Pneumatic Controller Emissions from a Sample of 172 Production Facilities

Prepared by Oklahoma Independent Petroleum Association

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Contents

Executive Summary

A study conducted by the Oklahoma Independent Petroleum Association (OIPA) provided examples of natural gas pneumatic controller emissions at production facilities across Oklahoma. The results addressed recognized knowledge gaps and were useful to assess the representativeness of previous reports. Improved quantification methods were applied to a new, up-to-date controller sample. The study examined controller emissions for a variety of facility characteristics such as age, production type (oil or natural gas), and state air permit applicability. By collecting data types not typically recorded, this study helped identify inconsistencies in pneumatic controller terminologies in past research.

Data Collection

The study included 172 oil and gas production sites selected from the Oklahoma assets of eight OIPA companies. A random selection of sites was used that had approximately equal numbers of newer sites versus older sites and oil sites versus gas sites. The sites contained 205 producing wells and 680 pneumatic controllers. With engineering calculations in mind to quantify emissions, data collected for each controller included:

- Controller make and model
- Controller supply pressure
- Volume contained within tubing between controller and actuator
- Actuator make and model
- Actuator physical dimensions
- Actuation count over a 15-minute observation period
- Located at oil site or gas site, based on Oklahoma Corporation Commission (OCC) filings
- Located at new site (first production in 2000 or later) or old site (1999 or earlier)
- Located at permitted site or permit-exempt site
- Supply gas composition

The data collected in the field was augmented with manufacturer specifications such as continuous bleed rates and gas volumes contained within the actuator.

Assumptions and Calculations

This study used assumptions for missing data and complex emissions scenarios, which resulted in conservatively high emissions. The assumption most influential on calculated emissions was default actuation frequency. It was impractical for the study team to monitor actuations for intervals exceeding 15 minutes, considering the time requirement for travel and observation. As a result, this study assumed that a controller with zero observed actuations over a 15-minute interval undergoes actuation once every 15-minutes. The data and assumptions were combined using the equation in Exhibit 1.

Exhibit 1: Pneumatic Controller Emissions Engineering Calculation

$$r_{tot} = \sum_{controllers} \frac{c}{z}\left[r_{bleed} + r_{seep} + lft\left(V_{controller} + V_{tubing} + V_{actuator}\right)\right]$$

Where:

r_{tot}	is the total emissions rate in standard cubic feet per hour (scfh) of natural gas, volatile organic compounds (VOC), or methane.
$\Sigma_{controllers}$	represents a sum over controllers in the sample with a desired trait, such as all controllers at oil sites.
c	is the site-specific volume fraction of natural gas, VOC, or methane. For natural gas, c is equal to 1.
z	is the site-specific gas compressibility.
r_{bleed}	is the manufacturer's specified bleed rate for a continuous bleed controller in scfh natural gas. This is 0 for intermittent vent controllers.
r_{seep}	is the seepage rate to reduce hysteresis in scfh natural gas. This is 0 for continuous bleed controllers.
l	is the relay multiplier which is 1 for controllers with no relay and 3 for controllers with a relay.
f	is the observed actuation frequency during data collection in actuations per hour. f is equal to 4 if no actuations were observed during data collection.
t	is the unitless actuator stem travel fraction for throttling controllers which is equal to 1 for a complete opening of the valve during actuation. This is always equal to 1 for on/off controllers.
$V_{controller}$	is the volume in the controller at supply pressure, in scf natural gas. This is not readily available, so a conservative allotment of 2 inches of tubing length is used to acknowledge this parameter.
V_{tubing}	is the volume in the tubing between the controller and actuator at supply pressure, in scf natural gas. This is determined from tubing length and diameter measurements for each controller.
$V_{actuator}$	is the volume in the actuator at supply pressure, in scf natural gas. This value is equal to manufacturer specifications of the gas space under the actuator diaphragm. Actuators with no available manufacturer specification conservatively defaulted to the dimensions of the entire actuator body.

Controller emissions were determined as the sum of the controller, tubing, and actuator emissions as a result of actuation plus any continuous bleed and seepage emissions. Any unintended leaks from the tubing, controller, and actuator were not included, as they are leak repair issues rather than pneumatic controller vent or bleed characteristics. Combining leaks and pneumatic controller emissions into a single value would introduce ambiguity since leaks would represent an unknown value of total controller emissions anywhere between 0 to 100% of the result. Combined leak and controller emissions data increases the difficulty of emissions mitigation since reduction options for leaks are different from pneumatic controllers. Replacement, refurbishment, or retrofit of a pneumatic controller does not address the root cause of equipment leaks in the same manner as leak detection and repair. Because of the difficulty in distinguishing metered gas as a leak or as a continuous bleed, future research to explore leaks specific to pneumatic controllers would be to record one set of measurements to represent a controller's base case emissions and then measure again as a case after leak detection and repair.

Results

The OIPA sample contained on average 3.83 intermittent vent controllers per site and 0.12 continuous bleed controllers per site. On average, intermittent vent controllers emitted 0.40 scfh gas and continuous bleed controllers emitted 21.54 scfh gas. Results are presented in two sections, summary of observations and summary of emissions calculations.

Summary of Observations

Exhibit 2 is a summary of the collected data.

Exhibit 2: Key Observational Results

Sites

172 sites (205 wells) visited for data collection
162 sites (190 wells) had natural gas pneumatic controllers
10 sites (15 wells) did not have natural gas pneumatic controllers

Controllers

680 natural gas pneumatic controllers
77 controller models
659 intermittent vent controllers
21 continuous bleed controllers

Average Controller Counts

4.0 pneumatic controllers per site
5.0 pneumatic controllers per new gas site
3.1 pneumatic controllers per old gas site
3.6 pneumatic controllers per well
5.3 pneumatic controllers per new oil site
2.7pneumatic controllers per old oil site

Actuation Frequencies

538 controllers (79%) had no actuations detected during the observation period and were assigned the default rate
126 controllers (19%) had actuation rates less frequent than the once per 15 minute default rate
16 controllers (2%) had actuation rates more frequent than or equal to the default rate

Key remarks were that a) the majority of controllers were intermittent vent, b) most intermittent vent controllers emitted infrequently, and c) inconsistent and non-explicit controller definitions in past research introduced significant controller count uncertainty in other work.

a) 97% of controllers were intermittent vent and 3% were continuous bleed which is a significantly different result than representations in past work. All continuous bleed controllers were level controllers and constituted about 12% of the level controllers in the sample.
b) 142 out of 680 controllers, or 21%, had an actuation rate supported by direct observation or other company records such as plunger runs. 538 controllers, or 79%, were observed for 15 minutes, did not actuate, and were assigned the conservatively high actuation rate of once every 15 minutes.
c) Of the 77 controller models identified, 17 models were in the Kimray SGT/FGT series of backpressure controllers. They accounted for 269, or 40%, of observed controllers. These backpressure controllers are often used for overpressure protection, rarely actuated when encountered in the field, and generally used the default assumed actuation rate of four per hour. Controller counts can therefore vary significantly depending on if these controller types are included or excluded. It is unclear if the counts and rates presented by other reports include or exclude these types of backpressure controllers. Some studies did not state explicit definitions, while others had non-explicit definitions that created conflicting interpretations.

Controllers were placed into one of four bins based on age (new or old) and production (oil or gas). A key observation was that the average controller count per site is higher by 2.2 for new sites than for old sites, which was due to the increased number of process units at some newer sites.

Summary of Calculations

Emissions from all controllers were 717 scfh gas before considering annual operating factors. Exhibit 3 displays the calculated emissions results as a histogram. Each bar along the x-axis is a controller whose magnitude is represented by the y-axis. The y-axis was truncated at 6 scfh gas, the maximum rate for a "continuous bleed natural gas-driven pneumatic controller" as defined in 40 CFR 60 subpart OOOO[1]. The y-axis was truncated so that the results can be compared against this regulatory value for new

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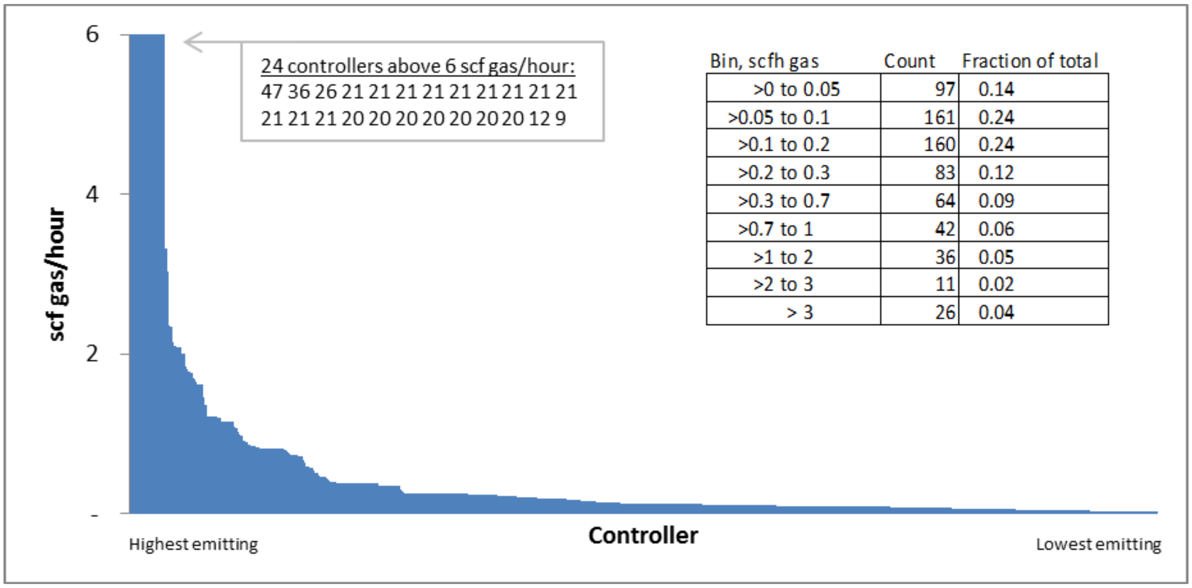
[1] EPA. Subpart OOO-Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution. www.ecfr.gov/cgi-bin/text-idx?SID=7a126adb4fe9f7e9056273a955236a5a&node=40:7.0.1.1.1.103&rgn=div6#se40.7.60_15430

sources and to allow the majority of controllers to be perceivable. The magnitude of each bar that exceeds the scale is shown in the first inset. A numerical histogram of all bars is shown in the second inset.

Exhibit 3: Pneumatic Controller Emissions Histogram, 717 scfh gas in total



24 controllers above 6 scf gas/hour:
47 36 26 21 21 21 21 21 21 21 21 21 21
21 21 21 20 20 20 20 20 20 20 12 9

Bin, scfh gas	Count	Fraction of total
>0 to 0.05	97	0.14
>0.05 to 0.1	161	0.24
>0.1 to 0.2	160	0.24
>0.2 to 0.3	83	0.12
>0.3 to 0.7	64	0.09
>0.7 to 1	42	0.06
>1 to 2	36	0.05
>2 to 3	11	0.02
> 3	26	0.04

The calculated results conformed to a pattern commonly found in oil and natural gas emissions sources: a small number of sources were responsible for the majority of emissions. This occurred because two heterogeneous categories were being combined. One way to describe the heterogeneity in this source category is to note that the largest emitter, 47 scfh gas, was a factor of 1,838 larger than smallest emitter, 0.03 scfh gas. The 24 controllers above the 6 scfh gas emissions rate represented 520 scfh gas or 73% of emissions. The remaining 656 controllers represented 197 scfh gas or 27% of emissions.

Exhibit 4 displays average rates for all controllers in the sample and for the two different controller types, continuous bleed and intermittent vent. The table shows rates for production gas, methane, and VOC. Hourly rates exclude annual operating factors. Annual rates incorporate annual operating factors.

Exhibit 4: Average controller emissions

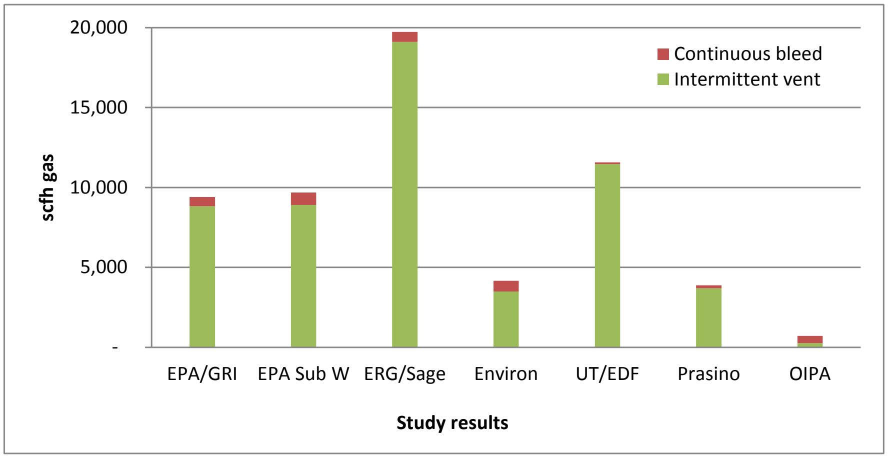
	scf/hour	Mscf/year	lb/hour	ton/year
All controllers				
Gas	1.05	8.78	▨	▨
Methane	0.85	7.08	0.030	0.125
VOC	0.085	0.70	0.012	0.049
Intermittent Vent				
Gas	0.40	3.24	▨	▨
Methane	0.33	2.64	0.012	0.047
VOC	0.031	0.25	0.004	0.018
Continuous Bleed				
Gas	21.54	182.65	▨	▨
Methane	17.23	146.15	0.609	2.585
VOC	1.79	15.05	0.247	1.038

The intermittent vent controllers' average hourly rate was a factor of 54 times lower than that of the continuous bleeds'. The difference was attributable to the continuous bleed stream rather than any features of the actuators or facilities. The average hourly rate results for methane and VOC followed the expected pattern based on gas composition, and VOC emissions were a small fraction of the total rates.

Comparison with Other Studies

Exhibit 5 shows the emissions from all 680 controllers in the OIPA sample when using different quantification methods. For each study, the most applicable emissions factor was chosen to represent the 659 intermittent vent controllers in the OIPA sample, and the most applicable emissions factor was chosen to represent the 21 continuous bleed controllers in the OIPA sample.

Exhibit 5: Emissions from OIPA controllers estimated using different study results



The exhibit illustrates that the existing body of work overestimates emissions from the OIPA controller sample. The degree of overestimation ranged from a factor of 5.4 in the Prasino study to a factor of 27.5 in the ERG/Sage study. The choice of intermittent vent controller quantification method is important since intermittent vent controllers are 97% of the OIPA sample. The OIPA results show that the majority of emissions occur from a small count of continuous vent controllers, but use of methods from other studies would incorrectly indicate that the majority of emissions occur from the large count of intermittent vent controllers. Therefore, the intermittent vent emission factors used in other work were a poor representation of emissions from controllers in the OIPA sample.

Conclusions

This study improved upon the body of work to characterize production site pneumatic controller emissions by:

- Providing an up-to-date pneumatic controller data set.
- Collecting data at a variety of site types.
- Estimating emissions by applying engineering calculations to data types not typically collected, such as actuation frequency and actuator volumes.
- Providing practical examples of emissions quantification challenges, such as the significant effect of controller definition and the assumptions necessary to describe complex operating scenarios.
- Using the average counts per site and emissions per controller to assess the representativeness of inventories and other quantification work.

The controller counts per site and the emissions per controller can be used as points of reference to assess the representativeness of inventories and other work. By using the results as a point of reference, OIPA found that prior work:

- underestimated the intermittent vent controller counts at the visited sites.
- overestimated the intermittent vent controller emissions at the visited sites.
- overestimated the continuous bleed controller counts at the visited sites.
- overestimated the continuous bleed controller emissions at the visited sites, though previous methods give results of the same magnitude.

The largest disagreement between the results and previous work is the characterization of intermittent vent controller emissions. The disagreement stemmed from knowledge gaps, different controller definitions, and use of historical data not representative of the visited sites. This study's up-to-date data, significant sample size, incorporation of a variety of site characteristics, all-encompassing controller definition, and conservatively high quantification assumptions provided evidence that intermittent vent controller emissions were not a significant emissions source compared to other emissions at production sites.

This study reported on controller makes, models, and functions. This information can help identify controller definition inconsistencies, which may have contributed to discrepancies between studies. Without explicit and consistent controller definitions, an emissions estimate receives subjective interpretations of what well pad equipment constitutes a pneumatic controller.

1. Introduction

This report was prepared by OIPA to provide examples of pneumatic controller emissions at production facilities in Oklahoma. The sample size was 172 oil and gas production sites which contained 205 producing wells and 680 pneumatic controllers.

The remainder of this introductory section provides background on the study's purpose and scope. Section 2 details the data collection procedure. Section 3 explains data quality assurance/quality control and calculation methods. Section 4 discusses the results. Section 5 provides conclusions. The appendices in Section 6 include a review of other recent emissions studies, a discussion of different pneumatic controller definitions, a discussion of issues considered in the study design, the data collection sheet, and results tables.

1.1.Goals and Motivation

The goals of this study were to:

- develop pneumatic controller counts per production site by sampling production facilities of all types in major hydrocarbon areas across the state.
- quantify emissions using actuation frequency observations, manufacturer data, and engineering calculations.
- compare controller emissions at different facility types such as age, oil or gas wells, and permit status.
- communicate the complexities of pneumatic controller emissions quantification.

OIPA conducted this study to satisfy two needs, one state-specific and one national. Oklahoma emissions inventories faced the uncertainties inherent in existing quantification methods, such as a recent report[2] relying on emission factors from previous studies, a limited set of state-specific information, and an unknown definition to identify controllers. Production facilities across the state vary significantly in age, location, product composition, design, and operating conditions. The OIPA study therefore collected new data from the state's unique population to addresses knowledge gaps. An extensive sampling of pneumatic controllers as a point of comparison can provide increased confidence in Oklahoma's estimated controller counts and controller emissions.

Nationally, several oil and gas emissions estimation efforts have taken place for reasons ranging from air quality regulation, emissions reporting, and/or economic assessment of emissions reduction. This study incorporated two improvements over existing emissions characterizations: closing data gaps and introducing methodology improvements.

- <u>Data Gaps:</u> The approach of many estimation efforts[3,4,5] has been to re-analyze a single underlying data set using different perspectives. The data in common to these studies is from a 1992 data

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[2] Environ 2012. 2011 Oil and Gas Emission Inventory Enhancement Project for CenSARA States www.deq.state.ok.us/aqdnew/Emissions/OilandGasAreaEmissions/Final_Report_CenSara_122712.pdf

[3] EPA. Table W-1A of Subpart W of Part 98—Default Whole Gas Emission Factors for Onshore Petroleum and Natural Gas Production www.ecfr.gov/cgi-bin/text-idx?SID=6119cc221d43f03a515de3a3d2b3ddd3&node=ap40.21.98_1238.1&rgn=div9

[4] EPA 2011. Oil and Natural Gas Sector: Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution. Background Technical Support Document for Proposed Standards. www.epa.gov/airquality/oilandgas/pdfs/20110728tsd.pdf

gathering effort[6]. Relying on data of over 20 years in age has created a knowledge gap as controller technology, facility design, process conditions, data collection methods, and understanding of the emissions have changed over time.

