	**360,079**	**393,776**	**1,206,882**	**100%**

As shown in Table 14, Grade 1 leaks are repaired quickly, taking a weighted average 4-day to fix. There is more variability in the average time to repair Grade 2 and 3 leaks where smaller utilities, such as SDG&E, SWG, WCGC, have shorter average repair times.

Table 14: Average Days to Repair by Entity, 2017[31]

Entity	Average Repair Days		
	Grade 1	Grade 2	Grade 3
PG&E	6	202	1328
SCG	1	166	728
SDG&E	1	50	32
SWG	1	4	21
WCGC	-	84	209
Weighted Average	**4**	**186**	**770**

Distribution M&R Stations:

PG&E, SoCalGas, SDG&E, and SWG reported 2017 total emissions in this category of 1,334,309 Mscf, a 14,973 Mscf (0.2%) increase from the 2016 total of 1,319,336 Mscf (see Table 15). Except for Blowdowns the emissions in this category are based on the number of M&R stations multiplied by a corresponding EF. The negligible YOY

[31] PG&E calculates its Average Repair Days based on the original discovery date, where leaks initial grade may not require immediate repair such as a Grade 3 leak, when it gets subsequently regraded to a higher grade the repair prioritization changes per the requirements for the new grade. However, the average number of days to repair does not account for the leak regrade date. Therefore, it does not take many regraded old Grade 3 leaks to skew the overall average time to repair.

change is largely due to change in station counts and re-categorization of assets (see Transmission M&R Station explanation of re-categorization of assets). The slight increase in Blowdown emissions occurred due to an adjustment to the calculation method, additional inspections due to sulfur buildup in some stations, inclusions of filter change-outs as an emissions category, and improved tracking of relief valve inspections. Overall, Distribution M&R Stations are the third largest contributor with 21% of the total emissions for 2017. When Transmission and Distribution M&R Station emissions are combined, 929,454 Mscf and 1,333,905 Mscf respectively, they total 2,263,359 Mscf, which makes up the single largest share of population-based emissions. The combined M&R station emissions comprise 35.4% of total system wide emissions.

Table 15: Distribution M&R Stations Emissions, 2015-2017

Source	2015 Baseline		2016		2017		2016 - 2017 YOY Change	
	Mscf	%	Mscf	%	Mscf	%	Mscf	%
Station Leaks & Emissions	1,347,773	100%	1,319,005	100%	1,333,905	100%	14,900	1%
Blowdowns	295	0%	331	0%	382	0%	50	15%
All Damages	-	0%	-	0%	23	0%	23	NA
Total	**1,348,067**	**100%**	**1,319,336**	**100%**	**1,334,309**	**100%**	**14,973**	**1%**

Customer Meters:

PG&E, SoCalGas, SDG&E, SWG, WCGC, and ANG reported emissions from meter leaks totaling 1,656,486 Mscf. Table 16 shows that in 2017 emissions increased by 11,488 Mscf, an increase of 1% from the previous year. The increase is due to additional customer meters.

Table 16: Customer Meter Emissions, 2015-2017

Source	2015 Baseline		2016		2017		2016 - 2017 YOY Change	
	Mscf	%	Mscf	%	Mscf	%	Mscf	%
Meter Leaks	1,635,911	100%	1,643,029	100%	1,654,910	100%	11,881	1%
Vented Emissions	2,363	0%	1,968	0	1,576	0%	(392)	(20%)
Total	**1,638,274**	**100%**	**1,644,997**	**100%**	**1,656,486**	**100%**	**11,488**	**1%**

Overall, the customer meters category has the largest share of the total emissions at 26%, and once again comprises the second largest share of population-based emission

estimates for the 2017 reporting year. MSA emissions are not expected to fluctuate widely YOY because they are based on an EF applied to the number of meter sets.[32] The overall number of meter sets do not change significantly from year-to-year (though at this time the trend is upward, that may not always be the case as services could evolve away from gas). In 2018, GTI completed a residential MSA study for CARB that is currently under review. The study randomly selected 500 household's meter sets in California. The objectives are to update the existing EF and to identify MSA components that are prone to leaking.

As in 2016, the MSA - All Damages sub-category data provided by respondents in 2017 was added to the DM&S - All Damages because PG&E is not able at this time to separate its MSA Above Ground damages from its DM&S Pipeline Above Ground damages. It is hoped that respondents will continue to evolve their databases and data management systems that will allow for differentiating between the damages on above ground DM&S pipelines and MSA system assets. Until such time that all respondents can separate their DM&S and MSA Above Ground damages they will be combined into the DM&S –All Damages sub-category.

Though Vented Emissions are relative insignificant it decreased by 392 Mscf between 2016 and 2017 primarily due to the implementation of an advanced metering initiative by SoCalGas.

Underground Storage:

PG&E, SoCalGas, CVGS, GRGS, LGS, and Wild Goose Storage (WGS) reported Underground Storage systems emissions for 2017. As seen in Table 17 below, total emissions were 180,144 Mscf in 2015, followed by a decrease of 41,602 (Mscf) in 2016 which reduced the total to 138,542 Mscf. However, in 2017, emissions increased by 90,251 Mscf (65%) resulting in 228,793 Mscf. The primary reasons for the emission increase in this category are due to changes to the reporting guidelines, reclassification of subcategories and additional leak surveys, which resulted in additional leaks and an increase of emissions YOY.

[32] Currently, the gas companies provide their actual MSA leaks found on their systems in their annual filings on an information only basis. In the future, along with the work CARB is doing to update EFs, it may be possible to use actual MSA leak survey data to estimate MSA emissions by extrapolating MSA survey leaks on the same basis as that used for DM&S pipeline leaks. This topic will be included in the workshop for updating annual reporting issues.

Table 17: Underground Storage Emissions, 2015-2017

Source	2015 Baseline		2016		2017		2016 - 2017 YOY Change	
	Mscf	%	Mscf	%	Mscf	%	Mscf	%
Storage Leaks & Emissions	15,016	8%	15,630	11%	7,577	3%	(8,053)	(52%)
Compressor Emissions	96,313	50%	25,163	18%	48,266	21%	23,104	92%
Blowdowns	46,358	24%	28,927	21%	31,405	14%	2,478	9%
Component Emissions	14,947	8%	26,595	19%	95,747	42%	69,152	260%
Compressor and Component Leaks	0	0%	42,217	30%	45,786	20%	3,569	8%
Dehydrator Vent Emissions	20,163	10%	11	0%	12	0%	1	13%
Total	**192,797**	**100%**	**138,542**	**100%**	**228,793**	**100%**	**90,252**	**65%**

Underground Storage emissions have increased dramatically from 2016 primarily due to PG&E's effort to capture and account for all components in the field versus relying on their asset database lists.[33] PG&E's effort accounted for 66,909 Mscf, or 74% of the YOY increase. In addition, virtually all respondents reported increased compressor operating hours, which added 23,104 Mscf or 26% to the 90,251 Mscf YOY increased emissions.

The Storage Leaks and Emissions decreased 8,053 Mscf (52%) from 15,630 Mscf in 2016 to 7,577 Mscf in 2017, largely due to a change in methodology used by PG&E as well as re-categorization of assets to the Component Emissions sub-category. PG&E opted to report wellhead leaks based on its own internally developed EF (108scf/day) for wellhead leaks.[34] They applied this EF across all facilities where the number of wellhead leaks per facility and total number of days leaking was determined using daily wellhead leak surveys. PG&E also removed controlled venting of components from this category and placed the emissions in the blowdown sub-category. SoCalGas revised its leak duration from 7 to 5 days to estimate emissions at Aliso Canyon storage facility, which could reduce associated emissions by 28%.

The Compressor Emissions increased by 23,104 Mscf (92%), commensurate with increased compressor operating hours for LGS, SoCalGas, PG&E and WGS. Their pressurized operating hours increased 67%, 43%, 35% and 45% respectively. SoCalGas's

[33] "In 2017 PG&E collected data on all venting components from individual facilities, compared to 2016 when a corporate database was utilized... Additionally, in 2017 PG&E used more accurate data to include all gas measurement devices…" Appendix 8 Year-Over-Year Comparison tab, Line 43.

[34] PG&E wellhead leaks EF is based on their own research into the Los Medanos wellhead leaks using a Hi-Flow sampler. CARB Staff reviewed PG&E's method and accepted the use of their self-developed EF. The next step is to determine whether this EF can be used by other wellhead operators. This topic will be included in the workshop for updating annual reporting issues.

compressors remained in pressurized idle mode 28% longer, though PG&E's compressors had 76% fewer pressurized idle time. Emissions are based on the emissions in these different modes of operation. The additional operational hours increased emissions by 11,808 Mscf. Also, in 2017, PG&E included vented emissions from compressors at Los Medanos and Pleasant Creek locations that were not included in 2015 and 2016 that contributed 1,210 Mscf to emissions.

The Blowdown emissions increased by 2,478 Mscf from 28,927 Mscf to 31,405 Mscf between 2016 and 2017, for a 9% increase, whereas the 2017 blowdowns decreased 14,953 Mscf or 32% from 2015. During 2017, SoCalGas increased compressor cycling to meet system operational demands and to support work under their Storage Integrity Management Program. In order to comply with the new DOGGR and CARB regulations, which require inspection of downhole casing and tubing in underground storage wells within active storage fields, storage operators should see increased blowdowns and associated emissions. Lastly, CVGS had one emergency shut down in 2017 due to a flame detector malfunction that resulted in evacuating 125 Mscf of gas from its system.