- Methodology: Other more recent studies have obtained new information through additional research or field data collection[7,8]. The newer sampling efforts did not always collect the types of data necessary for a complete description of controller emissions.
    - Manufacturer and model number information is not always provided. Make and model has utility in assessing such a heterogeneous emissions source category. Manufacturers publish specifications useful for quantifying emissions, such as continuous bleed rates and actuator volumes. Also, previous studies often quantified pneumatic controller emissions in terms of the controller, though the manufacturer and model of the actuator connected to the controller has a first order influence on intermittent vent controller emissions.
    - Direct measurement of pneumatic controller emissions is challenging. Studies that have collected new data generally employed direct measurement of controller emissions. Selecting a meter for a pneumatic controller's exhaust stream is subject to a number of constraints such as the non-constant emissions profile of pneumatic controllers. Emissions are characterized by large time intervals of near-zero emissions, transient rates when emitting, and low volumetric flow rates. Most meters are designed for steady state conditions rather than transient systems that exhibit variations on the order of a fraction of a second. The emissions profiles for two identical controller-actuator pairs are typically different because controller placement in the process, controller settings, and process conditions influence emissions. Similarly, the emissions profile of an individual controller and actuator will change over time as process conditions at the site change such as due to production decline, and/or as controller settings are adjusted. These dissimilarities mean that a spot measurement alone is a limited characterization of controller emissions. Additional practical matters are that exhaust ports on pneumatic controllers do not lend themselves to attachment of flow meters and that meters can exert backpressure on the controller which affects how the system functions. One recent discussion of pneumatic controller emissions quantification[9] suggests that engineering calculations using actuation frequencies and volumes for each controller-actuator system can overcome the challenges of direct measurement, especially for intermittent vent controllers.
    - Existing studies lack consensus on controller definitions, perhaps because of the complexity of pneumatic controller configurations and emissions profiles. The literature review in Section 6.1 and 6.2 encountered several definitions for a pneumatic controller. As one example, backpressure regulators are applicable to some definitions, are not applicable to other definitions, and are open to interpretation for other definitions. The ambiguity of the emissions source description adds additional uncertainty to controller counts and to average emissions rates. As will be detailed in Section 4, the backpressure controllers without a consensus

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[5] EPA 2014. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012. www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2014-Main-Text.pdf

[6] EPA/GRI 1996. Methane Emissions from the Natural Gas Industry. www.epa.gov/gasstar/tools/related.html

[7] Allen, David T. University of Texas 2013. Measurements of methane emissions at natural gas production sites in the United States. www.pnas.org/content/110/44/17768.full

[8] Prasino Group 2013. Determining Emissions Factors for Pneumatic Devices in British Columbia. Final Field Sampling Report. www.env.gov.bc.ca/cas/mitigation/ggrcta/reporting-regulation/pdf/Prasino_Pneumatic_GHG_EF_Sampling_Report.pdf

[9] Simpson, David A. "Pneumatic Controllers in Upstream Oil & Gas." SPE Oil and Gas Facilities. October 2014. www.spe.org/ogf/print/

> definition increased the count by an average of 40% in the collected data. Definitions to describe how controllers emit are also inconsistent and often contradictory. Exhibit 26 in Section 6 provides examples of different definitions and usages of the term “bleed” and how this creates a loss of understanding when one stakeholder communicates with another. It would be necessary to analyze inconsistencies in definitions to avoid making comparisons between results stemming from dissimilar understandings.

Thus, there was a breadth of work available to characterize U.S. pneumatic controller emissions, and the characterization can be improved upon by introducing up-to-date samples, collecting new data types, improving quantification methods, and using more transparent and consistent terminology.

1.2.Scope

OIPA scoped the study in February 2014. Exhibit 6 shows the outcome. Section 6.3 provides additional discussion of study design considerations which was used to establish this scope.

Exhibit 6: Study Boundaries and Definitions

<table>
<tr><td rowspan="8">Geographical boundaries</td><td colspan="2">All production sites within Oklahoma were eligible for inclusion. To help focus the planning and logistics, OIPA identified six geographic areas within Oklahoma that have significant production. Each geographic area was characterized by a list of target counties. The geographic areas helped to determine company coverage across the state based on the locations of each participant’s assets.</td></tr>
<tr><td>*OK geographic area*</td><td>*Target Counties*</td></tr>
<tr><td>Granite Wash</td><td>Beckham, Custer, Kiowa, Roger Mills, Washita , Greer</td></tr>
<tr><td>Mississippian</td><td>Alfalfa, Garfield, Grant, Kay, Major, Noble, Payne, Woods, Osage, Logan, Woodward, Harper</td></tr>
<tr><td>Woodford (Cana)</td><td>Blaine, Caddo, Canadian, Custer, Dewey, Kingfisher, Grady</td></tr>
<tr><td>South Central Oklahoma Oil Play (SCOOP)</td><td>Garvin, Grady, McClain, Stephens, Carter, Murray</td></tr>
<tr><td>Arkoma (Woodford)</td><td>Coal, Atoka, Hughes, Pittsburgh, Latimer, Haskell, LeFlore</td></tr>
<tr><td>Marmaton</td><td>Ellis, Texas, Beaver, Harper</td></tr>
<tr><td>Temporal boundaries</td><td colspan="2">Data collection occurred in June 2014 with the goal of collecting data at both new and old sites. OIPA defined new sites as those with first production in 2000 or later. OIPA defined old sites as those with first production occurring in 1999 or earlier. Based on discussions between OIPA member companies, these dates roughly correspond to when intermittent vent pneumatic controllers began being used in new equipment packages and when retrofit kits to convert continuous bleed controllers to intermittent vent controllers became available.</td></tr>
<tr><td>Participating companies</td><td colspan="2">Anonymous Company
Anonymous Company
Chaparral Energy
Chesapeake Energy
Continental Resources
Devon Energy
Marathon Oil
Newfield Exploration
OIPA targeted 10 to 20 sites from each company.</td></tr>
<tr><td>Facility definitions</td><td colspan="2">Data collection occurred only at production sites, which were defined as facilities with at least one producing well. This study’s classification of a production site as either oil or gas is based on the classification used in Oklahoma Corporation Commission (OCC) filings, which is a gas-oil ratio of 15,000 scf/barrel[10].</td></tr>
<tr><td>Operational boundaries</td><td colspan="2">Production sites were the only type of facilities visited by this study. Data was collected for all equipment at the selected sites.</td></tr>
<tr><td>Other site considerations</td><td colspan="2">• To facilitate improvement of the Oklahoma emissions inventory, the study provided the permit status for each site visited. Air permit status is defined as yes/no parameter to indicate if the site was subject to an air permit on the day of data collection or if it was permit-exempt.
• For comparison with other work, the study collected the producing well count at each site visited.
• Each company’s sites were divided into four bins based on new/old and oil/gas characteristics. An approximately equal number of sites were selected at random from each bin.</td></tr>
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[10] Oklahoma Administrative Code 165:10-1-7. www.oar.state.ok.us

Controller definitions	The study used the process control discussion conveyed by Simpson[9]. The study classified a controller as either continuous bleed or intermittent vent and as either throttling or on/off. To ensure no equipment potentially meeting a controller definition was overlooked, this study collected information on any pneumatic controller, pneumatic device, or pneumatic equipment that was not a pneumatic pump. This study used the following description to help identify pneumatic controllers for data collection: Gas pneumatic devices and controllers are powered by pressurized produced gas and are used for maintaining process conditions such as liquid level, pressure, delta pressure and temperature. Separate types of pneumatic controllers can be used for other applications such as monitoring and activating safety systems, or maintaining proper operating conditions of wells such as plunger lift systems. In this study, examples of gas pneumatic devices and controllers are backpressure valves, temperature controllers, pilot regulators, plunger controllers, level controllers, and well safety shutoffs. The end-devices, such as the actuators, operated by devices and controllers are included to completely describe each configuration. Also, controllers that have no emissions are not counted.

This study thus established four bins for data collection: new oil, new gas, old oil, and old gas. The presence or absence of a state air permit was also collected as an additional analytical dimension. Exhibit 7 is an expression of the desired study outcomes.

Exhibit 7: Desired Study Outcomes

Representativeness	• The results are representative of the pneumatic controller emissions from sites sampled by the study during the sampling time interval. It is reasonable to use the collected data to represent the sampled controllers over an annual time period in close proximity to when data collection occurred. • The samples provide a benchmark to assess if statewide inventories used representative pneumatic controller quantification methods. The samples are also useful as points of comparison to the definitions, methods, and results of other pneumatic controller emissions studies. • The study provides practical examples rather than an inferential statistics result. The results were not extrapolated to larger populations because of the variability in production characteristics, facility design, and use of non-natural-gas-pneumatic controllers between different populations.
Deliverables	• Provide controller counts ○ Average pneumatic controller counts per production site ○ Average pneumatic controller counts per facilities with different age, oil/gas production, and air permit status ○ Counts of controllers by manufacturer and model ○ Counts of controllers by continuous bleed and intermittent vent classifications • Provide emissions estimates ○ An investigation of emissions using actuation frequency observations and engineering calculations. ○ An investigation of controller emissions at facilities with different age, oil/gas production, and air permit status characteristics • Communicate the complexities of pneumatic controller emissions quantification.

Deliverables were classified into two quantitative categories and one qualitative category. The controller counts deliverable was based on direct observations where the only mathematical operations performed on the data are counts and averages. The emissions estimates deliverable was based on using collected data as inputs for engineering calculations as described in Section 3. Engineering calculations were chosen as the quantification method for this study based on the discussions reflected in Sections 1.1 and 6.3. The communication deliverable is to relay the knowledge gained from the literature review in Section 6.1 and the field data collection experiences.

2. Data Collection

Based on the study's goals and scope, OIPA prepared a data collection protocol to govern site selection and data collection. This section summarizes the protocol and the adjustments required due to circumstances in the field.

2.1.Site Selection

Prior to taking field data, a protocol was created to ensure that data was collected in a coordinated, consistent, and meaningful manner and that site selection was methodical. So that sites were selected in a non-arbitrary fashion, participating companies submitted a site list to OIPA consisting of all active, producing wells in the geographic areas assigned to them by this study. Participants preferred to submit information on a well basis rather than a site basis. The site list included the following information for each facility:

- Company
- County
- Lease Name
- Well API Number
- First production date
- Oil or gas well

Sites could not be selected at random from the list since it was desired to control the number of sites per operator, the geographic distribution of sites, site age, and the number of gas sites vs oil sites. Site selection occurred according to the following procedure:

1. Assigned each operator to two geographic areas to minimize travel and manpower requirements. Each company was assigned areas where it had a significant population of sites.
2. Companies truncated their site lists to included only sites from its assigned areas and submitted the truncated site lists to OIPA.
3. OIPA randomly selected the sites from the company's site list approximately one to seven days before site visits were scheduled. OIPA staff, rather than companies, made the selections to minimize the sensitivity that inspections, repairs, or other work was undertaken to influence results. The potential for making repairs or otherwise adjusting the site to affect the study was minimal: this study collected counts and actuation information, so leak repairs were a non-issue. Company work order scheduling and the degree of work required to make a pneumatic controller change made it impractical for companies to replace controller models to influence study results. Controller settings and process conditions were not likely adjusted to influence this study since 1) it is impractical to adjust level, pressure, and temperature settings since they affect site productivity and product quality and 2) company staff responsible for data collection were often separate from company staff responsible for day-to-day operations. Therefore, regardless of the minimal risk that sites could be altered to affect data collection, OIPA elected to select sites at random as a good practice based on the following:
    a. For each company, selected all company wells in one geographic area.
    b. Randomly chose two new gas wells, two new oil wells, two old gas wells, and two old oil wells from the selected wells.
    c. Selected one backup well of each type in the event that a given site was not available during data collection. Site non-availability issues were limited to situations where significant maintenance such as a workover was occurring or where there was a site access issue.
    d. Because companies preferred to submit information by well number, OIPA provided clarifications relative to sites. In the event that multiple wells from the same site were selected, the company was free to request additional random sites or to proceed with data collection at the originally selected sites. If OIPA selected a well on a multi-well site, all controllers at the site were included in the data collection.

2.2.Data Sheet

OIPA developed the data sheet shown in Section 6.5 for this study. The data types included in the sheet were outcomes of OIPA's study design considerations in Section 6.3 and study scope in Section 1.2. To ensure consistent data collection across all sites and companies, the data sheet included instructions and units of measure for each data point.

The data sheet was developed with engineering calculations in mind as the primary emissions quantification method. Key data points included:

- Located at air permitted or permit-exempt site
- Controller make and model
- Controller bleed classification, continuous bleed or intermittent vent
- Controller emission reduction retrofit status
- Controller serves a safety function (yes or no)
- Presence or absence of relay
- Controller supply pressure
- Volume contained within tubing between controller and actuator
- Actuator make and model
- Actuator physical dimensions, as a conservatively high representation of actuator gas volume if manufacturer volume information was not available
- Actuation count over a 15-minute observation period

This data allowed each controller/actuator combination to be augmented with manufacturer specifications such as continuous controller bleed rates and gas volumes contained within the actuator.

Actuation frequency is a key data point for emissions quantification and also the most time-dependent parameter. It was impractical for the study team to monitor actuations for intervals exceeding 15 minutes, considering the time requirement for travel and observation. As a result, this study assumed that a controller with zero observed actuations over a 15-minute interval undergoes actuation once every 15 minutes.

2.3.Additional Data

In addition to entries on the data collection sheet, companies also collected information from internal records and controller manufacturers. This information included:

- Site well count.
- Located at oil site or gas site. See Exhibit 6 for definitions.
- Located at new site or old site. See Exhibit 6 for definitions.
- County.
- Controller bleed rate as specified by manufacturer, if continuous bleed.
- Actuator volume as specified by manufacturer.
- Controller annual operating factor. The annual operating factor was equal to the well's producing time for 2013 divided by the number of days in 2013 since first production. If a site began to operate in 2014, the site's 2014 partial year operating factor was used.
- Most recent gas composition. The volume percent VOC and volume percent methane were taken from the most recent gas analysis at the gas meter of each site. Compressibility factors were also recorded if a gas analysis contained this parameter.

- Actuation frequency information. If the actuation frequency could not be established from the 15-minute observation period, other company records such as plunger timer settings were used if available.
- Seepage rate. Seepage rates published by one manufacturer[11] were assumed for all intermittent vent controllers. This value is not a significant contributor to the total volume, so the purpose of this parameter was to acknowledge this term emission in the calculations.

2.4.Data Collection Validation

Before beginning the data collection, OIPA conducted a field test and training session with representatives from participating companies to ensure consistent data collection and validation of the protocol. During the field test, OIPA enlisted the assistance of a pneumatic controller expert from a controller manufacturer to help troubleshoot unique or unanticipated situations.

The study group thought it possible that equipment or situations not anticipated by the data collection sheet could be encountered, so the field test was necessary before finalizing the data sheet. The field test duration was approximately ½ day including travel time. Sites were selected for their proximity to the study group's general location in Oklahoma City. OIPA included four test sites from two companies so that the trial run and data sheet validation had several site configurations. Because test sites were not randomly selected and because the data sheet was expected to be changed as a result of the field tests, no data from the field test appeared in the final data tables, analysis, results, or conclusions.

2.5.Protocol Adjustments

During data collection, some companies encountered unanticipated situations not encountered and resolved by the field test. As a result, some deviations from the data collection procedure occurred. Exhibit 8 is a list of these issues and how they were resolved.

Exhibit 8: Data Collection Deviations and Protocol Adjustments

Deviation	Protocol Adjustment
The final data sheet was mis-numbered. No item #9.	No change.
There were various sub-models, iterations, or versions of certain controllers, such as the Kimray T12, Cemco/Wellmark 6900, or the Invalco CT Flextube.	No differentiation was made between controller sub-models.
The presence of mechanical or electronic controls generated interest among participants while data collection was underway.	No change. After data collection, each company was asked to provide qualitative notes of the non-pneumatic controllers encountered. The observations were not analyzed quantitatively.
Some companies requested additional randomly selected backup sites since well maintenance schedules that can interfere with data collection change on a daily basis, and there is a time lag of several days between selection and visit.	Site substitutions were accepted for this reason. The alternative was a lower sample size. The study team had no foreknowledge of the controller characterizations at the original or replacement site.
If there were problems navigating to a site due to issues such as road closures or terrain, a nearby site was substituted by the data collectors.	Site substitutions were accepted for this reason. The alternative was a lower sample size. The study team had no foreknowledge of the controller characterizations at the original or replacement site.

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[11] Kimray Tech Bulletin #C109201. dnn.kimray.com/KimPedia/tabid/185/loc/print/Page/Tech-Bulletin-C109201-GenII-Bleed-Rate/language/en-US/Default.aspx

Deviation	Protocol Adjustment
Some companies excluded randomly selected sites that were too distant from the others to be practical. In this case the backup sites were visited instead because the goal was to accomplish data collection in a single day trip for the geographic area.	Substitutions were accepted for this reason. This may introduce bias towards sites that were more accessible to the study team within a day trip. It is not anticipated that a site's proximity to Oklahoma City was a strong driver of pneumatic controller emissions since all company sites in a given area were operated, maintained, and supplied from field offices serving a region.
The data sheet was not updated with the final OIPA gas composition data collection instructions.	Composition data was collected for each site rather than using a representative sample as instructed in the data sheet.

The site substitutions discussed in the table affected less than 10% of the sampled sites. The protocol adjustments section was included for completeness, as the data collection deviations do not significantly affect the quality of the data collected.

3. Data Analysis

The data analysis consisted of quality assurance/quality control (QA/QC) and implementing the engineering calculations to estimate emissions rates from the collected data.

3.1.QA/QC

Exhibit 9 is a table showing the data quality issues encountered and their resolutions. For any situation that required assumptions to fill missing data or to simplify complex operating scenarios, conservative values were used that resulted in higher than actual emissions estimates. The one exception is the common method for describing the molecular weights of pentanes+ or hexanes+ where a representative, rather than conservative, value was used. For completeness this assumption is explored in the sensitivity analysis in Section 4.

Exhibit 9: Data Quality Issues and Resolutions

Data quality issue	Resolution
As anticipated, some pressure gauges were absent or not functioning.	Assumed the highest encountered supply pressure for that controller or actuator type.
At one location, the actuator was inaccessible because the cabinet was stuck shut.	The controller and actuator were both in view and were recorded as Kimray T-12 and Kimray 112 SMT models, respectively. The tubing and actuator dimensions were not recorded with a tape measure, but the gas volume in the actuator was a known quantity from manufacturer information. Assumed the highest encountered tubing length for that controller and actuator type.
Temperature controllers were observed to be present on in-service vessels, but no fuel gas was being supplied because the burners were off.	Counted as in-service controllers since the controllers were pressurized. Company C determined the burner on time for use in its annual operating factor. All other companies over-estimated burner on time by using an operating factor equivalent to the well's annual producing hours per year.
Backpressure controllers were encountered on in-service vessels, but the line regulated by the controller was manually blocked off.	Counted as an in-service controller since the controller was pressurized. Used default actuation rate which is conservatively high based on company experience with these controllers. Applied the well's annual operating factor which over-estimated emissions.
Tubing length data was missing for some controllers.	Used the maximum length for controllers of that type. Controllers of the same model with an integrated actuator will have the same tubing length. The maximum length based on type, rather than the global maximum, was used because certain controllers, such as high/low pressure shutoffs, may have tubing lengths that are unrealistically long to use for other controller types.
Tubing length data was missing for some high/low pressure shutoff controllers.	A conservatively high value of 100 feet was assumed for the length.
Stem travel fraction was not provided for some controllers.	The maximum stem travel fraction of 1 was used. This corresponded to complete evacuation of the actuator, tubing, and controller volumes with each actuation.
Reviewed controller and actuator makes/models to determine if data was collected for equipment that does not meet the definition of pneumatic controllers.	A small number of data points were removed because they were pressure regulators or relief valves that did not emit. This outcome was expected due to OIPA guidance to collect data for any equipment that has the potential to be included in a broad definition of pneumatic controller.
For each site, reviewed the collected data and flagged any control functions that appeared to be missing.	For each flagged site, investigated the process flow and equipment to determine if pneumatic controllers were overlooked during data collection. In most cases, the control function was either not present or was being performed by non-pneumatic controllers. For a small number of sites, the high/low pressure shutoff controllers were determined to be missing, so these controllers were added to the data set after the site visit had taken place, and company records were examined to determine a conservatively high actuation frequency.