As noted above, Component Emissions increased by 69,152 Mscf (260%) to 95,747 Mscf from the 26,595 Mscf reported in 2016. PG&E accounted for 66,909 Mscf or 74% of this increase. Both Sempra utilities and PG&E reported operational changes focused on improving field verification and identification of components, and reliance on EFs and fewer engineering estimates also affected the overall emissions estimate compared to 2016. Since 2015 the reporting processes and definitions of individual emission categories have evolved which accounts for some of the increase. The emissions in this sub-category have increased by 48,649 Mscf between 2015 and 2017.

Specifically, in 2017, PG&E performed direct measurement of emissions for all venting components within individual facilities, whereas in 2016, a corporate database was used to provide an engineering estimate for this sub-category. Furthermore, the 2017 data includes additional emissions occurred during venting from all gas measurement devices such as moisture analyzers, sulfur analyzers, chromatographs and speed loops whereas this data was not developed nor included in the 2016 emissions information.

In 2016, SoCalGas reported their pneumatic device count based on previous GHG reports for their storage facilities. However, for 2017, SoCalGas conducted field verification at its Underground Storage facilities which discovered 68 additional low-

bleed pneumatic devices. The increase in emissions for 2017 is directly proportional to the increased component count as the emissions are calculated using the appropriate EF and total number of components.

Component Leaks also experienced an increase of 3,569 Mscf (8.5%) to 45,786 Mscf. Both PG&E and SoCalGas stated that they proactively conducted a comprehensive leak surveys pursuant to the requirements of the CARB Oil and Gas Regulation, which became effective January 1, 2018. The new leak surveys utilized more sensitive equipment than in prior years and thus discovered additional leaks compared to 2016. Conversely, the number of PG&E's leaks increased from 68 to 648 (853%) and the associated emissions increased by 13,307 Mscf (139%). Whereas, the number of SoCalGas's leaks increased from 295 to 682 (131%), and the associated emissions decreased 8,636 Mscf (29%). SoCalGas attributes the decrease to a changed emissions calculation methodology.

Staff found that in prior year's respondents had difficulty differentiating compressor leaks from component leaks, so starting in 2017 Compressor Leaks have been combined with Component Leaks in the Joint Report. All the prior year emissions shown in Compressor Leaks have been added to the Component Leaks sub-category. For example, in 2016 the reported emissions for the Compressor Leaks sub-category was 2,083 Mscf, which has been added to the 2016 Component Leaks originally reported as 40,133 Mscf (2,086 + 40,133 = 42,217 Mscf). There was no change to the 2016 total emissions as a result of this adjustment.

All six of these storage entities reported glycol dehydrator facilities that resulted in about 12 Mscf, a 1 Mscf increase from 2016. The increase occurred due to the inclusion by PG&E of an additional dehydrator for 2017.

Unusual Large Leaks:

Lastly, in 2017 there were three relatively large gas releases that did not fit any of the existing sub-categories; therefore, Staff grouped them into the Unusual Large Leaks category for transparency. SoCalGas experienced a transmission pipeline rupture resulting in a fugitive release of 29,500 Mscf.[35] PG&E experienced two releases on its

[35] Transmission Pipeline Leaks are based on the number of miles of transmission pipeline times an EF, therefore including actual leaks would violate the definition for this type of emission estimate. However, the emission is significant and though infrequent it should be considered in the overall emissions inventory.

transmission system due to operators incorrectly opening valves that released a total of 53,500 Mscf.

Lessons Learned

In 2017 the data collection and review process did not change significantly from 2016 and due to CPUC and CARB Staff and respondent's familiarity with the reporting templates and data management practices the reporting compilation process flowed smoothly. Staff had fewer follow-up questions and fewer revisions to the data, which in the past required additional time to analyze the report submittals. As a result, there are fewer lessons learned from this year's submittals, as follows:

- There has been considerable discussion regarding modifying the un-surveyed leak formula in Appendix 4. Staff made one adjustment to the formula for the 2017 data report; and will consider further modifications to the un-surveyed leak formula for the upcoming January 2019 workshop on template changes.
- Significant changes in DM&S pipeline emissions occurred due to correcting the calculation inputs for un-surveyed leaks, and an analysis on the impact to prior year reported emissions needs to be examined.
- Even though implementing maintenance BPs reduces blowdown emissions, because the annual maintenance activity levels fluctuate the corresponding fluctuation in Blowdown emissions could obscure the impact of the BPs. Therefore, emphasis should be made on differentiating the causes of the YOY emission changes, such quantifying emission reductions from BPs and changes in activity levels.
- Staff identified valuable data/information in the PHMSA Form 7100 filings, which was cross referenced to respondent filings. This increased Staff confidence that respondents are including emissions evidenced by the PHMSA filings.
- Currently, the gas companies provide their actual MSA leaks found on their systems in their annual filings. In the future, along with the work CARB is doing to update EFs, it may be possible to use actual MSA leak survey data to estimate MSA emissions by extrapolating MSA survey leaks on the same basis as that used for DM&S pipeline leaks. This topic will be included in the workshop for updating annual reporting issues.