Data quality issue	**Resolution**
Reviewed each site to identify uncommon designs and situations to ensure that the data sheet captured these scenarios adequately.	Several companies recorded two controllers sharing a common actuator. The QA/QC ensured that this situation was represented consistently. The decision was to show two lines, one for each controller, where the actuator was repeated. This ensures that emissions could only be over-estimated. A second situation was how to represent actuators on continuous bleed controllers. Most configurations supplied gas to the actuator from the continuous bleed stream so that actuator gas was a portion of the continuous bleed stream. For conservativeness, all actuator emissions are added to the continuous bleed rate.
Reviewed each data type for unexpected values, outliers, and out-of-range entries. Examples included stem travel fractions greater than 1, operating factors greater than 1, uncommon make/model names, and uncommon supply pressures.	Flagged data was investigated with the owning company. Outcomes were either correction of typos or confirmation that the data was valid as-entered.
Gas analysis information was not available for some sites.	Used a representative gas analysis from a nearby facility.
Gas analyses commonly speciate to hexanes+.	Any hexanes+ value in a gas analysis was given the molecular weight of hexane. This will not affect results significantly since, upon inspection of the gas analyses from the sampled sites, the hexanes+ mol% was typically a small fraction of the total VOC mol%.
Gas analysis contained limited information for some sites.	Some gas analyses provided speciation up to pentanes+. For these analyses, any pentanes+ value was given the molecular weight of pentane. Some gas analyses provided VOC as condensed liquids volumes. For these analyses, volumes were converted to ideal gas molar volumes to determine the mole % VOC. Gas composition data for some sites was limited to the methane and VOC mole %. The VOC molecular weight in these cases defaulted to the average VOC molecular weight of the remaining sites in the sample. Some gas analyses did not include methane and inerts, so OIPA conservatively assumed that methane volume percent was equal to 100-VOC-ethane.
Gas analyses are commonly on a dry basis.	No correction was made because this significantly increases the emissions estimate and gives a conservatively high result. Removing water vapor from the speciation increases the volume of hydrocarbon to higher than actual conditions in the controller/actuator system.
Oil or gas site designation	If the OCC well classifications for a site were not available, used company records to make a determination.

The issues in Exhibit 9 convey some of the intangible complexities in collecting controller emissions data: controllers have a variety of site-specific and time-dependent conditions and configurations. Acknowledging this level of detail in emissions inventories and regulatory analyses may help to improve uncertainty assessments and increase representativeness of published estimates.

Another QA/QC activity was to discuss the consistency of company determinations for safety and non-safety controllers. This issue is pertinent to the study, as a function of safety versus non-safety can relate directly to the actuation frequency of a particular device. The QA/QC process observed that an individual company may have designated one controller as safety and designated another controller of the same make/model as non-safety. This was a common occurrence for backpressure controller models capable of functioning either as pressure relief or backpressure control. This was also common for Kimray T-12 temperature controllers where one may be used to open or close the fuel supply while another may be used to throttle the fuel gas rate to a burner. An OIPA discussion about safety designations included several perspectives:

- One facet of safety in certain processes was using controllers in series so that one controller protects against high and low operating conditions while the other controller regulates the process.

- For some, but not all process conditions, a desired control function was to deactivate a flow if certain conditions occur and require that the site be visited to identify and resolve any potential problems.
- The abrupt removal of any given pressure, temperature, or level control function at a site could constitute an unsafe condition; therefore, all controllers had an inherent safety function.
- Using one controller type to perform the function intended for another controller type could introduce major unintended changes to ensure reliability and safety, such as equipment removal, site redesign, and product loss.
- Intermittent vent controller emissions quantities in this study were low in magnitude. Intermittent vent controllers serving a safety function actuate infrequently and have lower emissions quantities than many other types of intermittent vent controllers. The controller designs that protect against high and low pressures generally operate by holding static pressure on a pressure-to-open valve and will release pressure during uncommon high or low pressure conditions. The high/low shutdown devices are not controlling a process variable and are not significant contributors to total pneumatic controller emissions or to a site's overall emissions.

Based on this assessment of the safety designation concept, OIPA concluded that it was not clear how to assess pneumatic controller emissions results based on characterizations of safety versus non-safety.

3.2.Assumptions

Before applying the calculations to the data set, OIPA finalized its list of assumptions. Earlier sections of this report discussed assumptions in the context of study design and data QA/QC. Exhibit 10 is a comprehensive assumptions list. For any situation that required assumptions to fill missing data or to simplify complex operating scenarios, conservative values were used that resulted in higher emissions estimates. The one exception is the common method for describing the molecular weights of pentanes+ or hexanes+, and this assumption is explored in the sensitivity analysis in Section 4.

Exhibit 10: List of Assumptions

Parameter	Assumption
Supply pressure	For missing data, assumed the highest encountered supply pressure for that controller or actuator type.
Effect of relay on emissions	The presence of a relay on the controller increased the supply pressure in the controller, tubing, and actuator by a factor of 3.
Annual operating factor	For each controller, most companies used an operating factor equivalent to the well's annual producing hours per year. This overestimated emissions because it did not account for time when a specific controller was not in use, such as when a burner was intentionally not in use or when a line with a pressure controller was blocked off. Temperature controllers for Company C used an annual operating factor that accounted for burner on time.
Actuator volume	If manufacturer specifications were not available, used the dimensions of the controller taken during data collection and assumed that the entire actuator body contained gas. The volume was then represented as a cylinder based on actuator height and diameter.
Tubing volume	For missing tubing lengths, used the maximum length for controllers of that type. For high/low pressure shutoffs with missing tubing lengths, assumed conservatively high length of 100 feet.
Gas compositions	This study assumed that the most recent gas analysis taken at each site's gas meter was a valid representation of controller emissions compositions. Gas was sent to controllers from supply pots that, depending on the site design, can either serve all equipment on a site or can be equipment-specific. There may be gas composition variations between gas from a primary separator, a heater treater , and a gas meter. OIPA determined that the compositional variation across a site was not significant to differentiate for this study. This study also used the gas analyses on a dry basis and did not represent any water vapor present. This significantly increased the emissions estimates compared to actual operating conditions.

Parameter	Assumption
Gas compositions	Gas analysis information was not available for some sites, so this study used a representative gas analysis from nearby facilities. Also, any hexanes+ mole % was given the molecular weight of hexane. For gas analyses that speciated up to pentanes+, pentane plus was given the molecular weight of pentane. Some gas analyses provided VOC as condensed liquids volumes. For these analyses, volumes were converted to ideal gas molar volumes to determine the mole % VOC. For sites that provided VOC mole % rather than the mole % of the VOC constituents, the VOC molecular weight defaulted to the average of the other sites in the sample. Gas analysis information did not include methane and inerts for some sites, so this study conservatively assumed methane volume percent was equal to 100-VOC-ethane.
Gas compressibility	If not available within the site gas analysis, the minimum compressibility value encountered in the data set was used which was 0.9958. The minimum value represented more gas occupying the controller-tubing-actuator system than if the gas were ideal.
Continuous bleed controller bleed rate	The continuous bleed rate was taken from manufacturer specifications which was typically a maximum value based on maximum supply pressure. The actual supply pressure for each controller was not scaled to the manufacturer's maximum supply pressure, which overestimated continuous bleed emissions. The controller's state of repair was not a factor for determining bleed rate because this study considers the controller's state of repair to be a combination of maintenance and leak repair issues rather than a pneumatic controller characteristic. Controllers, like all equipment, require maintenance over time. Controller selection is a separate area of responsibility from site operations and maintenance. Replacement of an older controller with a newer controller does not necessarily address the root cause of equipment leaks. Equipment leak issues are best quantified and addressed as an independent source category.
Intermittent vent controller seepage rate	The seepage rate to reduce hysteresis was published by Kimray[11] for intermittent vent controllers in on/off mode and in throttle mode. OIPA assumed these values are applicable to non-Kimray intermittent vent controllers. If on/off or throttle was not specified for a controller, defaulted to the higher throttle mode seepage rate.
Stem travel fraction	If the unitless stem travel fraction was unknown, assume the maximum value of 1.
Controller volume	No manufacturer information was available to characterize this volume. OIPA assumed two inches of additional tubing length to represent gas in the controller that was vented along with the actuator and tubing volumes.
Gas temperature	No temperature correction was applied because it is inconvenient to measure the temperature of supply gas and to confirm that the temperature does not fluctuate spatially and temporally. 60°F standard conditions were assumed as the lower bound temperature, yielding the highest possible calculated emissions. This is conservative since data was collected in June during summer ambient conditions and since gas temperatures were typically at or above the assumed temperature to inhibit hydrate formation.
Actuation frequency	Assumed controller actuations occur regularly with a single distinct frequency over the course of the year. If a frequency was not determined from the 15-minute observation period and company records, assumed one actuation every 15 minutes.
Oil or gas site designation	If the OCC well classifications at a site were not available, used company records to make a determination.
Actuator emissions on continuous bleed controllers	For conservativeness, all actuator emissions were added to the continuous bleed rate, which over-estimated total actuator emissions since actuators receive supply gas from the controller bleed.

3.3.Spreadsheet calculations

Each controller was represented as a row in a spreadsheet, and all field data, other data, and assumptions were inputted for each controller. The data and assumptions were combined in the spreadsheet according to the engineering calculation in Exhibit 11.

Exhibit 11: Pneumatic Controller Emissions Engineering Calculation

$$r_{tot} = \sum_{controllers} \frac{c}{z}\left[r_{bleed} + r_{seep} + lft\left(V_{controller} + V_{tubing} + V_{actuator}\right)\right]$$

Where:

r_{tot}	is the total emissions rate in standard cubic feet per hour (scfh) of natural gas, volatile organic compounds (VOC), or methane.
$\Sigma_{controllers}$	represents a sum over controllers in the sample with a desired trait, such as all controllers at oil sites.
c	is the site-specific volume fraction of natural gas, VOC, or methane. For natural gas, c is equal to 1.
z	is the site-specific gas compressibility.
r_{bleed}	is the manufacturer's specified bleed rate for a continuous bleed controller in scfh natural gas. This is 0 for intermittent vent controllers.
r_{seep}	is the seepage rate to reduce hysteresis in scfh natural gas. This is 0 for continuous bleed controllers.
l	is the relay multiplier which is 1 for controllers with no relay and 3 for controllers with a relay.
f	is the observed actuation frequency during data collection in actuations per hour. f is equal to 4 if no actuations were observed during data collection.
t	is the unitless actuator stem travel fraction for throttling controllers which is equal to 1 for a complete opening of the valve during actuation. This is always equal to 1 for on/off controllers.
$V_{controller}$	is the volume in the controller at supply pressure, in scf natural gas. This is not readily available, so a conservative allotment of 2 inches of tubing length is used to acknowledge this parameter.
V_{tubing}	is the volume in the tubing between the controller and actuator at supply pressure, in scf natural gas. This is determined from tubing length and diameter measurements for each controller.
$V_{actuator}$	is the volume in the actuator at supply pressure, in scf natural gas. This value is equal to manufacturer specifications of the gas space under the actuator diaphragm. Actuators with no available manufacturer specification conservatively defaulted to the dimensions of the entire actuator body.

The seepage, controller, and tubing volumes were added for completeness since OIPA anticipated that these volumes were not major contributors to pneumatic controller emissions.

The spreadsheet contained a total of 680 rows representing controllers encountered during data collection that were in service for at least part of the year. This included controllers that were connected to supply pressure but were not active during data collection due to burners being off, compressors being off, or lines being bypassed. For each of these controllers, the hourly rate r_{tot}, was calculated regardless of the status in which the controller was found. Pneumatic controller emissions estimates expressed as hourly rates were not multiplied by annual operating factors. Pneumatic controller emissions estimates expressed as annual rates were multiplied by annual operating factors.

The spreadsheet contained an additional 33 rows representing out-of-service controllers encountered during data collection. These represented controllers permanently disconnected from supply pressure that had a zero annual operating factor, were on-site junk, or were otherwise no longer serving a control function. It was not uncommon to encounter an out-of-service controller located next to the in-service controller that succeeded it. The study made note of these controllers so that other efforts can be informed of how this collected data was interpreted. The study otherwise disregarded these controllers and did not include them in emissions calculations, data analysis, or conclusions.

The spreadsheet made note of 10 sites visited for data collection that had zero pneumatic controllers. These sites were included in the total site count in the calculations, analysis, and conclusions.

4. Results

The results discussion begins in Section 4.1 with a summary of the observations prior to executing the engineering calculation. Section 4.2 presents the engineering calculation results in terms of total emissions from all sampled controllers. Section 4.3 develops average emissions per controller. Section 4.4 provides the average counts and emissions by site type. Section 4.5 analyzes the sensitivity of the calculated emissions results to the assumptions. Section 4.6 compares the results to other recent studies.

4.1.Discussion of observed data types

The collected data included controller counts, makes, models, and actuation frequencies. This information was reviewed prior to calculating emissions to gain an improved understanding of the controllers in the sample. Exhibit 12 contains key observational results. It includes four headings: sites, controllers, average controller counts, and actuation frequencies.

Exhibit 12: Key Observational Results

SITES

172 sites (205 wells) visited for data collection
162 sites (190 wells) had natural gas pneumatic controllers
10 sites (15 wells) did not have natural gas pneumatic controllers

CONTROLLERS

680 natural gas pneumatic controllers
77 controller models
659 intermittent vent controllers
21 continuous bleed controllers

AVERAGE CONTROLLER COUNTS

4.0 pneumatic controllers per site
5.0 pneumatic controllers per new gas site
3.1 pneumatic controllers per old gas site
3.6 pneumatic controllers per well
5.3 pneumatic controllers per new oil site
2.7pneumatic controllers per old oil site

ACTUATION FREQUENCIES

538 controllers (79%) had no actuations detected during the observation period and were assigned the default rate
126 controllers (19%) had actuation rates less frequent than the once per 15 minute default rate
16 controllers (2%) had actuation rates more frequent than or equal to the default rate

The sites summary heading in Exhibit 12 indicates that 94% of visited sites had natural gas pneumatic controllers. The 6% of sites without natural gas pneumatic controllers used a combination of hydraulic, electronic, mechanical, and/or instrument air, controls depending on the site. All ten of these sites were in the New Oil category.

The controllers heading shows that the majority of the sample was intermittent. 97% of the controllers were intermittent vent which is a significantly different result than representations in other studies. The 3% of controllers that were continuous bleed were all level controllers and constituted about 12% of all level controllers.

The average controller counts heading first compares the quantities of [total controllers divided by total sites] to [total controllers divided by total wells]. As most sites were single well pads, the two quantities differ by less than one. The average count of controllers per site was higher than some previous estimates which may be due to this study's all-encompassing definition of a pneumatic controller in Section 1.2. The average controller counts heading next compares the controller counts for each of the four bins established by the study. The trend was that newer sites have approximately two more controllers on average than older sites, regardless of the oil or gas production type. Newer sites in the sample had more controllers because they were more likely to be multi-well pads and were more likely to have additional complexity such as a compressor or an increased number of vessels. Regarding the topic of vessel counts, this study found that it is unreliable to estimate the size of a controller population from equipment counts. One common estimation method is to multiply a representation of vessel counts by an assumed ratio of controllers per vessel. This technique was not valid for the equipment in this study because there were multiple controller arrangements used to accomplish a single process control function. For example, this study encountered vessels carrying out temperature control using zero, one, two, and three pneumatic controllers, depending on the vessel. Multiple controllers can be used in series to ensure high temperature shutdown, low liquid level shutdown, and maintaining temperature about a set point. Conversely, the control function may have been accomplished by a non-natural-gas-pneumatic controller. Establishing representative controller per equipment type is not straightforward since designs are necessarily non-standard.

Finally, the actuation frequencies heading in Exhibit 12 demonstrates that most sampled intermittent vent controllers emitted infrequently. Out of 680 controllers, 142 or 21% had an actuation rate supported by direct observation or other company records such as plunger runs. 538 controllers, or 79% of the sample, were observed for 15 minutes, did not actuate, and were assigned the conservatively high actuation rate of once every 15 minutes. Based on company records and experiences for the visited locations, OIPA concluded that many controllers actuate on the order of daily, weekly, or yearly. Controllers used for backpressure control or overpressure protection may have been included in the site design according to the assumed worst-case frequency that occurred only when a new well is brought into production, and then they actuated less frequently as production declined. High/low pressure controllers that shut the well in may have actuated a few times per year. Thus, the actuation frequency assumption significantly increased calculated emissions results, and this assumption was applied to the majority of controllers in the sample.

The distribution of controller makes and models was another outcome of reviewing the collected data. Exhibit 13 shows the most commonly encountered controller models out of a total of 77 models. Those controllers where both the make and model could not be determined were grouped into a single model.

Exhibit 13: Common controller models

Make	Model	Count	Fraction of Total
Kimray	212 SGT-BP	155	0.23
Kimray	230 SGT-BP-D	58	0.09
Murphy	LS200N	56	0.08
Kimray	30 HPG-D	47	0.07
Kimray	T-12	40	0.06
Kimray	30 PG	23	0.03
Kimray	330 SGT BP	23	0.03
Wellmark	6900	21	0.03
Not available	Not available	18	0.03
Axelson	300	18	0.03
Wellmark	2001NB	17	0.03
Wellmark	Snaptrol ST2TP	15	0.02
Kimray	Gen II	12	0.02
IPS	Differential Controller	11	0.02
Wellmark/Cemco	6900	11	0.02
Kimray	312 SGT-BP	10	0.01
All other (61 models)		145	0.21

The controller make and model information was useful to assess controller definitions, either explicit or implicit, used in past research. Of the 77 controller models identified, 17 were in the Kimray SGT/FGT series of backpressure controllers. These backpressure controllers accounted for 269, or 40%, of all observed controllers. These controllers can be configured for backpressure regulation or overpressure protection and rarely actuated when observed. A review of previous work in Sections 6.1and 6.2 concluded that some studies allowed enough subjectivity in their pneumatic controller definition to either include or exclude these backpressure controllers. Other work did not state explicit definitions and allowed subjective interpretation of what equipment was under study. Thus, controller count estimates may vary significantly if it is not clear how controllers are defined.