- PG&E developed a wellhead leak EF based on their own research into the Los Medanos wellhead leaks using a Hi-Flow sampler. They did this to establish wellhead emissions on actual site data, and "…in order to show progress in emission reductions and leak management over time." The next step is to determine whether their methods and/or this EF can be used by other wellhead operators for the same purpose. This topic will be included in the workshop for updating annual reporting issues.
- The definition for what constitutes Unusual Large Leaks needs to be refined at the upcoming Templates workshop to ensure that appropriate transparency and reasonable disclosure of large leaks going forward.

Conclusion:

The major findings from the 2017 data are:

- Blowdown emissions increased significantly YOY from 2016 by 262 MMscf or 70% but they were only 32 MMscf or 5% greater than 2015 Baseline Blowdowns. In 2016 utilities did not experience a significant change in maintenance activity from 2015 while at the same time they implemented work bundling and pressure reduction BPs that reduced Blowdown emissions. In 2017 work bundling and cross pressurization to reduce line pressures prior to performing work were still in use, but a significant increase in transmission system maintenance activity resulted in an increase of 218 MMscf. Transmission Blowdowns were the largest contributor to the aggregated Blowdowns source of emissions. These types of YOY fluctuations need to be expected and factored into any expected emissions reductions planning. (See Table 8: Blowdown and Vented Emissions by System Category, 2015-2017.)
- The method used to calculate un-surveyed DM&S - Pipeline Leaks was changed to exclude O&M discovered leaks, which overstated the amount of un-surveyed leaks and associated emissions. The change resulted in a decrease in un-surveyed leaks for most distribution companies, however, Sempra utilities realized the greatest impact. The change in method was due to new information from Sempra (SoCalGas and SDG&E) that a considerable portion of the leaks that had been previously classified as survey were O&M source leaks. While the sum of leaks did not change, there was a considerable change in the count of un-surveyed leaks due to the proportional allocation of Survey leaks factored in the

calculation of un-surveyed leaks. In addition, the total sub-category of DM&S – Pipeline Leaks is not comparable to prior years, since virtually all the decrease in 2017 emissions is based on this change and not due to any other factor.

- The 2017 total increase of 2% from 2016 emissions was primarily a result of increases in Blowdowns of 262 MMscf, Vented Emissions of 108 MMscf (largely driven by the increase in the combined Underground Storage's Compressor Emissions of 23 MMscf and Component Emissions of 69 MMscf), where these were partially offset by decreases in Graded Pipeline Leaks of 194 MMscf, and All Damages 138 MMscf. (See Table 3: Total Emissions Grouped by Source Classification, 2015 – 2017)
- CARBs new survey regulations for Underground Storage and Compressor facilities, which went into effect January 1, 2018 increased reported items leaking and associated emissions in 2017 as entities proactively initiated survey protocols in advance of the January 1, 2018 implementation date. However, we believe the quarterly surveys will identify leaks that in the past may not have been identified because of the new reporting requirements. In addition, the long-term impact will be the early detection and abatement of leaks and unnecessary vented emissions at these facilities.
- PG&E described efforts aimed at verifying component assets at its facilities to update and the implementation of a new asset accounting system. These efforts better identified components within their compressor and storage facilities, which directly affect emissions based on the count of different types of components, thus resulted in additional emissions in Compressor Stations and Underground Storage.
- In 2017 PG&E was able to identify the pipe material of DM&S - Pipeline Leaks, which improved its estimates of un-surveyed leaks by material type. Staff has not evaluated whether the method for obtaining the pipe material can be obtained for their prior year filings, and if so, what impact that may have on previously reported emissions.

Appendix A: Methods for Estimating Emissions

Explanation of methods used for reporting and estimating leaks and emissions in the Joint Report.		
System Categories	**Emission Source Categories**	**Description**
Transmission Pipeline	Pipeline Leaks	Pipeline operators were instructed to provide emissions using the approved EF by number of miles of pipeline. It was determined that use of the EF from INGAA Greenhouse Gas Emission Estimation Guidelines for Natural Gas Transmission and Storage - Volume 1 GHG Emission Estimation Methodologies and Procedures (September 28, 2005 - Revision 2) - Table 4-4 study would be the best available for Transmission Pipeline emissions at this time.
	All damages (as defined by PHMSA)	Event specific emissions data reported where emissions were estimated either from modelling or size of breach using pressure and duration to calculate the emissions.
	Pipeline Blowdowns	The blowdown emissions are calculated based on unique equipment attributes and measured with engineering calculations on an individual basis.
	Component Emissions:	The emissions from components associated with transmission pipeline operations are based on the recommended EFs outlined in Appendix 9 of the Data Request. In some cases, the components did not meet the definition for the EFs and discrete approximations based on manufacturer provided leak rates, direct measurement of the different operating states as well as the for specific values recommended for use in calculating component specific leaks times number of units of equipment.
	Pneumatic Devices	
	Pressure Relief Valves	
	Component Leaks:	This new category was added to the reporting templates for RY 2016. The purpose is to capture fugitive component leaks in this category. This differentiates them from emissions from components that result from normal operations or by design. No emissions were reported in this category for RY 2016.
	Odorizer (Odorizer and Gas Sampling Vents)	The EFs recommended in Appendix 9 were used where directly applicable, however where transmission pipeline dehydrator equipment did not match the pipeline operators used the discrete equipment attributes and operations profile to estimate emissions. The methods used appeared to provide the best estimate of emissions given the variety and operating context of these facilities.
Transmission M&R	M&R Stations	The emission estimate for M&R stations are based on the EFs recommended in Appendix 9 multiplied by the population of each type of M&R station.