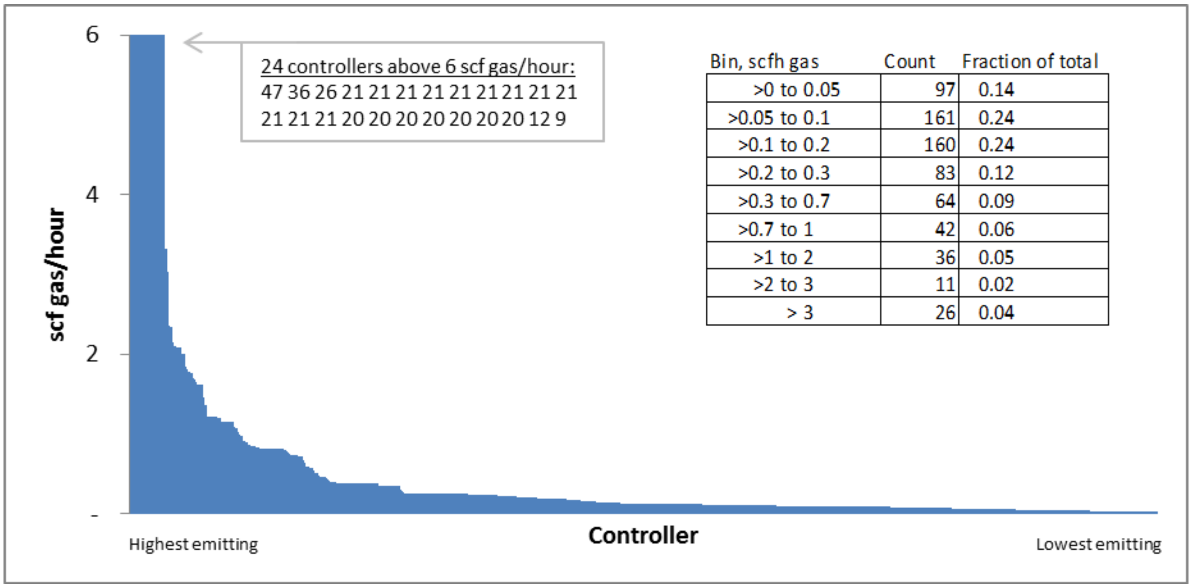
The make and model information was also useful for adding context to how level controllers have been interpreted in past work. Many studies have conceptualized pneumatic controller emissions in terms of only level controllers because temperature and backpressure controllers were observed to be more likely to have complex behavior such as throttling or long periods of no actuation. Level controllers were often studied because they are typically the subject of replacement or retrofit projects. The count of level controllers in this study was also influenced by the number of compressors within the sample of sites. Not all sites include compression, and some sites with compression have multiple compressors present. Some but not all compressors have a liquids knockout vessel level controller and one scrubber level controller per compression stage, so an individual compressor has the potential to contribute significantly to the site's level controller count. Level controllers constitute about 175 controllers, or 26% of all controllers in the sample. The most common models were the Murphy LS200N, Wellmark 6900, Wellmark 2001NB, and Wellmark Snaptrol ST2TP. A total of 147 level controllers were intermittent, which included 31 continuous bleed models using Wellmark Mizer retrofit kits. The number of continuous bleed level controllers that were not retrofitted was 21. All continuous bleed controllers encountered were level controllers. These results demonstrate that level controllers did not constitute a majority of pneumatic controllers, and most level controllers were intermittent. The extent to which continuous bleed level controllers were retrofitted was about 60%. This result was not appropriate to represent controllers outside of the sample because retrofit programs vary significantly by company and operating area.

Another observation from the collected data was the variability in gas VOC content. Gas compositions varied significantly from site to site based on the hydrocarbon reservoir(s) being produced and how each site was operated. This study elected to collect gas composition at each site because it was not representative to use averages to characterize any individual location. The VOC content ranged from 0.01 to 28 mole percent, with an average of 8 mole percent. The gas VOC content therefore varied significantly between sites. The average value reported here was valid to characterize the sample but was not valid to infer compositions at other locations.

4.2.Calculated emissions totals

Emissions from all 680 controllers were quantified to be 717 scfh gas before considering annual operating factors. Exhibit 14 visualizes the calculated emissions results as a histogram. Each bar along the x-axis is a controller whose magnitude is represented by the y-axis. The y-axis is truncated at 6 scfh to represent this rate of regulatory significance in 40 CFR 60 Subpart OOOO and so that the scale allows for the majority of controllers to register visibly on the graph. The magnitude of each bar that exceeds the scale is shown in the first inset. A numerical histogram of all bars is shown in the second inset.

Exhibit 14: Pneumatic Controller Emissions Histogram, 717 scf gas/hour total



24 controllers above 6 scf gas/hour:
47 36 26 21 21 21 21 21 21 21 21 21 21
21 21 21 20 20 20 20 20 20 20 12 9

Bin, scfh gas	Count	Fraction of total
>0 to 0.05	97	0.14
>0.05 to 0.1	161	0.24
>0.1 to 0.2	160	0.24
>0.2 to 0.3	83	0.12
>0.3 to 0.7	64	0.09
>0.7 to 1	42	0.06
>1 to 2	36	0.05
>2 to 3	11	0.02
> 3	26	0.04

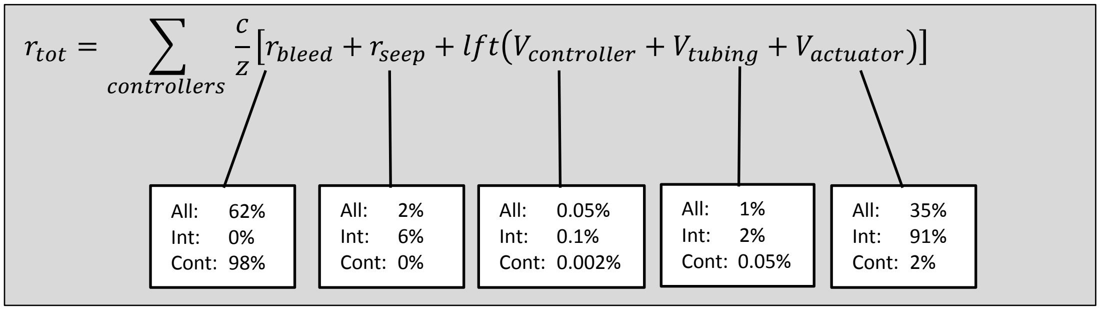
The calculated results conformed to a pattern commonly found in oil and natural gas emissions sources: a small number of sources were responsible for the majority of emissions. The total magnitude of the results can be put in context by visualizing how the entire chart area would be filled by blue bars using methods from 40 CFR 98 Subpart W[3]. Under Subpart W, each controller would be required to use an emission factor of either 13.5 scfh gas for "intermittent bleed pneumatic device vents" or 37.3 scfh gas for "high continuous bleed pneumatic device vents." This study encountered no controllers meeting the Subpart W definition of "low continuous bleed pneumatic device vents."

The majority of controllers, 418 , emitted 0.2 scf gas per hour or less, while 24 controllers emit more than 6 scf gas per hour. This sample was heterogeneous because the site conditions, control functions, and make/models were not sufficiently common between controllers even though all controllers are typically assigned to the same emissions source category. The heterogeneity in this source category can be described by noting that the largest emitter, 47 scfh gas, is a factor of 1,838 larger than smallest emitter, 0.03 scfh gas.

In these results, 24 controllers were above the 6 scfh gas emissions rate and represented 520 scfh gas or 73% of emissions. The remaining 656 controllers represented 197 scfh gas or 27% of emissions. Since the focus of study is often on the highest emitters regardless of the overall magnitude, the additional information is provided that 10 of the top 24 controllers were from old sites and 14 were from new sites. 2 were from oil sites and 22 were from gas sites.

The pneumatic controller emissions had five rate components based on the engineering calculation in Exhibit 11. The relative contribution of each component is illustrated in Exhibit 15 for all controllers in the sample, for only intermittent vent controllers in the sample, and for only continuous bleed controllers in the sample.

Exhibit 15: Relative contribution from each emissions term, 717 scf gas/hour total



$$r_{tot} = \sum_{controllers} \frac{c}{z}\left[r_{bleed} + r_{seep} + lft\left(V_{controller} + V_{tubing} + V_{actuator}\right)\right]$$

Exhibit 15 shows that the two major emissions components are bleed rate and actuation rate, as expected. For intermittent vent controllers, the majority of emissions occurred from depressurizing the actuator. For continuous bleed controllers, the majority of emissions occurred from the continuous bleed port. The combined sample of all controllers was a mix of emissions in proportion to the makeup of intermittent vent and continuous bleed controllers in the sample.

Since pneumatic controller emissions are expressed in a variety of forms depending on the regulatory purpose, the emissions were also totaled by gas component and in several types of units. Exhibit 16 expresses total emissions in terms of scfh, thousand standard cubic feet (Mscf)/year, pound (lb)/hour, and ton/year where one ton is equivalent to 2,000 lb. Hourly rates did not incorporate annual operating factors. Annual rates included annual operating factors.

Exhibit 16: Emissions totals for all 680 controllers

	scf/hour	Mscf/year	lb/hour	ton/year
All controllers				
Gas	717	5970	▨	▨
Methane	577	4810	20	85
VOC	58	479	8	33
Intermittent Vent				
Gas	264	2135	▨	▨
Methane	216	1741	8	31
VOC	20	163	3	12
Continuous Bleed				
Gas	452	3836	▨	▨
Methane	362	3069	13	54
VOC	38	316	5	22

Several observations from the exhibit were:

- For all controllers, the VOC component was a small fraction of the total emissions.
- The total VOC emissions from 680 controllers dispersed across 172 visited sites were 33 tons per year. This is not a significant quantity from an air quality perspective. Using averages from this study, a quantity of approximately 813 controllers on site would have been necessary to reach the equivalent of the 40 tons per year VOC limit in the Oklahoma Air Quality Permit By Rule OAC 252:100-7-60.5[12]. The average count of controllers per site from this study was 4.0. The

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[12] Oklahoma Department of Environmental Quality. Permit By Rule Oil And Natural Gas Sector. www.deq.state.ok.us/AQDNEW/resources/forms/100-223.pdf

controllers at any individual production site in this study were therefore not significant to a site's VOC emissions total.

- The exhibit is useful to discuss cost-effectiveness of emissions reductions. The intermittent vent controller emissions represented primarily actuator gas that was not practical or economic to capture, control, retrofit, or replace. The continuous bleed controller portion represented an emissions quantity subject to site-specific technical assessments to determine the viability of emissions reductions. The economics of any replacement or retrofit would include the cost to travel to locations dispersed across the state to service an individual controller. Using the emissions to represent revenues exaggerates the actual cash flow due to the conservatively high emissions quantification methodology. For this sample, economies of scale were not present given the relatively small number of continuous bleed controllers scattered across eight different companies and throughout the state.

4.3.Calculated emissions averages

Average emissions per controller were calculated. Exhibit 17 shows emissions averages in four sets of units for all controllers as well as for intermittent vent and continuous bleed controllers separately.

Exhibit 17: Emissions per controller

	scf/hour	Mscf/year	lb/hour	ton/year
All controllers				
Gas	1.05	8.78	▨	▨
Methane	0.85	7.07	0.030	0.125
VOC	0.085	0.70	0.012	0.049
Intermittent Vent				
Gas	0.40	3.24	▨	▨
Methane	0.33	2.64	0.012	0.047
VOC	0.031	0.25	0.004	0.018
Continuous Bleed				
Gas	21.54	182.65	▨	▨
Methane	17.23	146.15	0.609	2.585
VOC	1.79	15.05	0.247	1.038

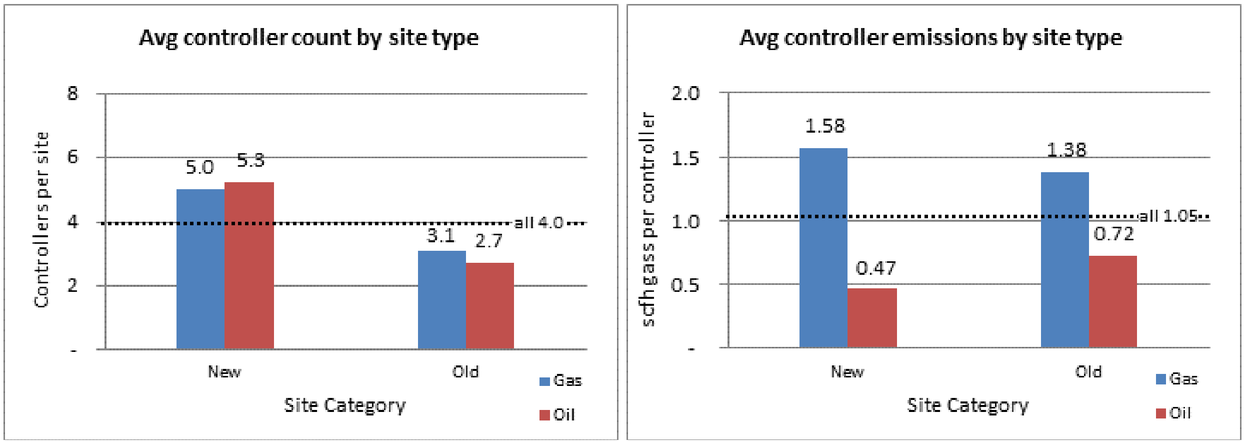
The results for average emissions rates paralleled the results for total emissions from Exhibit 16. VOC emissions were a small portion of the total, controller emissions rates were not significant relative to a site's emissions from all sources, and the cost-effective emissions reduction assessment would be limited to the continuous bleed controllers distributed throughout the sample. The average rates constitute the emissions factors that described this group of controllers. The study's emissions factors are compared to previously published results in Section 4.6.

4.4.Differences by site type

This study collected a number of characteristics to describe each site to help address knowledge gaps in the existing body of work. There has been limited information to describe the pneumatic controller differences between new and old sites, oil and gas sites, and sites that have air permits versus those that are permit-exempt. A topic of speculation has also been how pneumatic controllers may vary by company. For these site characteristics, this section shows the differences in count of controllers per site and in emissions.

Exhibit 18 is a comparison of each of the four bins defined by the study. The left hand graph shows the count of controllers divided by the count of sites. The right hand graph shows the average emissions per controller by site type. The average for all controllers in the sample is represented by a horizontal dotted line. Each graph represents all 680 controllers across all 172 visited sites.

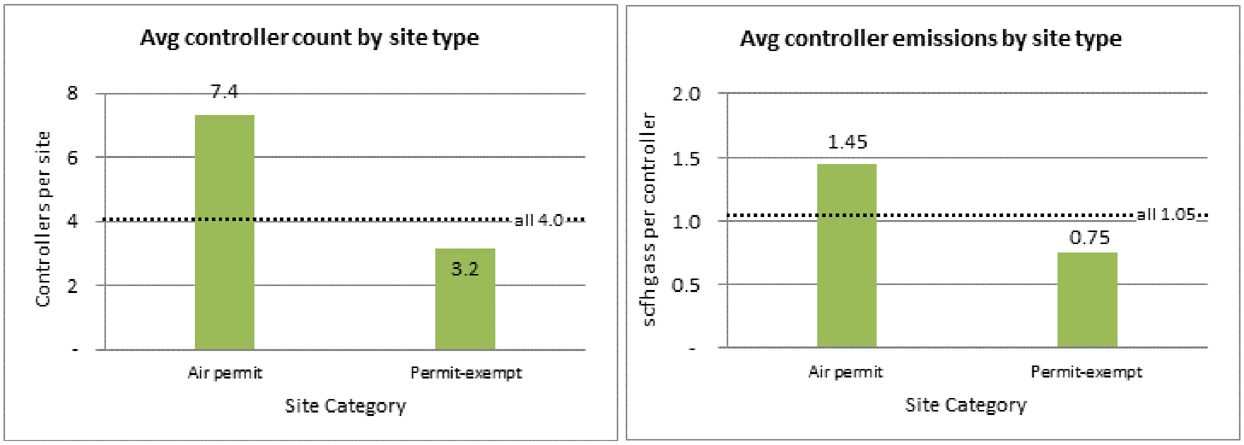
Exhibit 18: Average counts and emissions by site type



The average count of controllers per site value was 2.2 higher for new sites than for old sites. Newer sites were more likely to be multi-well pads and to have additional complexity such as a compressor or an increased number of vessels. A controller on a gas site emitted about 0.97 scfh more on average than a controller on an oil site. This is primarily because 20 of the 21 continuous bleed controllers were found at gas sites. OIPA identified no specific process reasons to differentiate the continuous bleed level controller requirements of gas wells and oil wells.

Exhibit 19 is a set of graphs constructed in the same manner but now distinguishing between sites with state air permits and sites that were permit-exempt.

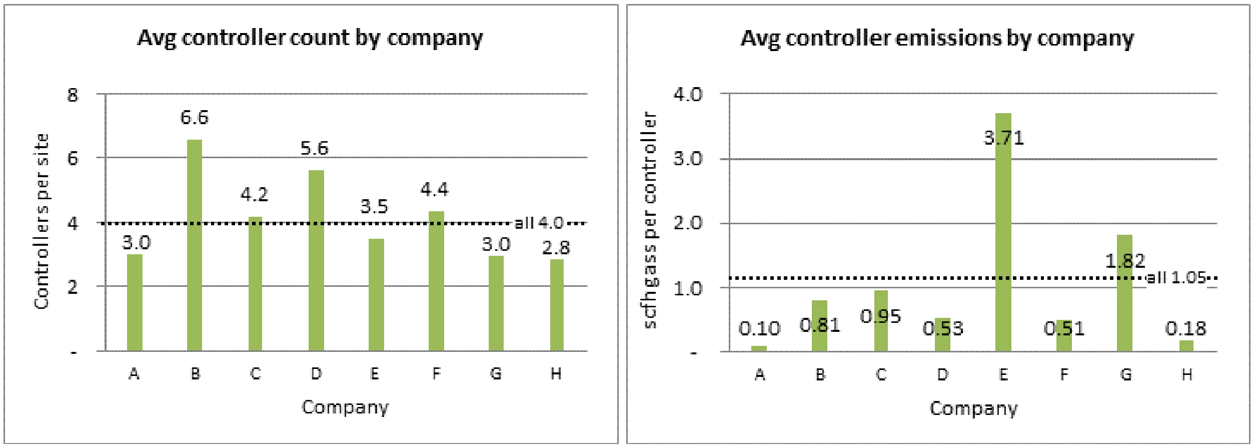
Exhibit 19: Average counts and emissions by site permit status



The count of controllers divided by the count of sites was 4.2 higher for permitted sites than for permit-exempt sites. The difference between these site categories was that sites with air permits were even more recently constructed than the group of sites designated as New. Therefore, permitted sites had a greater likelihood of increased complexity such as compressors or additional process vessels.

Exhibit 20 is a set of graphs constructed in the same manner but now distinguishing between companies.

Exhibit 20: Average counts and emissions by company



The number of controllers per site ranged from 2.8 to 6.6 depending on the company. The average emissions ranged from 0.10 to 3.71 scfh gas per controller depending on the company. Six of the eight company per-controller averages were below the global average. The two companies with rates higher than the global average had the majority of the continuous bleed controllers in the sample.

All per-controller averages presented by this section were below the 6 scfh gas value that has regulatory significance. The average rates of this study were significantly lower than emission factors found in other published work. Section 4.6 includes a more in-depth treatment of emission factor comparisons.

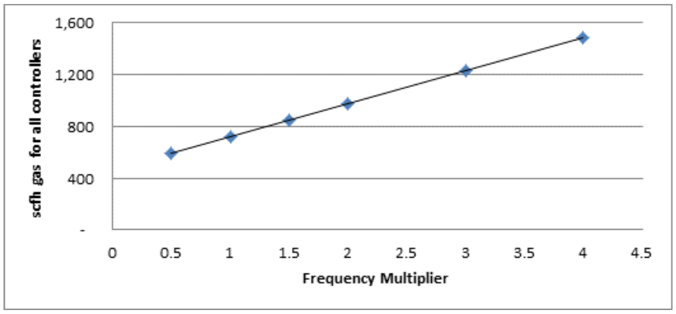
4.5.Sensitivity of assumptions

A sensitivity analysis was conducted on key assumptions. A sensitivity analysis, rather than an uncertainty analysis, was appropriate for the quantification methods employed in the study because the methods gave conservatively high, worst-case emissions rates rather than actual emissions. The default actuation frequency assumption was investigated to demonstrate that it resulted in conservatively high emissions calculations. The assumption of using hexane's molecular weight for all hexanes+ components was investigated to demonstrate that it did not have a significant effect on the results.