	M&R Components Emissions.	The purpose of this category is to capture emissions that occur in M&R station components that result from normal operations or by design of the component. The emissions from components are captured in the EF used on a station by station basis and the discrete information on a subset of components in the facility would duplicate emissions and present misleading count information. Until further work can be done with more comprehensive survey techniques relying on the recommended EFs on a station by station basis is considered the best estimate of emissions at this time.
	M&R Leaks	This new category was added to the reporting templates for RY 2016. The purpose of this category is to capture fugitive leaks on components within the M&R station, and create a record as a basis for evaluating using actual measured leaks rather than an M&R station EF for estimating emissions. Currently the discrete leaks for M&R stations would be captured in the recommended EFs used to estimate the M&R station emissions and only where it could be determined that inclusion of discrete M&R leaks were not duplicated would they be included in the count of emissions for this category.
	M&R blowdown	Blowdown emissions were estimated based on the calculation of the unique equipment volume being vented corrected for pressure and temperature at the time of the release. The estimates for blowdown events in general provide a reliable emission estimate.
Transmission Compressor Stations	Compressor Equipment - Centrifugal and Reciprocating.	The emissions calculated based on the direct measurement of each compressor unit given its operating state and pressure, and then the emissions are based on number of operating hours in each operating state.
	Compressor Leaks:	This new category was added to the reporting templates for RY 2016. The purpose is to capture fugitive leaks in this category, and differentiate them from emissions from compressors that result from normal operations or by design. There were no discrete compressor leaks in RY 2016.
	Equipment and pipeline blowdowns	Blowdown emissions were estimated based on the calculation of the unique equipment volume being vented corrected for pressure and temperature at the time of the release. The estimates for blowdown events in general provide a reliable emission estimate.
	Components Emissions.	The equipment and component emissions are based on the leaks detected at the compressor stations times the recommended EF for that type of equipment per Appendix 9. The purpose of this tab is to capture emissions that result from normal operations or by design.
	Component Leaks:	This new category was added to the reporting templates for RY 2016. The purpose is to capture fugitive component leaks in this category. This differentiates them from emissions from components that result from normal operations or by design. No emissions were reported in this category for RY 2016.

	Compressor Station Storage Tanks	These emissions are based on discrete tank pressure fluctuations due to exterior temperature fluctuations. The initial volume of gas release calculation is based on the starting and ending pressures assuming a constant temperature.
Distribution Mains and Services Pipelines	Pipeline Leaks - Below Ground	The emissions from leaks detected in 2016 in Distribution Mains and Service pipelines are calculated assuming that the leak was emitting from the first day of the calendar year through date of repair, or the entire year if not repaired in 2016, times the recommended EF. For identified leaks carried over from prior years the emissions are calculated from the beginning of the year through repair date (if repaired in 2016) or end of year times the recommended EF. In addition, leaks occurring in un-surveyed parts of operator's service territory were estimated based on the leak occurrence rate in the surveyed portion of the territory extrapolated based on number of years in the survey cycle to come up with the number of expected leaks in the un-surveyed territory times the recommended EF. This method of estimating the emissions from leaks occurring in un-surveyed portions of the service territory is considered a reasonable way of approximating the emissions and takes into account the frequency of leak detection surveys.
	Pipeline Leaks - Above Ground	See above for below ground leaks. Above ground leaks associated with MSAs are not counted in the volume or the numbers of leaks in order to prevent misleading representation of emissions as well as potential for duplication of emissions volumes.
	Blowdowns and Venting	Blowdown emissions were estimated based on the calculation of the unique equipment volume corrected for pressure and temperature at the time of the release. The estimates for blowdown events in general provide a reliable emission estimate.
	All damages (as defined by PHMSA)	Emissions from damages for Above Ground (AG) Non-hazardous and MSA damages are calculated based on company EF for above ground facilities times the number of days leaking unless an engineering estimate could be performed to measure the emissions. For AG Hazardous and Below Ground Code 1 damages, emission was estimated based on engineering calculation using pipe size, damage opening size, and duration. For Code 2 and Code 3 damages, the EF for Distribution pipeline leaks was used. In 2015 and 2016 all damages for DM&S above and below ground as well as MSA above ground damages are aggregated in this category.
		Where an estimate was not made at the time of the event, the emission was estimated from population of similar events with respective pipe material and pipe size.