The study's assumed default frequency was a worst-case scenario that the controller actuated immediately before and immediately after the 15-minute observation interval. Exhibit 21 shows the actuation frequency sensitivity analysis results. The actuation frequency for each controller in the data set was scaled by the multiplier shown in the first column. This frequency multiplier affected the controller, tubing, and actuator emissions. Although most continuous bleed controllers use bleed gas to actuate the motor valve, OIPA determined that some continuous bleed controllers possibly had separate supply gas for actuation. Therefore, the frequency multiplier also affected continuous bleed controller, tubing, and actuation emissions even though this is an overestimate. The multiplier also affected the emissions rates of controllers that did not actuate but were assigned a default actuation frequency. A multiplier of one represented the base case. For each multiplier, the emissions from all controllers were summed and then divided by the total emissions in the base case. The percent of base case emissions is shown in the second column. A graphical representation of the analysis is shown below the table.

Exhibit 21: Actuation frequency sensitivity

Actuation frequency multiplier for all controllers	Resulting % of total scfh gas
0.5	82%
1	100%
1.5	118%
2	136%
3	172%
4	208%



The sensitivity results were linear in accordance with the engineering calculation in Exhibit 11, where the intercept was equal to the bleed and seepage rates of the sample. An increase or decrease in actuation frequency by a factor of 0.5 increased or decreased total emissions by about 18%. The emissions rate for sampled controllers approximately doubled if the assumed actuation frequency is increased by a factor of four to once every 3.75 minutes. The multipliers themselves also overestimate the effect of actuation frequency since actuator emissions for continuous bleed controllers are represented as a separate stream of supply gas rather than from the continuous bleed stream.

The sensitivity analysis demonstrated that the study results are conservatively high emissions estimates. All controllers were assigned the same frequency multipliers for convenience. Many controller types that defaulted to the assumed frequency were believed to actuate on the order of per day, week, or year. For comparison, a frequency of once per week would correspond to a multiplier of about 0.0015.

It is plausible but unlikely that any observation interval could have underestimated the actuation frequency if a controller actuated immediately before observation, actuated once during observation, and actuated once immediately after observation. The potential for this situation occurred at controllers with a single observed actuation, which was a total of six controllers. For the entire sample, this scenario equates to a multiplier of about 1.03. The sensitivity analysis indicates that this situation does not significantly affect the results.

The common method to represent the hexanes+ molecular weight was also subjected to a sensitivity investigation. This study used the molecular weight of hexane to represent the hexanes+ component of VOC emissions. The hexanes+ value was typically a smaller component of VOC emissions compared to lighter VOCs and thus did not influence the total lbs/hour calculation significantly. To demonstrate this, the sensitivity analysis doubled the hexanes+ molecular weight. The lbs/hr VOC emissions increased by a factor of approximately 1.05 which confirms that the common method used by this study was reasonable.

4.6. Comparison with other studies

OIPA reviewed the existing body of pneumatic controller emissions quantification work prior to designing the study. This section first compares methodologies and results of selected studies and then applies the other results to the OIPA sample to assess if they are representative of the emissions observed during data collection.

Exhibit 22 shows the methodologies and key traits from a selection of previous studies. These studies are compiled and discussed in greater detail in Sections 6.1 and 6.2.

Exhibit 22: Methods and sample size of previous studies

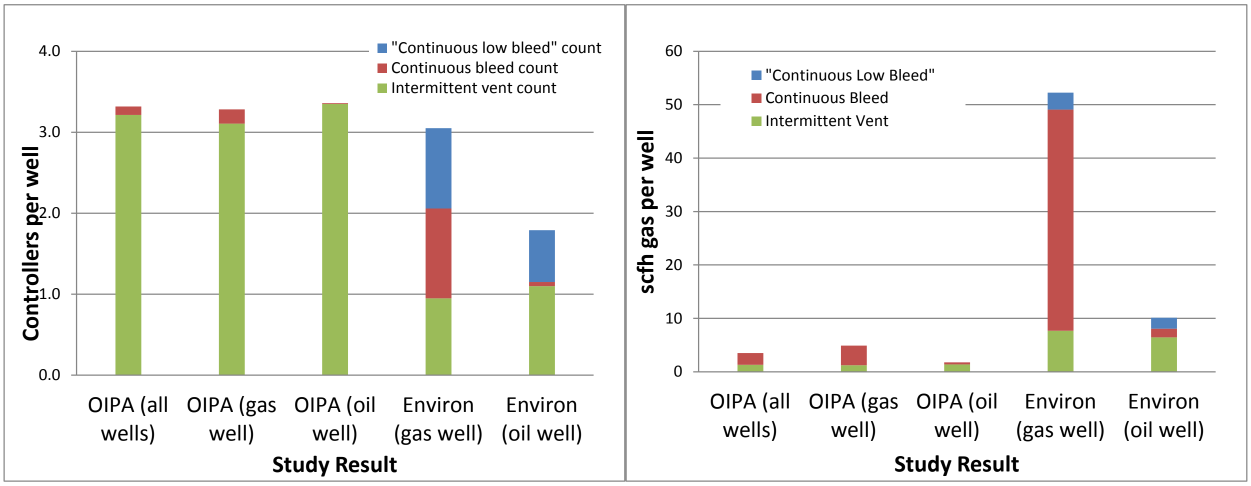
Emissions Quantification Methodology	Number of Sites	Number of Controllers	Remarks
GRI/EPA 1996. Sampling year 1992.			
Connected a flow meter to supply gas line between pressure regulator and controller to measure gas consumption of controller. A cumulative flow rate and the current flow rate (scfh) were recorded and extrapolated to gas consumption per day. For steady state operating conditions, one data point was taken for 15-20 minutes. For variable flow rates, several one-hour measurements were taken. Also used data from other reports.	22 onshore production sites for controller counts Unknown site count from data in other reports/ studies	35+9+7 separate devices quantified using data from the other reports/ studies	•The controller count data requires interpretation, as lines of data and columns of data did not match. Some count values were out of the expected range. The average controller count per site was 191 with a range of 1 to 999. •The study noted that emissions in the field can be higher than manufacturer data due to nozzle corrosion resulting in more flow through a larger opening; broken or worn diaphragms, bellows, fittings, and nozzles; corrosives in the gas leading to erosion or corrosion of control loop internals; improper installation; and lack of maintenance, such as replacement of supply gas filter; foreign material lodged in the pilot seat; and wear in the seal seat.
ERG/Sage 2011. Sampling years 2010 and 2011.			
At each site an IR camera survey was made to find detectable vents or leaks for all equipment including pneumatic controllers. Then a toxic vapor analyzer was used to obtain a pats-per-million-volume (ppmv) reading. Vents and/or leaks detectable by an IR camera or with a measured concentration over 500 ppmv were measured with a Hi Flow Sampler for an unknown time interval, though an entire Hi Flow Sampler run was stated to last approximately 3 to 5 minutes. Canister samples were also taken in conjunction with some Hi Flow Sampler measurements, but it is not known if canister samples were used specifically for pneumatic controller emissions.	375 well pads, 8 compressor stations, 1 processing facility, 1 saltwater treatment facility, 1 drilling operating, 1 fracturing operating, 1 flowback	489 pneumatic valve controllers with emissions detectable by IR camera or an emissions concentration over 500 ppmv	•The results do not represent an average emissions rate since an unknown, but likely large, number of controllers that had no detectable emissions were not included in the data set. •The emissions measured in this study included both the controller's design vent rates (either continuous bleed or intermittent vent during the measurement interval) plus any leaks due to wear and tear and other factors.
UT/EDF 2013. Sampling year not found.			
•Vented and/or leak emissions were measured using a Hi Flow Sampler. The sampling time interval was not reported. Large differences in rates of emissions were noted. The smallest non-zero emission rate measured by the Hi Flow system was determined to be 0.00048 scf per minute, and therefore the detection limit was assumed to be less than or equal to that value.	Approximately 150 production sites from nine participants	305 randomly selected pneumatic controllers	•At the first sites (unknown number), only those controllers showing vented and/or leak emissions detectable by an IR camera were measured. At later sites, random pneumatic controllers were measured. The study treated both data sets as one after a statistical analysis showed no systematic difference. •The reported results for average emissions rates from low bleed controllers and from intermittent controllers in the study subject to interpretation since controller types are not well-documented. In an attempt to explain potential reasons for the large variation of emissions (factor of ten) between the Gulf Coast area and the Rocky Mountain area, the authors offer controller definition as one possibility. This issue does not affect the average emissions rate reported for both types of controllers taken together. •Emissions are biased high since only those controllers with significant detectable emissions were measured for the first set of measurements. Since the first data set contained controllers with non-detectable emissions, those controllers would need to be added to the total data set before obtaining representative average vent and/or leak rates. •No "continuous low bleed' controllers were encountered. •Measured emissions included vent rates (either continuous bleed or intermittent vent) plus any leaks due to wear and tear and other factors.
Prasino 2013. Sampling year 2013.			
A Calscan Hawk 9000 Vent Gas Meter was used to measure "bleed rate". This method allowed for "time series bleed rate values" and for automatic pressure and temperature correction. One noted disadvantage is backpressure on the bleed gas being measured. Additional data collected included controller type, make and model; controller action (throttling or snap-acting); condition of controller; and gas type. Flow measurement time was 30 minutes or until 2 cubic feet of gas emitted from the controller was collected. It was noted that even a 30 minute time period produced a wide range of rates for intermittent controllers depending on whether, and if so, how many times, the control valve was actuated.	"30 different producing fields"	765	•Based on measurements from this study, mean average bleed rates for "continuous high bleed" controllers (9.2 scfh) are 75% less than the U.S. EPA default value of 37.3 scfh used in Subpart W GHG reporting calculations. •Based on measurements from this study, mean average bleed rates for "high intermittent bleed" controllers (8.8 scfh) are 35% less than the U.S. EPA default value of 13.5 scfh used in Subpart W. •Emissions results include any equipment leaks.

The comparison of study methods indicated that:

- Each of the four selected studies used metering as a key component of pneumatic controller emissions quantification, indicating that one gap in the existing body of work is use of engineering calculations. Simpson provided a detailed discussion of problems introduced when using meters to quantify pneumatic controller emissions[9] that can be avoided by using engineering calculations.
- Three of the four selected studies chose only emitting controllers for measurement. While emitting controllers can generate more interest from research teams, the results are biased towards higher emitting controllers. The majority of controllers observed by OIPA did not emit. Additionally, emitting controllers do not generate emissions continuously over an annual period, such as when they are disconnected, when intermittent vent controllers are not actuating the motor valve, or when the well is shut in.
- Each of the four selected studies incorporates the unknown portion of a controller's emissions that is a leak rather than an intentional release. For any given controller, the percentage of the metered value that is a leak is unknown and can range from 0 to 100%. A future research area would be to record one set of measurements to represent a controller's base case emissions and then record emissions again after a leak detection and repair case. Combining leaks and pneumatic controller emissions into a single value introduces ambiguity in inventories. Combined emissions data increases the difficulty of emissions mitigation since reduction options for leaks are different from pneumatic controllers. Replacement, refurbishment, or retrofit of a pneumatic controller does not address the root cause of equipment leaks in the same manner as leak detection and repair. Because of terminology inconsistencies between studies, it is unknown if intermittent vent controllers with continuous leaks were measured and analyzed as continuous bleed controllers. Such a scenario would over-represent the number of continuous bleed controllers encountered by a study and suggest an emissions reduction solution that does not address the emissions.

Exhibit 23 compares the average controller counts and average emissions per well from this study to the recent Environ study[2]. The Environ study developed average controller counts per well and emission factors for both oil wells and gas wells using a combination of literature values and industry surveys. The Environ study includes results by county in Oklahoma, so the exhibit takes averages of all Environ county results so that results can be compared. The exhibit also includes the "continuous low bleed" controller category which is a term not used by this study but is necessary to convey the entirety of the Environ results.

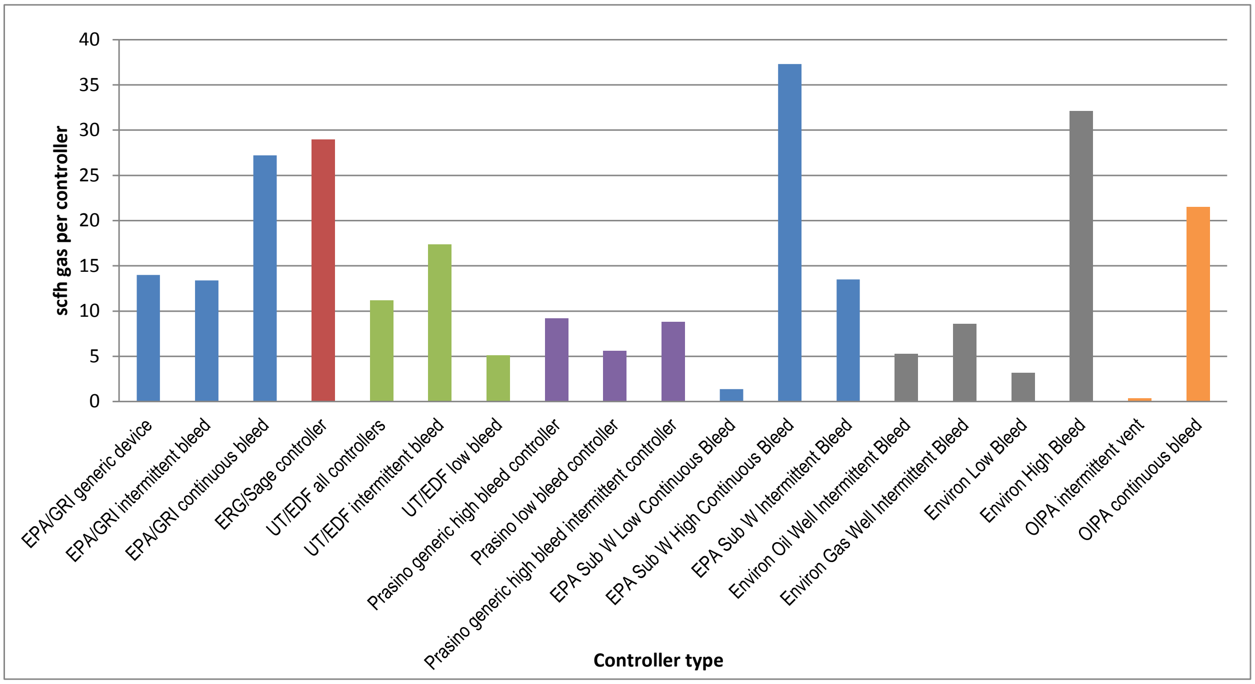
Exhibit 23: Counts and emissions per well from OIPA and Environ studies



The Environ study counts per well are lower than what was found in the OIPA sample. Environ's average gas well controller count is lower by a factor of 0.93. Environ's average oil well controller count is lower by a factor of 0.53. Although the counts are lower, Environ's results over predict emissions in the OIPA sample. For gas wells, the Environ results overestimate emissions per well from the OIPA data set by a factor of 10.6. For oil wells, the Environ results overestimate emissions per well from the OIPA data set by a factor of 5.8. The Environ results overestimate emissions in the OIPA sample because of the mix of controller types and the emissions factors. Environ shows more continuous bleed and "continuous low bleed" controllers per well than what was observed in the OIPA sample. Each Environ emission factor is also higher than the corresponding OIPA factor. The two most significant contributors to the overestimate are the larger than actual continuous bleed controller count and the larger intermittent vent emissions factor.

Exhibit 24 compares emissions factors from different studies. Each combination of study and controller type is represented as a bar on the x-axis. Emissions in scfh gas are represented on the y-axis. Controller terminology and definitions are not necessarily consistent between studies. Since studies report emissions in different units, all results were converted to an scfh gas basis. This exhibit applied a molecular weight of 18 to convert the ERG/Sage factor into uniform units. The exhibit took an average of all pneumatic controller models in the Prasino study under 6 scfh gas to develop the "low bleed controller" factor, where each model had equal weighting. Further discussion of numerical results from previous studies is covered in Section 6.1.

Exhibit 24: Comparison of Emissions Factors



The OIPA continuous bleed controller emissions factor is of the same magnitude as many results from previous studies. Factors from other studies ranged from 0.1 to 1.7 times the OIPA continuous bleed factor. Most factors lower in magnitude than the OIPA continuous bleed factor were associated with "intermittent" or "low bleed" controller labels which are not directly comparable.

The OIPA intermittent vent controller emissions factor is lower than all other emission factors. When using factors from the previous studies to represent the OIPA sample, intermittent vent controller emissions are overestimated by factors ranging from 3.5 to 93. The factor closest in magnitude is the "low continuous bleed pneumatic device vents" factor from 40 CFR 60 Subpart W, but intermittent vent and continuous bleed are mutually exclusive categories of pneumatic controllers and not directly comparable.

The most commonly encountered model in the OIPA sample was the Kimray 212 SGT-BP which is an intermittent vent controller. For these controllers, the average emissions were 0.10 scfh gas. Among the emission factor options from other studies, the closest match was the 1.39 scfh gas "low continuous bleed pneumatic device vents" factor from 40 CFR 60 Subpart W, but this factor was not applicable since the 212 SGT-BP is not a continuous bleed controller. The most applicable Subpart W factor is the 13.5 scfh gas "intermittent bleed" factor, which overestimates emissions by a factor of 33.7. Use of the other emission factors is not representative of observed emissions from these controllers, and many other controller models in the OIPA sample had the same issue.

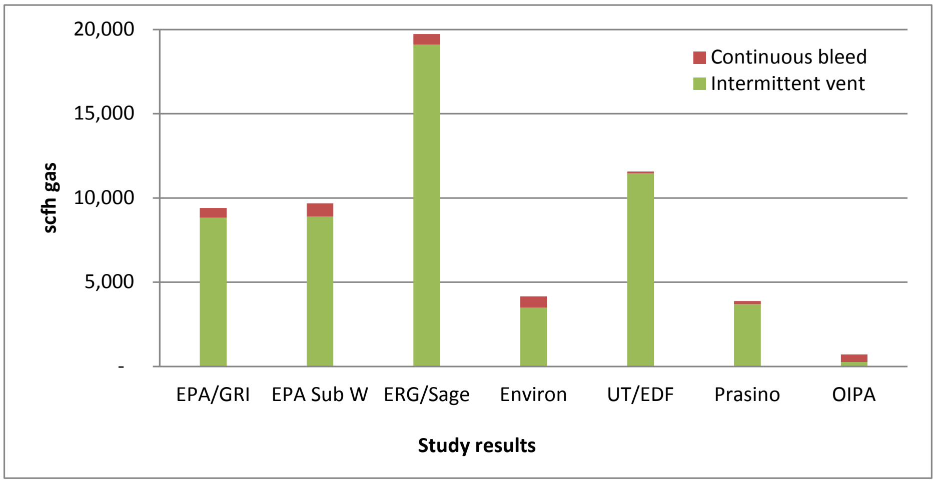
In the exhibit, the span of the emissions factors is two orders of magnitude, and an assortment of terms are used to describe the pneumatic controllers. The factors from other studies are not capable of representing emissions from the sampled OIPA controllers because:

- it is not clear that the same equipment was considered a pneumatic controller from study to study,
- it is not clear that a pneumatic controller of a particular make and model would be classified consistently from study to study,

- it is not clear how to apply these factors to common controller models found in the OIPA sample, and
- quantification methods differ from study to study as further discussed earlier in this section and in Section 6.1.