	Components - Pneumatic Devices	Emissions from components such as pneumatic devices are based on manufacturer specifications for bleed rate given the pressure.
	Component Leaks:	This new category was added to the reporting templates for RY 2016. The purpose is to capture fugitive component leaks in this category. This differentiates them from emissions from components that result from normal operations or by design. No emissions were reported in this category for RY 2016.
	Odorizer (Odorizer and Gas Sampling Vents)	Not applicable for this category.
Distribution M&R Stations	M&R Stations	The emission estimate for M&R stations are based on the EFs recommended in Appendix 9 multiplied by the population of each type of M&R station.
	Blowdowns	Blowdown emissions were estimated based on the calculation of the unique equipment volume corrected for pressure and temperature at the time of the release. The estimates for blowdown events in general provide a reliable emission estimate.
	Component Emissions	The purpose of this category is to capture emissions that occur in M&R station components that result from normal operations or by design of the component. The emissions from components are captured in the EF used on a station by station basis, and any discrete leak information from components in the facility would duplicate emissions and present misleading count information. Until further work can be done with more comprehensive survey techniques, continued reliance on the recommended EFs on a station by station basis is considered the best estimate of emissions at this time.
	Component Leaks:	This new category was added to the reporting templates for RY 2016. The purpose of this category is to capture fugitive leaks on components within the M&R station, and create a record as a basis for evaluating using actual measured leaks rather than an M&R station EF for estimating emissions. Currently the discrete leaks for M&R stations would be captured in the recommended EFs used to estimate the M&R station emissions and only where it could be determined that inclusion of discrete M&R leaks were not duplicated would they be included in the count of emissions for this category.
Commercial, Industrial and Residential Meters	Residential and Commercial Meters	The emissions for this category are based on the MSA population count times the recommended EF per Appendix 9. There is substantial work currently being done to update EFs for MSAs and in future any updated EFs could be backward applied to 2015.

	Actual MSA Leaks	This new category was added to the reporting templates for RY 2016. The purpose of this category is to capture fugitive leaks on MSAs, and create a record in order to form a basis for evaluating using actual measured leaks rather the number of meters in the population times an EF to estimate emissions. Currently the discrete MSA leaks would be captured in the current method using EFs time the population of meters.
	All damages (as defined by PHMSA)	Emissions from damages for Above Ground (AG) Non-hazardous MSA damages should be calculated based on company EF for above ground facilities times the number of days leaking. For AG Hazardous damages, emission should be estimated based on based on engineering calculation using pipe size, damage opening size, and duration. The reported damages in this category were re-categorized and included with DM&S pipeline damages because not all respondents were capable of separating out their AG - MSA related damages with their AG - DM&S damages. Grouping them all together in this year's report is consistent with the grouping used in 2015. However, in the future separating the respective AG damages will help differentiate the source of damages and emissions.
	Component Emissions:	This new category was added to the reporting templates for RY 2016. The purpose of this category is to capture fugitive leaks on components other than MSAs in the MSA systems to determine whether such leaks existed. In addition, if such leaks existed this could form a basis for evaluating using actual measured leaks rather than an EF for estimating emissions. No component leaks were identified or reported in 2016.
	Vented Emission from MSA	Emissions from venting MSAs are based on the number of events times the estimated volume release by MSA and/or the type of activity.
Underground Storage	Facility Leaks	Emissions in this category are based on EPA GHG Subpart W data EFs multiplied by the number of units of each equipment type. Or respondents may use EFs from MRR Leaker Emission Factor Table W-4, or they may choose to use Leaker based EFs, which means that if a survey is conducted, those components found not to be leaking would be recorded with zero emissions as opposed to applying a population-based EF. Just as those components found to be leaking would use a "Leaker EF" with a proscribed value.
	Compressor Emissions	Emissions from storage facility compressors are calculated in the same manner as for compressors in other categories. See the description in the Compressor Station category.
	Compressor Leaks:	This new category was added to the reporting templates for RY 2016. The purpose is to capture fugitive leaks in this category, and differentiate them from emissions from compressors that result from normal operations or by design. The emissions from components associated with compressor operations are based on the recommended EFs outlined in Appendix 9 of the Data Request.