Exhibit 25 shows the emissions from all 680 controllers in the OIPA sample when using emission factors from different studies. Each bar represents a specific study or report. The magnitude of each bar represents the predicted emissions from the OIPA controller sample when using the emissions factors from that study. For each study, the most applicable emissions factor was chosen to represent the 569 intermittent vent controllers in the OIPA sample, and the most applicable emissions factor was chosen to represent the 21 continuous bleed controllers in the OIPA sample. No "continuous low bleed" factors were used since OIPA did not encounter any such controllers.

Exhibit 25: Emissions from OIPA controllers estimated using different study results



The exhibit illustrates that the existing body of work overestimates emissions from the OIPA controller sample. The degree of overestimation ranged from a factor of 5.4 in the Prasino study to a factor of 27.5 in the ERG/Sage study. The OIPA results show that the majority of emissions occur from a small count of continuous vent controllers, but use of methods from other studies would incorrectly indicate that the majority of emissions occur from a large count of intermittent vent controllers. Therefore, the intermittent vent emission factors used in other work is a poor representation of emissions from controllers in the OIPA sample. The choice of intermittent vent controller quantification method is important since intermittent vent controllers are 97% of the OIPA sample.

5. Conclusions

This study addressed knowledge gaps in previous work by introducing an up-to-date sample, collecting new data types, improving quantification methods, and using more transparent terminology. The results provided new data that can be used to validate the results of other emissions quantification work. For intermittent vent controllers, other studies used lower controller counts and much higher emissions factors than the randomly selected examples of this study. For continuous bleed controllers, other studies used higher controller counts and an emission factor that is too high but of the appropriate magnitude to represent the sample.

Intermittent vent controller counts in other studies were lower than results found here likely due to this study's use of an expansive pneumatic controller definition. Emissions estimates from other studies were higher than results found here likely due to knowledge gaps that a) overestimated the population of continuous bleed controllers, and b) overestimated the emissions of intermittent vent controllers by several orders of magnitude. The OIPA emission factors developed for the sampled controllers employed a number of assumptions that significantly over-estimated emissions, but the results did not approach the magnitude of previous factors. Continuous bleed controllers are responsible for the majority of emissions in the sample, but count of continuous bleed controllers was low at the visited sites. Intermittent vent controllers generated a minimal quantity of emissions relative to all emission sources at a production facility. Thus, this study provided evidence to eliminate previous knowledge gaps and develop more representative assumptions to characterize production site pneumatic controller emissions.

This study also reported on controller makes, models, and functions. This information can help explain the controller definition inconsistencies, which was a contributor to discrepancies between previous studies. Without explicit and consistent controller definitions, an emissions estimate will have subjective interpretations about what well pad equipment constitutes a pneumatic controller.

This study was the first known effort to investigate pneumatic controller differences between new, old, oil, gas, permitted, and permit-exempt sites. The most significant difference was between controller counts at new sites and old sites in the sample. New sites had 2.2 more controllers on average because some newer sites had more process units. This characteristic was further emphasized in the difference of 4.2 controllers per site between permitted and permit-expect sites. The group of permitted sites generally represented the most recently constructed and most complex sites amongst all sites visited. This study also found differences in average controller emissions rate between site types, but these differences were not significant given that all emission rate averages in this study are much lower than previous studies.

This study provided comparative examples rather than inferential statistics. The intent was to provide real examples that are useful to assess the magnitude of other estimates. The results were sufficient to characterize emissions for each pneumatic controller during its observation period and to develop reasonable estimates of each controller's emissions over an annual period in proximity to the observation period. The following is a discussion of representativeness based on OIPA company dialogue and the sensitivity analysis:

- The pneumatic controller counts and emissions were characteristic of the sampled sites only. Several site-specific parameters made it impractical to extrapolate these findings, such as the availability of electric power or instrument air; process conditions that tolerate use of mechanical controls; company-specific operating procedures; differing design decisions to set equipment on the pad or off the pad; pad complexity; and operational changes over time.

- The number of controllers per major piece of equipment was characteristic of the sampled sites only. While certain equipment types suggest the presence of pneumatic controllers, the OIPA study team encountered a variety of control solutions that invalidate the use of ratios for scale up. First, the use of mechanical, electronic, and/or hydraulic controls was commonplace. The number of non-pneumatic controllers, and their placement within a process, varied from site to site. Second, there was not a one-to-one matching of a control need to a controller count. For example, the study team encountered anywhere between zero to three temperature controllers for a heating process, depending on the design. Multiple controllers can be used in series to ensure high temperature shutdown, low liquid level shutdown, and maintaining temperature about a set point.
- The methane and VOC compositions were characteristic of the sampled sites only. Compositions vary significantly from site to site. This study collected site-specific compositions to avoid extrapolation uncertainties and to demonstrate the composition variability. An average value was a poor representation of any single site in this sample and would be a poor representation of other sites outside of this sample.

6. Appendices

6.1.Literature review

OIPA identified the body of work quantifying oil and gas production pneumatic controller emissions such as studies, surveys, inventories, economic emissions reduction analyses, and reports. OIPA selected four efforts for a detailed written review to identify strengths, weaknesses, and opportunities upon which the OIPA study can build. The remainder of section 4.6 is a discussion of this past work. As discussed in Section 1.1, Section 6.2, and elsewhere, pneumatic controller terminology is not consistent between investigators. OIPA's review cites the terminology of the reviewed studies which was not necessarily in agreement with the terminologies and definitions in the OIPA study. In addition to terms and definitions, another point of incompatibility was that the reviewed studies incorporated some type of direct measurement. This creates methodology differences where the OIPA study is not affected by metering problems and measurement errors discussed by Siimpson[9], and the reviewed studies include any equipment leak emissions that are expressed at the controller's exhaust port while the OIPA study does not.

1996 GRI/EPA: Pneumatic Devices

Gas Research Institute (GRI)/U.S. Environmental Protection Agency. 1996c. Research and Development, Methane Emissions from the Natural Gas Industry, Volume 12: Pneumatic Devices. June 1996. (EPA-600/R-96-080l). www.epa.gov/gasstar/tools/related.html

Study Goal:

- Quantify annual methane emissions from the natural gas industry. 1992 baseline. The study addressed pneumatic devices for production sites, gas processing, and transmission. Only the production (upstream) is reviewed here.

Controller Definitions:

- "A pneumatic device is a mechanical device operated by some type of compressed gas."
- "There are two primary types of pneumatic devices that discharge natural gas; 1) control valves that regulate flow, and 2) gas-actuated block valves."
- "The controller bleed rate may be intermittent – alternating between bleeding gas to the atmosphere and not bleeding gas – or the controller may continually bleed gas at various rates (throttling)."
- Table 3-1 lists 1) snap-acting intermittent, 2) throttling intermittent, and 3) throttling continuous bleed, but not snap-acting continuous bleed.
- "These devices can have two distinct bleed modes: a stationary bleed rate and an actuating bleed rate. The stationary bleed is the rate of gas released when the signal is constant, and the device is not moving. For intermittent bleed controllers, the stationary bleed rate is zero. For continuous bleed controllers, the stationary bleed rate is non-zero; it is required to maintain a constant gas supply to the device to provide for a quick response to changes in the controlled process."
- Two controller designs: 1) orifice flapper for continuous bleed and 2) snap-acting for intermittent.
- "Depending on the design of the controller, the stationary position may or may not involve a continuous bleed rate. However, the actuation cycle, which is the actual movement or stroke of the valve stem from open to closed and back, always results in the release of gas. This cycle only

occurs when the signal changes and control is needed. The frequency of this occurrence will be different for every application."

- "The various parameters that can affect the yearly average actuating bleed rate for a snap-acting or throttling device are: 1. Number of full stroke cycles per year (how often the valve makes a full stroke cycle); 2. Actuating chamber size; and 3. Supply gas pressure."

Data Collected:

- 1992 Base Year
- Measured emissions from other studies, manufacturer's data, and data collected from site visits
- 1. Basic device type (intermittent versus continuous bleed), the instrument manufacturer, and model number were gathered from several sites by visual inspection; 2. Instrument populations; 3. Supply gas pressure and type; and 4. Field measurements of continuous bleed devices were provided from existing sources."

Method for Site Selection:

- Not addressed, though many data points came from other reports/studies.

Sampling Methods:

- Methods used for the data obtained from a Canadian Producers Association (CPA) report were not provided.
- The industry data in Table 4-4 and for intermittent bleed devices were derived by having a contractor connect a flow meter to the supply gas line between the pressure regulator and the controller to measure the gas consumption of the controller. A cumulative flow rate and the current flow rate (scfh) were recorded and extrapolated to gas consumption per day. For steady state operating conditions, one data point was taken for 15-20 minutes. For variable flow rates, several one-hour measurements were taken.

Data Used to Determine Emissions Factors:

- Included data from a CPA report that measured 19 snap-acting devices with average of 213 scfd (8.88 scfh) and 16 throttling devices with average of 94 scfd (3.9 scfh).
- Table 4-3 Manufacturer Bleed Rate for Continuous Bleed Pneumatic Devices: 0 scfd to 2150 scfd (89.6 scfh).
- Table 4-4 Measured Emission rates for Continuous Bleed Devices. This was survey data provided by Tenneco Gas Transportation, 1994 and Chevron, 1995. Data was for nine (9) onshore and nine (9) offshore devices. For the 18 devices measured, data ranged from 108 scfd (4.50 scfh) to 2,334 scfd (97.2scfh). Average for production facilities of 872 scfd (36.3 scfh). Note that 36 scfh has become the EPA standard emission factor for continuous high bleed pneumatic devices.
- The study included industry data for seven (7) intermittent bleed devices at onshore production facilities. Measurements ranged from 211 scfd (8.79 scfh) to 950 scfd (40 scfh), with an average of 511 scfd (21.3 scfh).
- The study conducted a count of pneumatic devices at 22 onshore production sites to determine a representative fraction of intermittent bleed versus continuous bleed devices. Table 4-5 showed 0.35 +/- 43% as continuous bleed and 0.65 +/- 43% as non-continuous bleed.

Average Count per Site:

- Table 4-5 summarized the counts of devices at 22 onshore production sites, but the data requires subjective interpretation as lines of data and columns of data did not match and some values were out of the expected range. However, the final totals showed 4,204 devices for an average of 191 per site with a range of 1 per site to 999 per site.

Methane Concentration:

- The study used a methane concentration of 78.8% by volume.

Average SCFH per Controller:

- The study determined a "weighted methane emission factor" for a "generic" device of 345 scfd (14 scfh) based on a "selected natural gas emission factor" of 323 scfd (13.4 scfh) for intermittent bleed and 654 scfd (27.2 scfh) for continuous bleed and the methane concentration of 78.8%. Note that 13.5 scfh is now the EPA default emission factor for intermittent controllers for GHG reporting in Subpart W for onshore petroleum and natural gas production.

Special Notes:

- Table 4-3 noted that the Invalco CT Series had a design bleed rate from 510 scfd (21 scfh) to 960 scfd (40 scfh), but that "a retro kit is available for this series of devices to reduce the typical bleed rate from 960 scfd to less than 22 scfd (0.9 scfh)." This suggests that 'retrofit kits" were available as early as 1992 for converting continuous high bleed controllers to intermittent controllers.
- The reference to "snap-acting" was to describe how a pilot valve worked to change a weak control pressure signal to a strong actuator supply pressure signal which is not consistent with OIPA's definitions.
- The study noted that emissions in the field can be higher than reported manufacturer's data due to nozzle corrosion resulting in more flow through a larger opening; broken or worn diaphragms, bellows, fittings, and nozzles; corrosives in the gas leading to erosion or corrosion of control loop internals; improper installation; and lack of maintenance, such as replacement of supply gas filter; foreign material lodged in the pilot seat; and wear in the seal seat.

ERG/Sage City of Fort Worth Study

Eastern Research Group, Inc. and Sage Environmental Consulting, LP. 2011. City of Fort Worth Natural Gas Air Quality Study: Final Report. Prepared for the City of Fort Worth. July 13, 2011. fortworthtexas.gov/uploadedFiles/Gas_Wells/AirQualityStudy_final.pdf

Study Goal:

- Main goals were to determine how much air pollution was being released by natural gas exploration in Fort Worth, did sites comply with environmental regulation, how emissions affect off-site air pollution levels, and if the city's required setbacks protect public health. Information about emissions from pneumatic controllers was incidental to the overall goals of this study.

Controller Definitions:

- No attempt was made to distinguish between types of pneumatic controllers as the study was concentrated on equipment components, including controllers that were considered to be venting (either continuous bleed or intermittent) and/or leaking sufficient for detection with an IR camera.

Data Collected:

- Emissions from 489 pneumatic valve controllers that had vent and/or leak emissions detectable by the IR camera were measured.

Method for Site Selection:

- Sites were selected from a large list of site locations for vent or leak surveying on a random basis each day. Site owners had no prior knowledge of the sites selected for sampling.

Sampling Methods:

- At each site an IR camera survey was made to find detectable vents or leaks for all equipment including pneumatic controllers. A Toxic Vapor Analyzer (TVA) was also used to obtain a ppmv reading. Vents and/or leaks detectable by an IR camera or with a TVA measured concentration over 500 ppmv were measured with a Hi Flow Sampler.

Data Used to Determine Emissions Factors:

- Data from the Hi Flow Sampler along with gas concentrations from canister samples (if taken for that specific vent or leak or canister data from other similar sites) were used to determine emissions rates.

Average Count per Site:

- Not reported.

Methane Concentration:

- The study reported emissions as Total Organic Compounds (TOC) and as Volatile Organic Compounds (VOC). Specific methane concentrations were not provided.

Average SCFH per Controller:

- For the 489 pneumatic controllers that were determined to have detectable vent and/or leak emissions, the TOC emissions were estimated to be 3,003 tons per year, or 6.1 tons per year per controller. No specific or average gas concentrations were provided. Using a typical MW of 18 for dry natural gas produced in the Fort Worth area of the Barnett Shale yields a slightly lower rate of 29 scfh.

Special Notes:

- The emissions measured in this study included both the controller's design vent rates (either continuous bleed or intermittent venting during the sample time) plus any leakage due to wear and tear and other factors that can influence leakage. The study indicates that a continuous emissions from a controller is equivalent to a failure of the pneumatic valve controller
- The reported emissions rate for all controllers measured are not indicative of an average rate for controllers since an unknown, but likely large, number of controllers that had no detectable emissions were not included in the data set.

2013 UT/EDF Emissions Study

Allen, David, T., et al. 2013. Measurements of methane emissions at natural gas production sites in the United States. Proceedings of the National Academy of Sciences (PNAS) 500 Fifth Street, NW NAS 340 Washington, DC 20001 USA. October 29, 2013. 6 pgs. www.pnas.org/content/early/2013/09/10/1304880110.full.pdf+html

Study Goal:

- Take direct measurements of methane emissions at onshore natural gas sites to help inform policymakers, researchers, and industry about some of the sources of methane emissions from the production of natural gas.

Controller Definitions:

- No controller definitions were made. The study used whatever the operator of a studied site stated a particular controller to be, either intermittent controller, low bleed controller , or high bleed controller. No high bleed controllers were found in the study. No model numbers or other descriptions are provided in the study paper.

Data Collected:

- Emissions from 305 randomly selected pneumatic controllers were measured. This represented 41% of the total controllers at all the test sites. At the first sites (unknown number), only those controllers showing vented and/or leak emissions detectable by an IR camera were measured. At later tested sites every pneumatic controller was measured. The study treated both data sets as one after a statistical analysis of data using the two approaches showed no systematic difference.

Method for Site Selection:

- Approximately 150 production sites were selected from nine volunteer companies. Selection was made by selecting a range of geographic areas to sample and selecting a minimum number of sampling targets in each area. Typically, production sites were randomly selected but based on proximity to completion sampling sites from a list of potential sites provided by host companies. For the Gulf Coast the study team could make day trips to production sites, so those sites were randomly selected from hundreds of potential sites provided by host companies.

Sampling Methods:

- Vented and/or leak emissions were measured using a Hi Flow Sampler. The sampling time period was not reported. Large differences in rates of emissions were noted (to be expected with a mix of continuous low bleed and intermittent vent controllers). The smallest non-zero emission rate measured by the Hi-Flow system was 0.00048 scfm and therefore the detection limit was assumed to be less than or equal to that value.

Data Used to Determine Emissions Factors:

- Data from the Hi Flow Sampler was used for emissions rate calculations.

Average Count per Site:

- Not reported.

Methane Concentration:

- Based on the reported emissions rates of methane and natural gas, an average methane concentration across all samples of 94 mol% can be inferred (see below).

Average SCFH per Controller:

- The average emissions rate per controller varied from 1.26 scfh for the Rocky Mountain area to 17.3 scfh for the Gulf Coast area. Average emissions rate per controller were 11.2 scfh for all controllers (mix of intermittent bleed and low bleed controllers). For 55 sites where site operators reported only intermittent bleed controllers, an average rate of 17.4 scfh was reported. For 24 sites where site operators reported only low bleed controllers, an average emissions rate of 5.1 scfh was reported.

Special Notes:

- The reported results for average emissions rates from low bleed controllers and from intermittent controllers in the study are somewhat questionable, since the type of controllers measured is not well documented. In an attempt to explain potential reasons for the large variation of emissions (factor of ten) between the Gulf Coast area and the Rocky Mountain area, the authors offer one possibility on page S-31 of the study's Supporting Information: "The definition of low-bleed controllers may be issue, however. All low bleed devices are required to have emissions below 6 scf/hr (0.1 scf/m), but there is not currently a clear definition of which specific controller designs should be classified as low bleed and reporting practices among companies can vary." However, this does not affect the average emissions rate reported for both types of controllers taken together. Results from a second UT/EDF are expected to be published in late 2014.
- The emissions measured in this study included both the controller's design vent rates (either continuous bleed or intermittent venting during the sample time) plus any leakage due to wear and tear and other factors that can influence leakage.
- Emissions from pneumatic controllers in this study are biased high since only those controllers with significant detectable emissions were measured for the first set of measurements. Since the first data set contained controllers with non-detectable emissions, those controllers would need to be added to the total data set before obtaining representative average vent and/or leak rates.

2013 Prasino Group Study

The Prasino Group. 2013. Determining Bleed Rates for Pneumatic Devices in British Columbia; Final Report. Prepared for the Science and Community Environmental Knowledge Fund. December 18, 2013. www.env.gov.bc.ca/cas/mitigation/ggrcta/reporting

Study Goal:

- Determine the average bleed rate of pneumatic controllers and pumps when operating under field conditions in British Columbia for GHG reporting and potentially offset purposes.

Controller Definitions:

- The study was mostly interested in emissions rates from high bleed controllers based on the WCI Reporting Regulation definition of a bleed rate greater than 0.17 m3/h (6 scfh). However, the study included some borderline high/low bleed controllers in an initial list of available controllers by including controllers with manufacturer's bleed rates of 4.2 scfh and higher. The study then developed a list of 15 of the most common controllers used in the field for which measurements would be taken. This list was estimated to represent 97% of the controllers in use. The list included four low bleed controllers based on their common use in the field.
- The study used the term "bleed rate" to mean emissions for continuous bleed controllers, venting from intermittent controllers, and any additional emissions from leakage. "Static bleed rates" are used to describe continuous bleed emissions when actuation is not occurring.

“Dynamic bleed” rates are used to describe continuous bleed emissions when actuation is occurring.

- The study introduced the term “high bleed intermittent” controllers. This is evidently a description for intermittent controllers that had measured average emissions above 6 scfh.

Data Collected:

- The study collected 765 measurements of pneumatic controllers. Except for one model, collected at least 30 measurements for each of the 15 controllers targeted. 64 of the measurements were for controllers classified as “others” rather than one of the targeted controllers.

Method for Site Selection:

- A non-probability technique called opportunistic sampling was used, where sampling locations were chosen purposefully. The method was based mostly on proximity to Fort St. John, exclusion of locations with winter access only, and areas with a high concentration of devices.