	Blowdown and Venting	Blowdown emissions were estimated based on the calculation of the unique equipment volume corrected for pressure and temperature at the time of the release. The estimates for blowdown events in general provide a reliable emission estimate.
	Components Emissions:	Component emissions are based on the emissions that occur as a result of normal operation of the component or its design. The emissions detected during GHG leak survey pursuant to the GHG Mandatory Reporting Regulation and each component's EF times the population count. All leak and component emission estimates are based on the assumption that the leak is leaking the entire year or during its identified hours of operation.
	Component Leaks:	This new category was added to the reporting templates for RY 2016. The purpose is to capture fugitive leaks in this category, and differentiate them from emissions from components that result from normal operations or by design. The emissions from components associated with transmission pipeline operations are based on the recommended EFs outlined in Appendix 9 of the Data Request.
	Dehydrator Emissions	Because there are several different types and configurations of dehydrators and it was determined that the majority of respondent's dehydrators use a control device to eliminate natural gas emissions. Therefore, only those dehydrators which vent natural gas are included in this category. The dehydrator emission estimate is based on the engineering estimate, manufacturer's data, or MRR prescribed method of calculating natural gas emissions.

Appendix B: Definitions

For the purposes of SB 1371, the definitions of "leak" and "gas -loss" and the formula for calculating a "system-wide gas leak rate" were defined in a different manner than elsewhere. A "leak" was defined as any breach, whether intentional or unintentional, whether hazardous or non-hazardous, of the pressure boundary of the gas system that allows natural gas to leak into the atmosphere. Any vented or fugitive emission to the atmosphere is considered a "leak". Examples of leaking components include defective gaskets, seals, valve packing, relief valves, pumps, compressors, etc. Gas blowdowns during operations, maintenance and testing (including hydro-testing) were also included as leaks. Consequently, this leak definition is broader than the Pipeline Hazardous Material and Safety Administration's (PHMSA) definition.

The gas respondents are required by Federal Law, 49 CFR 192, to survey their systems for leaks, which could be hazardous to public safety or property. To accomplish this, the gas utility companies developed graded leak programs to detect, prioritize and repair the safety related types of leaks. The same definitions are used within this report and are as follows:

- Graded Leaks – hazardous leaks or, which could potentially become hazardous as described below:
  - A "grade 1 leak" is a leak that represents an existing or probable hazard to persons or property and requiring prompt action, immediate repair, or continuous action until the conditions are no longer hazardous.[36]
  - A "grade 2 leak" is recognized as being non-hazardous at the time of detection but justifies scheduled repair based on the potential for creating a future hazard.[37]
  - A "grade 3 leak" is a leak that is not hazardous at the time of detection and can reasonably be expected to remain not hazardous.[38]
- Vented Emissions are releases of gas to the atmosphere, which occur during operations or maintenance, for a safety reason. Some examples are:
  - Purging (a.k.a. "blowdown") gas prior to hydro-testing a line.
  - Gas releases designed into the equipment function, such as gas emitting from relief valve vents or pneumatic equipment.
  - Gas releases caused by operations, maintenance, testing, training, etc.
  - Ungraded Leaks are the remaining leaks, which are not hazardous to persons and/or property.

36 Refer to GO 112-F for more information.

42 Ibid.

38 Ibid.

For further information please see CPUC GO 112-F.

Lastly, in 2014 the system-wide gas leak rate was calculated as a percent of total input for the 12 months ending June 30 of the reporting year. However, Staff determined that there were problems with this calculation and opted not to report a leak rate using this formula. The formula for calculating a system-wide gas leak was written as follows:

Pipeline Hazardous Material and Safety Administration (PHMSA) Modified Equation for Lost and Unaccounted for (LAUF) Gas:

[(Purchased gas + produced gas + transported gas entering the gas system) minus (customer use +company use + appropriate adjustments + gas injected into storage + transported gas leaving the gas system)] divided by (Purchased gas + produced gas + transported gas entering the gas system) = System Wide Gas Leak Rate.

Note: transported gas includes gas purchased by customers and transported in common carrier pipelines.

In section 5 of the 2015 Joint Report, "Baseline System-Wide Emissions Rate," Staff determined the value for 2015 to be 0.32% by using the total emissions from all source categories (6,601.2 MMscf) divided by the Total Annual Volume of Gas Transported (2,056,950 MMscf). The five sources for Total Annual Volume of Gas Transported include:

- Gas Injected into Storage
- Storage – Gas Used by the Gas Department
- Gas Transported to Customers in the State
- Gas Transported to Customers out of State
- Distribution – Gas Used by the Gas Department

Appendix C: Article 3, Section 975 (c) and (e)(6)

Article 3. Section 975

(c) As soon as practicable, the commission shall require gas corporations to file a report that includes, but is not limited to, all of the following:

(1) A summary of utility leak management practices.

(2) A list of new natural gas leaks in 2013 by grade.

(3) A list of open leaks that are being monitored or are scheduled to be repaired.

(4) A best estimate of gas loss due to leaks.

(e) The rules and procedures adopted pursuant to subdivision (d) shall accomplish all the following:

(6) to the extent feasible, require the owner of each commission-regulated gas pipeline facility that is an intrastate transmission or distribution line to calculate and report to the commission and the State Air Resources Board a baseline system-wide leak rate, to periodically update that system-wide leak rate calculation, and to annually report measures that will be taken in the following year to reduce the system-wide leak rate to achieve the goals of the bill.

Appendix D: Conversion of Natural Gas to Carbon Dioxide Equivalents

The conversion of natural gas volume to carbon dioxide equivalent mass requires the use of a GWP value. CARB used the GWP value of 25 (100-year value) from the IPCC, AR4, for previous GHG emissions inventory. The following calculations show the conversion of the total emissions from this report. The conversion was done in two steps. In the first step, the calculation shows the volumetric natural gas that contains exactly one metric ton of methane.

$$1\ MT\ CH4 * \frac{2{,}204.62\ lbs\ CH4}{1\ MT\ CH4} * \frac{1\ lb\ mole}{16.04246\ lb\ CH4} * \frac{379.48\ scf\ of\ CH4\ gas}{1\ lb\ mole}$$

$$* \frac{1.0\ scf\ of\ natural\ gas}{0.934\ scf\ of\ CH4\ gas} * \frac{1\ Mscf}{1{,}000\ scf} = 55.835\ Mscf\ of\ natural\ gas$$

Using this volumetric unit, the 2017 total emissions, 6,399 MMscf, is equivalent to about 2.86 MMTCO2e, as shown below:

$$6{,}398{,}549\ Mscf\ natural\ gas * \frac{1\ MT\ CH4}{55.835\ Mscf\ of\ natural\ gas} * \frac{25\ CO2e}{1\ CH4} = 2{,}864{,}936\ MT\ CO2e$$

CARB has also used the GWP value of 72 (AR4, 20-year) in the Short-Lived Climate Pollutant Plan and Oil and Gas Regulation. Based on the higher GWP, the 2017 total emissions, 6,399 MMscf is about 8.25 MMTCO2e, as follows:

$$6{,}398{,}549\ Mscf\ natural\ gas * \frac{1\ MT\ CH4}{55.835\ Mscf\ of\ natural\ gas} * \frac{72\ CO2e}{1\ CH4} = 8{,}251{,}016\ MT\ CO2e$$

The use of 1.0 scf of natural gas per 0.934 scf of CH4 gas accounts for composition of natural gas being not 100% methane. The American Gas Association published a value of 93.4% to be used as a default methane concentration that is comparable to what respondents reported.[39] The standard cubic foot "scf" for measuring gas is based on 60 degrees Fahrenheit at atmosphere pressure.

In addition, respondents reported trace amounts of concentration for ethane, inert gases, and other elements and compounds. There was not an entry for carbon dioxide explicitly, and so it cannot be assumed that all the inert gas was carbon dioxide. A calculation was performed that showed CO2 emissions from the inert gases would be less than 0.1% of the total and is excluded in this report.

[39] AGA, GHG Guidelines, page 39, April 18, 2008, http://s3.amazonaws.com/zanran_storage/www.aga.org/ContentPages/18068841.pdf

Appendix E: Proposed Changes to Data Request Template

The following proposed template changes will be discussed in the workshop planned for the winter 2018. See Lessons Learned section of the report where the discussion of issues may lead to changes to the reporting templates. The following template changes are planned for the workshop:

Appendix 2:

- Add "O = Other" as category label for device type.

Appendix 4:

- Reinforce practices that ensure Template Values are properly transferred and included in the Appendix 8 Summary workbook.
- Evaluate if a running three-year average should be used in the formula for un-surveyed leaks.
- Discuss if there is an official revision to prior data, should previous reports use the latest un-surveyed leaks formula.
- Correct "Origianl Grade" to "original Grade."

Appendix 6

- Correct "Number of Days Leaking", which was included twice, to only one instance.

Appendix 7:

- Modify the EF for emissions to be on a per day basis rather than a per year basis. For example, "Valve" has an EF of 129.998 Mscf/year/dev", which could be updated in Appendix 9 with an EF of 0.3562 Mscf/day/dev.
- Consider correcting the header of the Column "Vapor Recovery Unit AND/OR thermal oxidizer" by deleting "AND."

Appendix 8:

- Discuss how to define and categorize Unusual Large Leaks for differentiation from normal activity and ensure adequate transparency of system events.
- Discuss if the system-wide leak formula should use "withdrawals from storage" instead of "injections into storage" as it currently uses the latter.
- Add a note that the gray shading to the column on 2015 emissions does not denote that no emissions should be entered. Rather the note on the column can specify that 2015 data should be entered with the gray shading denoting that the data is unique in being the baseline.
- Appendix 8 will be modified to include an additional column for the subsequent 2018 analysis. Each additional year will involve adding another column.