Sampling Methods:

- A mass flow meter (Calscan Hawk 9000 Vent Gas Meter) was used to measure the “bleed rate”. This method allowed for “time series bleed rate values” and for automatic pressure and temperature correction. One noted disadvantage to the mass meter is slightly more backpressure on the bleed gas being measured. Additional data collected included the controller type, make and model; controller action (throttling or snap-acting); condition of controller; and gas type.
- A flow measurement sampling time of 30 minutes was used, or until 2 cubic feet of gas was collected. This allowed the measurement to capture all continuous bleed rates plus, for intermittent controllers, capture both the “static” bleed rate and the “dynamic” bleed rate that occurs when the control valve is actuated. It was noted that even a 30 minute time period produced a wide range of bleed rates for intermittent controllers depending on whether, and if so how many times, the control valve was actuated during the 30 minute time period.

Data Used to Determine Emissions Factors:

- Data from the mass flow meter measurements was used to determine average emissions factors for each specific controller and a generic bleed rate for both a High Bleed Controller and a High Bleed Intermittent Controller.
- To determine an average rate, the study used the mean value of all data.

Average Count per Site:

- Not reported.

Methane Concentration:

- Not reported. All bleed rates were in scfh of total gas.

Average SCFH per Controller:

- For all 15 specific model controllers sampled, the mean average bleed rate ranged from 0.53 scfh to 15 scfh. For five specific model controllers that would be considered low bleed controllers (< 6 scfh) based on manufacturer’s specifications, the mean average bleed rate ranged from 1.2 scfh to 9.5 scfh, with an average bleed rate of 5.6 scfh. For those controllers that, based on measured bleed rates, were considered to be High Bleed Controllers, a “generic” average bleed rate of 9.2 scfh was reported. For those controllers that, based on measured bleed rates, were considered to be High Bleed Intermittent Controllers, a "generic" average bleed rate of 8.8 was reported. The mean average bleed rate for the Kimray HT-12 temperature controller (intermittent bleed) was reported as 1.2 scfh.

Special Notes:

- Based on measurements from this study, mean average bleed rates for continuous high bleed controllers (9.2 scfh) are 75% less than the U.S. EPA default value of 37.3 scfh used in Subpart W GHG reporting calculations.
- Based on measurements from this study, mean average bleed rates for what would be considered low bleed controllers based on manufacturer's date (5.6 scfh) are 400% higher than the U.S. EPA default value of 1.39 used in Subpart W.
- Based on measurements from this study, mean average bleed rates for high intermittent bleed controllers (8.8 scfh) are 35% less than the U.S. EPA default value of 13.5 scfh used in Subpart W. If measurement data for any low intermittent bleed controllers, such as the Kimray T-12 (1.2 scfh), were included with the high intermittent bleed controller data, then a lower average bleed rate for all intermittent bleed controllers would be expected.

6.2.Controller Definitions

Previous studies have developed descriptions of pneumatic controller functionality, though the text descriptions are not always in agreement or have been subject to multiple interpretations. A variety of equipment with diaphragms, spring-loaded components, tubing connections, and/or valve seats can be present at a production facility. The equipment present will vary depending on parameters such as the location, production type, vessel upon which it is installed, and company. Some equipment types are commonly not considered pneumatic controllers, such as tank pressure relief valves or pneumatic pumps. Other equipment types may have a nebulous definition depending on the party classifying the equipment. A common example of a piece of equipment with an ambiguous definition is a Kimray SGT/FGT backpressure controller. This type of controller can be installed on a vessel so that its sole function is to act as a pressure relief valve such as those found on pressurized tanks. The controller is configured to send gas to a lower-pressure destination such as a storage vessel, control device, or vent line if the high pressure set point is reached. In this application, the backpressure controller will vent supply gas through an exhaust port when pressure on the diaphragm is above the pressure setting. The vented supply gas is a separate stream from the process gas relieved across the opened valve. In this situation, the classification of a pneumatic controller versus a pressure relief valve is interpretive. As a second example of subjectivity, some equipment at production sites may have its pneumatic function limited to a motor valve while the control function is carried out via electronic, hydraulic, or other means. An additional component to a controller definition is frequency of emissions. Many controllers actuate infrequently, on the order of a few actuations per day, per month, or per year depending on the controller. Controllers of all actuation frequencies often share a common definition, and as a result a single emissions factor is a poor representation of such a controller grouping.

Terminology used to describe how controllers emit to the atmosphere is also inconsistent. Exhibit 26 is a selection of definitions and descriptions from different references.

Exhibit 26: Inconsistent Definitions Describing "Bleed"

Definition/Description	Reference
"A pneumatic device is a mechanical device operated by some type of compressed gas." "There are two primary types of pneumatic devices that discharge natural gas; 1) control valves that regulate flow, and 2) gas-actuated block valves." "The controller bleed rate may be intermittent – alternating between bleeding gas to the atmosphere and not bleeding gas – or the controller may continually bleed gas at various rates (throttling)." "These devices can have two distinct bleed modes: a stationary bleed rate and an actuating bleed rate. The stationary bleed is the rate of gas released when the signal is constant, and the device is not moving. For intermittent bleed controllers, the stationary bleed rate is zero. For continuous bleed controllers, the stationary bleed rate is non-zero; it is required to maintain a constant gas supply to the device to provide for a quick response to changes in the controlled process." "Depending on the design of the controller, the stationary position may or may not involve a continuous bleed rate. However, the actuation cycle, which is the actual movement or stroke of the valve stem from open to closed and back, always results in the release of gas. This cycle only occurs when the signal changes and control is needed. The frequency of this occurrence will be different for every application." "The various parameters that can affect the yearly average actuating bleed rate for a snap-acting or throttling device are: 1. Number of full stroke cycles per year (how often the valve makes a full stroke cycle); 2. Actuating chamber size; and 3. Supply gas pressure."	EPA/GRI 1996. Methane Emissions from the Natural Gas Industry. www.epa.gov/gasstar/tools/related.html
"Continuous bleed means a continuous flow of pneumatic supply natural gas to the process control device (e.g. level control, temperature control, pressure control) where the supply gas pressure is modulated by the process condition, and then flows to the valve controller where the signal is compared with the process set-point to adjust gas pressure in the valve actuator" "High-bleed pneumatic devices are automated, continuous bleed flow control devices powered by pressurized natural gas and used for maintaining a process condition such as liquid level, pressure, delta-pressure and temperature. Part of the gas power stream that is regulated by the process condition flows to a valve actuator controller where it vents continuously (bleeds) to the atmosphere at a rate in excess of 6 standard cubic feet per hour. "Intermittent bleed pneumatic devices mean automated flow control devices powered by pressurized natural gas and used for automatically maintaining a process condition such as liquid level, pressure, delta-pressure and temperature. These are snap-acting or throttling devices that discharge all or a portion of the full volume of the actuator intermittently when control action is necessary, but does not bleed continuously." "Low-bleed pneumatic devices mean automated flow control devices powered by pressurized natural gas and used for maintaining a process condition such as liquid level, pressure, delta-pressure and temperature. Part of the gas power stream that is regulated by the process condition flows to a valve actuator controller where it vents continuously (bleeds) to the atmosphere at a rate equal to or less than six standard cubic feet per hour."	40 CFR 98 Subpart A www.ecfr.gov/cgi-bin/text-idx?SID=593e5e37be5c3e7ba2e85a4cb6479315&node=se40.21.98_16&rgn=div8
"Bleed rate means the rate in standard cubic feet per hour at which natural gas is continuously vented (bleeds) from a pneumatic controller." "Continuous bleed means a continuous flow of pneumatic supply natural gas to the process control device (e.g., level control, temperature control, pressure control) where the supply gas pressure is modulated by the process condition, and then flows to the valve controller where the signal is compared with the process set-point to adjust gas pressure in the valve actuator." "Pneumatic controller means an automated instrument used for maintaining a process condition such as liquid level, pressure, delta-pressure and temperature."	40 CFR 60 Subpart OOOO www.ecfr.gov/cgi-bin/text-idx?SID=7a126adb4fe9f7e9056273a955236a5a&node=40:7.0.1.1.1.103&rgn=div6#se40.7.60_15430

Definition/Description	**Reference**
“The continuous bleed type uses a stream of gas which is constantly flowing through a tiny nozzle to atmosphere. Near the set point a small flapper moves close to the nozzle causing back pressure which works internally to actuate the de- vice being controlled”. “The very elements of design which allow the pilot to operate without any detectable dead-band or lag in control, do not allow for the necessary elements for tight shut-off. For this reason a small amount of gas will normally seep from the vent of the pilot. This is defined as bleed rate.”	Kimray Tech Bulletin #C109201 dnn.kimray.com/KimPedia/tabid/185/loc/print/Page/Tech-Bulletin-C109201-GenII-Bleed-Rate/language/en-US/Default.aspx
The bulletin provides emissions quantifications for intermittent (snap and throttle) liquid level controllers and does not explicitly define “bleed.” The bulletin cites 40 CFR 60 Subpart OOOO.	Norriseal Technical Bulletin No. 120802 www.norriseal.com/files/comm_id_47/NOR_Bulletin_No.120802_080912.pdf
The study did not distinguish between types of pneumatic controllers as the study was concentrated on equipment components, including controllers that were considered to be venting and/or leaking sufficiently for detection with an IR camera. “Pneumatic Valve Controllers were the most frequent emission sources encountered at well pads and compressor stations. These controllers use pressurized natural gas to actuate separator unloading valves. Under normal operation a pneumatic valve controller is designed to release a small amount of natural gas to the atmosphere during each unloading event. Due to contaminants in the natural gas stream, however, these controllers eventually fail (often within six months of installation) and begin leaking natural gas continually.”	Eastern Research Group, and Sage Environmental Consulting. City of Fort Worth Natural Gas Air Quality Study: Final Report. July 13, 2011. fortworthtexas.gov/uploadedFiles/Gas_Wells/AirQualityStudy_final.pdf
“Pneumatic devices are control devices located at the well site that are powered pneumatically by high-pressure produced gas. These devices are typically under operation throughout the year and they may or may not vent the working fluid during operation, making them a potentially significant source of VOC emissions.” … “Here it is assumed that four configurations can be found in a typical well: high bleed, low bleed, intermittent and no bleed.”	Environ 2012. 2011 Oil and Gas Emission Inventory Enhancement Project for CenSARA States www.deq.state.ok.us/aqdnew/Emissions/OilandGasAreaEmissions/Final_Report_CenSara_122712.pdf
No controller definitions were made.	Allen, David, T., et al. 2013. Measurements of methane emissions at natural gas production sites in the United States. Proceedings of the National Academy of Sciences (PNAS) 500 Fifth Street, NW NAS 340 Washington, DC 20001 USA. October 29, 2013. www.pnas.org/content/early/2013/09/10/1304880110.full.pdf+html

Definition/Description	**Reference**
The study used the term “bleed rate” which includes bleed rates for continuous bleed controllers, venting from intermittent controllers, and any additional emissions from leakage. The study used the term “high bleed intermittent” controllers. This is evidently a description for intermittent controllers that had measured average emissions above 6 scfh. “Static bleed rates” are used to describe continuous bleed emissions when actuation is not occurring. “Dynamic bleed” rates are used to describe continuous bleed emissions when actuation is occurring. “Pneumatic controllers and pumps use pressurized fuel gas to perform operations such as pressure control, temperature control, liquid level controller and chemical injection. This fuel gas is subsequently released to the atmosphere after the operation is performed. The bleed rate of a pneumatic device is defined as the amount of fuel gas released to the atmosphere per hour.”	The Prasino Group. 2013. Determining Bleed Rates for Pneumatic Devices in British Columbia; Final Report. Prepared for the Science and Community Environmental Knowledge Fund. December 18, 2013. www.env.gov.bc.ca/cas/mitigation/ggrcta/reporting.
“Process controllers are devices that sense a physical state (process variable) and direct an end device to take an action to modify that physical state. The choice of end device is largely immaterial to the amount of motive-force media that is released or where it is released. As discussed previously, this discussion is limited to local and remote pneumatic and electropneumatic controllers. There are many ways to classify pneumatic and electropneumatic controllers, but they can be completely defined with two parameters: • Service: Is it used for on/off control, or does it throttle the process? • Depressurization method (Table 2): Does it bleed supply gas continuously (continuous bleed), or does it vent actuation gas at the end of the on cycle (intermittent vent)?”	Simpson, David A. “Pneumatic Controllers in Upstream Oil & Gas.” SPE Oil and Gas Facilities. October 2014. www.spe.org/ogf/print/

Some references use “bleed” as a synonym for “emission.” Some references use “bleed” to classify controllers that are not intermittent. Some references use “bleed” to describe the portion of controller emissions that occurs when the controller is not moving the actuator. The wording from different studies/reports therefore has the possibility to interact in incompatible ways. One reference’s definition must match another for numerical results to be directly comparable. Thus, one reason why numerical results from different studies are not in agreement is that the type of emissions and the type of controllers being studied are not described clearly enough and may be different from study to study.

6.3.Study Design Considerations

To develop this study’s methodology, OIPA investigated the key variables that affect controller emissions and evaluated the variety of data collection methods.

Variables affecting emissions: Exhibit 27 is a list of variables that can affect controller emissions. With field data collection in mind, OIPA described the variables using two categories, 1) if a variable is possibly available before traveling to the site and 2) if a variable pertains to the entire site or the specific controller. Due to variations in records across companies, not all parameters designated as known a priori were available. The table also lists common issues identified during OIPA discussions that make quantification so difficult for this emissions source category and potential solutions during data collection.

Exhibit 27: Variables Affecting Pneumatic Controller Emissions

Variable	*Known a priori?*	*Site or Controller Basis?*	*Data Collection Issues*	*Potential Solutions*
Controller age	y	Site	Controller age typically not available, especially if nameplate is missing or illegible	Use date of first production at site as a surrogate, although controllers may be replaced after start of production and as

Variable	*Known a priori?*	*Site or Controller Basis?*	*Data Collection Issues*	*Potential Solutions*
				equipment is removed and exchanged
Supply gas composition	y	Site	•Gas composition varies based on type of production and geologic formation •Gas composition may vary across the site	•Collect compositional analysis from each site rather than relying on assumptions and regional averages that are not representative •Gas analyses are commonly performed at the gas meter. Differences across a site were discussed and determined to be negligible
Oil or gas site	y	Site	Subjectivity in determining this	Use OCC definitions if available
Site has permit or is permit-exempt	y	Site	N/A	N/A
Count of controllers per site	Y	Site	A consistent method is needed to determine what constitutes a controller	Use Simpson paper[9] for consistent controller definition. Collect data on any item that is not clearly a spring-loaded or weighted pressure relief valve and not a pneumatic pump. This includes digital valve controllers or solenoids that use a non-natural-gas-pneumatic signal to actuate a valve using pressurized natural gas.
Controller manufacturer and model	y	Controller	Nameplate or stamp not always visible	Take photo so that make/model can be inferred later or so that similar looking controllers can be grouped together as being of the same unknown model
Controller type: continuous throttle, continuous on/off, intermittent vent throttle, intermittent on/off	y	Controller	A continuous bleed rate is non-constant in its magnitude	Continuous bleed emissions are a function of the supply pressure, the gas gravity, and the orifice size. Manufacturer gas consumption charts typically only have the rate at maximum supply pressure.
Actuator manufacturer and model	y	Controller	Nameplate or stamp not always visible in the field	Take photo so that make/model can be inferred later or so that similar looking controllers can be grouped together as being of the same unknown model
For intermittent vent controllers, dimension of the bonnet/diaphragm housing and supply gas tubing to estimate the gas released if the entire volume is depressurized during an actuation.	n	Controller	N/A	N/A
Vessel attributes (flow rate, vessel dimensions, volume per liquid dump, pressures, temperatures)	y	Controller	•Equipment sizing affects actuation frequency. A larger vessel may dump a larger liquids volume each actuation than a	•Record vessel type, its function in the process, and its dimensions •Record the data collection stop and start time. Use SCADA if

Variable	*Known a priori?*	*Site or Controller Basis?*	*Data Collection Issues*	*Potential Solutions*
			smaller vessel. •The spot throughputs during data collection may not be available if data is recorded at daily or hourly time increments	available; otherwise convert flow rates to an average spot rate
Controller settings (high and low set points in the process affect when controller actuates)	n	Controller	Impractical to determine this without clear knowledge of vessel baffling and the set points	This may be a data point for a few sites but not all
Controller maintenance condition	n	Controller	A clear set of descriptors is required. Any fugitive losses would need to be identified and possibly quantified	This study is not focused on leaks and will not collect leak data
Controller stroke frequency	n	Controller	•Some intermittent vent controllers may actuate over a time interval that is too long to be useful for a data collection effort that visits multiple sites per day. A temperature controller on a heater burner pilot may not actuate at all in a 24 hour period •Some controllers have actuation volumes that are small enough that there is a risk of non-detection using olfactory/visual/auditory techniques. Not all actuations are as obvious as liquids dumps.	•Options: a) determine the minimum emissions rate that is of interest for this study and then determine the observation time based on this rate. b) determine the maximum practical observation time and back-calculate the potential rates that this would produce if one actuation occurred during that time. c) each company can monitor the first site in each bin for a longer duration of time with the goal of trying to observe at least one actuation, then the others will be monitored for a shorter duration •It may be possible to detect actuation by the gauge reading, a process condition change, or by placing tape or soap solution at the exhaust point.
Supply gas pressure	n	Controller	Some controllers/ instruments may not take supply gas from a supply pot and may instead regulate the gas pressure internally in the controller body	Data sheet may need space to record the controller settings and readings for any gauges on the controller
Tubing and diaphragm housing dimensions	n	Controller	Some tubing may be inaccessible (buried, elevated, etc)	For some tubing lengths, conservative assumptions may be necessary
Presence of absence of a “relay”	n	Controller	“Relay” is another term requiring a deliberate and transparent definition. A “relay” can increase the emissions of the controller/actuator system.	Controllers with a “relay” are assumed to increase emissions by a factor of three, based on input from a technology expert. An example of such a control setup may be where a controller sends signal gas to another controller at higher supply pressure to actuate a large valve.

Because of the large number of variables influencing a controller’s emissions, it is impractical for this study to isolate and investigate the effect of each in a controlled situation. To collect practical examples based on variables that are likely of value to other investigators, OIPA chose two primary variables: oil/gas site classification and site age classification. For data collection, OIPA targeted a wide range of site ages and a roughly equal proportion of oil vs gas sites. Although the operators involved with this study effort generally had equipment inventories and pneumatic controller counts available a priori, there were still instances in which equipment may have been switched out since the most recent inventorying effort. Additionally, there were sites selected that did not have any pneumatic controllers on location. OIPA included these sites within the broader study selection and analysis. Many site and controller characteristics were available prior to site selection. For some companies, a parameter designated as known a priori in the above exhibit may not have been available due to variations in each company’s records. As a result, the only site parameters accessed before data collection were location, oil/gas site, and age.

Controller designs and models change over time, and a controller’s state of repair may also be an emissions issue. Controllers, like all equipment, will deteriorate over time when used in the field which may cause emissions increases. Addressing deterioration is a combination of maintenance and leak repair issues. Controller selection is a separate area of responsibility from site operations and maintenance. Additionally, older controllers may be located at sites with more production decline than newer controllers, which can affect the actuation frequency. Controller age is not typically tracked and is difficult or impossible to determine in the field.

The presence of an air permit or exemption is also a site characteristic, and the extent to which it is indicative of pneumatic controller emissions is unknown and not previously studied. Based on company experiences, permit-exempt sites are likely to be characterized as older sites while sites with air permits are likely to be characterized as new sites. Although there may be overlap between the site characteristic of age and permit status, it is informative to include both as a dimension in the data analysis.

Methods to quantify emissions: In Exhibit 28, OIPA identified the potential methods to collect pneumatic controller emissions rate data and evaluated this list to choose the appropriate methods for this study. The data collection methods require careful consideration due to the complexity of pneumatic controller emissions profiles. Controllers do not emit at a steady rate or according to a universal cyclic pattern. Controllers do not always have a discrete exhaust port, and the same controller make/model can be used with different equipment and set to numerous different configurations. For these reasons it is impractical to collect mass rate measurements over a short time scale (matter of minutes or hours) and present them as characteristic of pneumatic controller emissions.

Exhibit 28: Quantification methods

Method	*Pros*	*Cons*	*Outcome*
Vendor literature values for gas consumption in units of [scf gas / hour]	-Reduces complexity of the study if emissions rates are already determined	-Only available for continuous bleed controllers, so this approach did not cover the majority of controllers -Will need to contact manufacturer for a better understanding of how the gas consumption value was determined	Included in study for continuous bleed rates
Vendor literature values for actuator volume in units of [scf gas / each actuation]	-Reduces complexity of the study if emissions rates are already determined	-Only available for certain models	Included in study for actuation volumes if available
Engineering calculations	-May be only option in the absence of manufacturer literature	-May be difficult to determine the number of actuations and/or volumetric dimensions for some controllers in the field	Included in study for actuation volumes, when manufacturer actuation volumes were unknown
Direct measurement using high volume sampler in units of [scf gas / hr]	-Emissions of the specific controller in the field will be quantified	-Intended for a steady state continuous emissions source, but controller emissions will be unsteady -Some controllers may not have an exhaust port that lends itself to direct measurement using high flow sampler attachments -Attachment of a meter affects flow out of the controller's exhaust port	Did not include in study
Direct measurement using turbine meter in units of [scf gas / hour]	-Emissions of the specific controller in the field will be quantified	-Some controllers may not have an exhaust port that lends itself to direct measurement with this meter that requires a flanged or screwed fitting -Attachment of a meter affects flow out of the controller's exhaust port -Meters may not be capable of representing the non-continuous emission rates from controllers	Did not include in study
Hooking up a pressurized cylinder, counting the actuations and other activity, and weighing the cylinder before and after.	-Eliminates uncertainty with vendor data or volumetric estimates	-Requires process modification which requires additional time, equipment, and staffing resources	Did not include in study. Too impractical for this study.

6.4.Methodology discussion

After OIPA identified key variables affecting emissions and the available quantification methods, it developed a data collection methodology. This section conveys OIPA's decision-making discussion as the methodology was being developed.

<u>Sample Size:</u> The sample size was determined by the resources available to devote to the study. The level of effort included staff time to organize the study, travel time to each site, data collection time for each site, and staff time to prepare the data and results. The result of the OIPA company discussion was a consensus that ten sites per company was a reasonable upper bound on an individual company's level of effort. A more rigorous statistical evaluation of variable stratification and sample size was not conducted because the results of this study are not intended to be scaled to a larger population of controllers; however, the sample size is designed to take advantage of multiple sites and operators in the State of Oklahoma in a short period of time.

Geographic Areas: The number of sites in the sample provided adequate coverage of oil and gas production operations across the state. OIPA defined six geographic areas based on the below table.

OK geographic area	*Counties*
Granite Wash	Beckham, Custer, Kiowa, Roger Mills, Washita , Greer
Mississippian	Alfalfa, Garfield, Grant, Kay, Major, Noble, Payne, Woods, Osage, Logan, Woodward, Harper
Woodford (Cana)	Blaine, Caddo, Canadian, Custer, Dewey, Kingfisher, Grady
SCOOP	Garvin, Grady, McClain, Stephens, Carter, Murray
Arkoma (Woodford)	Coal, Atoka, Hughes, Pittsburgh, Latimer, Haskell, LeFlore
Marmaton	Ellis, Texas, Beaver, Harper

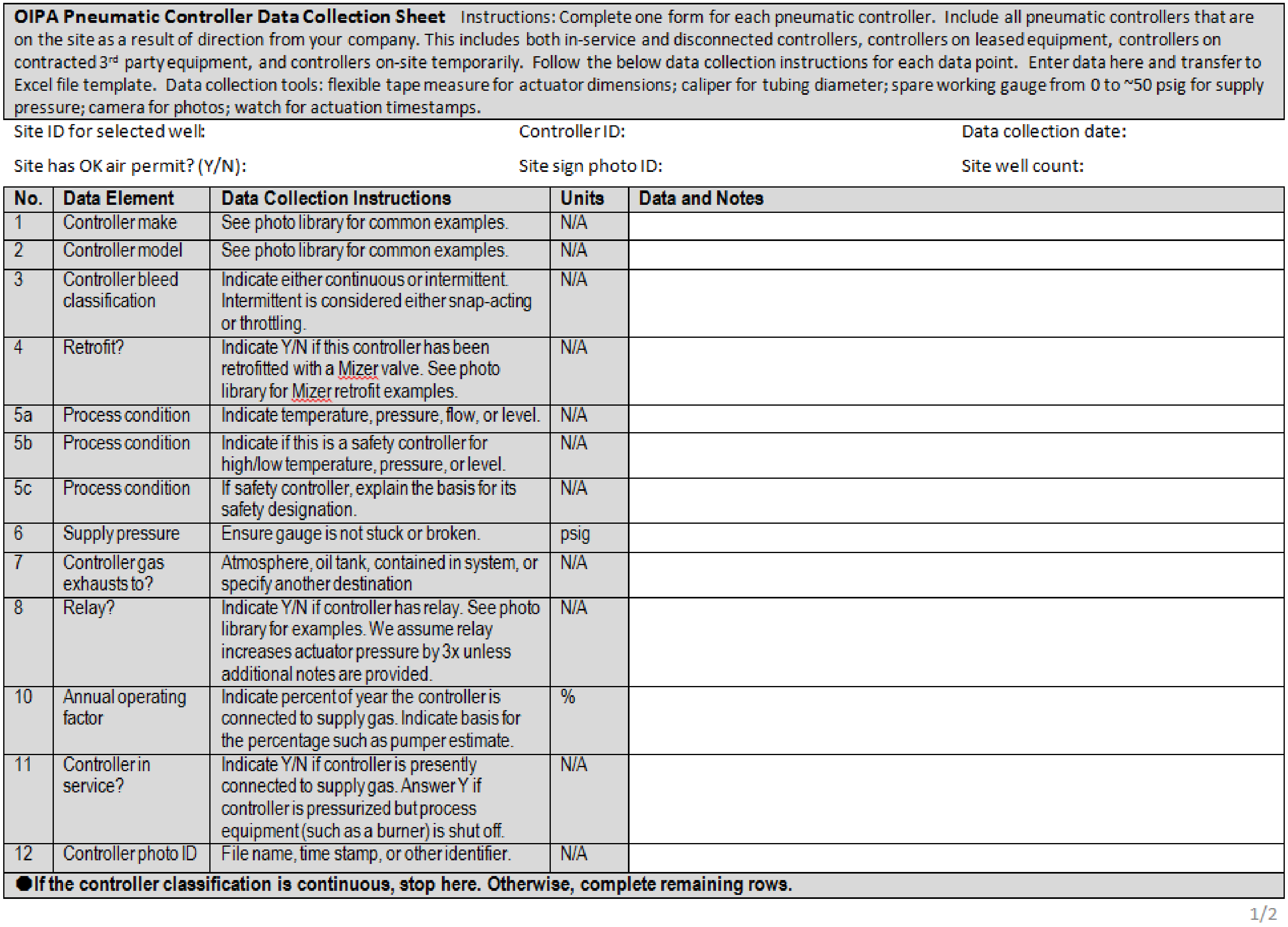
Production Type: Within a given geographic area, site types can be further subdivided into oil or gas sites. This study investigated differences between oil and gas sites since there were different counts, and different controller functions, depending on if the site is designed for oil or for gas production. The oil or gas classification is typically done at the well bore level, not the site level. Companies classified each of their sites as either oil or gas based on the regulatory filing made with the OCC.

Selection Bins and Biases: This study thus established six geographic areas of study, where each area has four bins for data collection: New Oil, New Gas, Old Oil, and Old Gas. The study intended to assign two companies to each geographic area so that a single bin was not unduly influenced by a single company's facilities design or production strategy.

Based on the study goals, there was an equal emphasis to all four bins in each area, and the intent was to collect approximately the same amount of data for each of the four bins. Some areas may not have had a large population of sites for a given bin. For example, oil development areas may have a small population of gas sites. These types of limitations were not investigated beforehand due to resource constraints and the study goal to collect example data. As a result, the count of sites in each bin was not equal. Giving equal emphasis to oil versus gas and new versus old introduces biases into the sampling because each bin is given equal representation in the sample size, but the number of sites in each bin statewide is not equal. OIPA considered this bias to be acceptable since it did not conflict with the study goal of characterizing pneumatic controller counts and emissions for a selected sampling of controllers across the state.

The results were not intended to be scaled up to represent a larger controller population. The study did not define the total population of sites in each site type nor attempt to assign strata in the study design to assess the statistical significance of the samples. The study also did not exhaustively identify all factors that may have an impact on controller counts and emissions, nor investigate confounding variables influencing the site types being studied. Variables such as the original owner, equipment age (as opposed to site age), and equipment supplier have an uncharacterized impact on controller emissions. The samples were taken from a population of Oklahoma wells operated by eight independent producing companies of various sizes (company size has a variety of metrics which are not explored by this study) with an unestablished representativeness to other companies. The results of this study cannot be extrapolated to account for variables such as availability of electric power, facility design, equipment age, gas composition, company-specific standards, and cold versus warm ambient conditions. Additionally, well count per pad varies widely based on company operating strategies, facility age, geologic formation, and other characteristics. The prevalence of different equipment packagers, difference operating conditions, different operating strategies, and different availabilities of non-pneumatic controllers throughout the country mean that the study results were not demonstrated to be representative of national emissions. The emissions factors cannot be paired with controller counts that use different controller definitions. Resource and scheduling constraints, in addition to an incompatible study goal, meant that these scaleup issues were not addressed.

6.5.Data collection sheet



OIPA Pneumatic Controller Data Collection Sheet Instructions: Complete one form for each pneumatic controller. Include all pneumatic controllers that are on the site as a result of direction from your company. This includes both in-service and disconnected controllers, controllers on leased equipment, controllers on contracted 3rd party equipment, and controllers on-site temporarily. Follow the below data collection instructions for each data point. Enter data here and transfer to Excel file template. Data collection tools: flexible tape measure for actuator dimensions; caliper for tubing diameter; spare working gauge from 0 to ~50 psig for supply pressure; camera for photos; watch for actuation timestamps.

Site ID for selected well:
Controller ID:
Data collection date:

Site has OK air permit? (Y/N):
Site sign photo ID:
Site well count:

No.	Data Element	Data Collection Instructions	Units	Data and Notes
1	Controller make	See photo library for common examples.	N/A	
2	Controller model	See photo library for common examples.	N/A	
3	Controller bleed classification	Indicate either continuous or intermittent. Intermittent is considered either snap-acting or throttling.	N/A	
4	Retrofit?	Indicate Y/N if this controller has been retrofitted with a Mizer valve. See photo library for Mizer retrofit examples.	N/A	
5a	Process condition	Indicate temperature, pressure, flow, or level.	N/A	
5b	Process condition	Indicate if this is a safety controller for high/low temperature, pressure, or level.	N/A	
5c	Process condition	If safety controller, explain the basis for its safety designation.	N/A	
6	Supply pressure	Ensure gauge is not stuck or broken.	psig	
7	Controller gas exhausts to?	Atmosphere, oil tank, contained in system, or specify another destination	N/A	
8	Relay?	Indicate Y/N if controller has relay. See photo library for examples. We assume relay increases actuator pressure by 3x unless additional notes are provided.	N/A	
10	Annual operating factor	Indicate percent of year the controller is connected to supply gas. Indicate basis for the percentage such as pumper estimate.	%	
11	Controller in service?	Indicate Y/N if controller is presently connected to supply gas. Answer Y if controller is pressurized but process equipment (such as a burner) is shut off.	N/A	
12	Controller photo ID	File name, time stamp, or other identifier.	N/A	

●If the controller classification is continuous, stop here. Otherwise, complete remaining rows.

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13a	Observed actuations	Record observation start time. For liquid dumps, do not test controller or otherwise manually dump liquids beforehand.	hh:mm:ss	
13b	Observed actuations	Record time(s) of any actuation(s).	hh:mm:ss	
13c	Observed actuations	Indicate how each actuation was detected (sound, gauge move, stem travel, etc).	N/A	
13d	Observed actuations	Record end time for observing actuations. Observe controller for 15 minutes.	hh:mm:ss	
14	Estimated actuation rate	Estimate actuation rate and explain its basis. Use experience, expert judgment, SCADA, plunger timers, or other site-specific info. For SCADA info such as plunger runs, provide actuation count for the calendar day of this site's data collection. This row is necessary because actuations may be infrequent and not observed while collecting data. Default assumptions: 15 mins for level controller; 60 mins for temperature controller; weekly for liquid level float on flare knockout vessel.	minutes / stroke	
15	Actuator make	N/A	N/A	
16	Actuator model	N/A	N/A	
17a	Actuator volume	Use flexible tape measure for actuator diameter. Default assumption is that each actuation causes max stem travel, and entire actuator volume is emitted to atmosphere.	in	
17b	Actuator volume	Use tape measure for actuator height.	in	
17c	Actuator volume	Use tape measure for max actuator stem travel.	in	
18a	Tubing volume	Use flexible tape measure to determine length of tubing that contains supply gas.	in	
18b	Tubing volume	Use caliper for tubing diameter.	in	
19	Actuator gas exhausts to?	Controller only (most common), atmosphere, contained in system, or specify other destination.	N/A	
20	Actuator photo ID	File name, time stamp, or other identifier.	N/A	
21	Gas composition	Supply one representative gas composition for all sites in this area based on the most recent sample taken at a gas meter run.	Mole fraction	

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6.6.Site and controller data

Company Identifier	Site Identifier	Oil or Gas	New or Old	OK County	Site Has OK Air Permit? (Y/N)	Site Well Count
A	1	Gas	New	Grady	N	1
A	2	Gas	Old	Grady	N	1
A	3	Gas	Old	Grady	N	1
A	4	Gas	Old	Grady	N	1
A	5	Gas	New	Grady	N	2
A	6	Oil	New	Grady	N	1
A	7	Oil	Old	Grady	N	1
A	8	Gas	Old	Grady	N	1
A	9	Gas	Old	Grady	N	1
A	10	Oil	Old	Grady	N	1
A	11	Oil	Old	Kingfisher	N	1
A	12	Gas	Old	Kingfisher	N	1
A	13	Gas	Old	Kingfisher	N	1
A	14	Gas	Old	Kingfisher	N	1
A	15	Gas	Old	Kingfisher	N	1
A	16	Gas	Old	Kingfisher	N	1
A	17	Gas	New	Kingfisher	N	1
A	18	Gas	New	Kingfisher	N	1
A	19	Oil	Old	Kingfisher	N	1
A	20	Oil	Old	Kingfisher	N	1
B	21	Gas	Old	Custer	N	1
B	22	Oil	Old	Custer	N	1
B	23	Gas	New	Washita	N	1
B	24	Gas	Old	Washita	N	1
B	25	Oil	New	Beckham	Y	1
B	26	Gas	New	Roger Mills	N	1
B	27	Gas	New	Roger Mills	N	1
B	28	Gas	New	Roger Mills	N	1
B	29	Oil	New	Roger Mills	Y	1
B	30	Oil	New	Roger Mills	Y	1
B	31	Gas	Old	Garfield	n	1
B	32	Oil	Old	Major	n	1
B	33	Oil	Old	Major	n	1
B	34	Gas	New	Major	n	1
B	35	Gas	Old	Major	n	1
B	36	Oil	New	Major	n	1
B	37	Gas	New	Woods	y	1
B	38	Oil	New	Woods	y	2
B	39	Gas	New	Woods	y	2
C	40	Gas	New	Grady	y	2
C	41	Gas	New	Grady	y	2
C	42	Gas	New	Grady	y	2
C	43	Gas	New	Grady	y	2
C	44	Gas	New	Grady	y	1
C	45	Gas	New	Grady	y	1
C	46	Oil	Old	Stephens	n	3
C	47	Oil	Old	Stephens	n	3
C	48	Oil	Old	Stephens	n	3
C	49	Oil	Old	Stephens	n	1
C	50	Oil	Old	Stephens	n	1
D	51	Gas	Old	Canadian	N	1

Company Identifier	Site Identifier	Oil or Gas	New or Old	OK County	Site Has OK Air Permit? (Y/N)	Site Well Count
D	52	Oil	Old	Dewey	N	1
D	53	Gas	Old	Canadian	N	1
D	54	Oil	New	Grant	Y	1
D	55	Oil	New	Grant	Y	1
D	56	Oil	New	Grant	Y	1
D	57	Oil	Old	Dewey	N	1
D	58	Gas	Old	Canadian	N	1
D	59	Gas	Old	Canadian	N	1
D	60	Oil	New	Grant	Y	1
D	61	Oil	New	Grant	Y	1
D	62	Oil	New	Grant	Y	1
D	63	Oil	New	Grant	Y	1
D	64	Gas	Old	Canadian	N	1
D	65	Oil	New	Grant	Y	1
D	66	Oil	New	Grant	Y	1
D	67	Oil	New	Grant	Y	1
D	68	Gas	Old	Canadian	N	1
D	69	Gas	Old	Canadian	N	1
D	70	Oil	New	Grant	Y	1
E	71	Gas	New	Canadian	Y	2
E	72	Gas	New	Canadian	N	1
E	73	Gas	New	Canadian	N	1
E	74	Gas	New	Canadian	Y	2
E	75	Gas	New	Canadian	Y	2
E	76	Gas	New	Canadian	Y	1
E	77	Gas	New	Canadian	Y	3
E	78	Gas	New	Canadian	Y	2
E	79	Gas	New	Canadian	N	1
E	80	Gas	New	Canadian	Y	3
F	91	Gas	Old	Custer	N	1
F	92	Oil	Old	Grady	N	1
F	93	Oil	New	Stephens	Y	1
F	94	Gas	New	Stephens	Y	1
F	95	Oil	New	Garvin	Y	1
F	96	Oil	Old	Custer	N	1
F	97	Oil	New	Garvin	Y	1
F	98	Oil	New	Blaine	Y	1
F	99	Oil	New	Canadian	Y	1
F	100	Oil	Old	Grady	N	1
F	101	Gas	New	Gas	Y	1
F	102	Gas	Old	Grady	N	1
F	103	Gas	Old	Grady	N	1
F	104	Oil	Old	Dewey	N	1
F	105	Gas	Old	Canadian	N	1
F	106	Oil	New	Canadian	Y	1
F	107	Oil	Old	McClain	N	1
F	108	Oil	New	Canadian	Y	1
F	109	Oil	New	Grady	Y	1
F	110	Gas	New	Canadian	N	1
G	111	Gas	Old	Kingfisher	N	1
G	112	Oil	New	Kingfisher	N	1
G	113	Oil	New	Kingfisher	N	1
G	114	Oil	New	Kingfisher	N	1

Company Identifier	Site Identifier	Oil or Gas	New or Old	OK County	Site Has OK Air Permit? (Y/N)	Site Well Count
G	115	Oil	New	Kingfisher	N	1
G	116	Oil	New	Kingfisher	N	1
G	117	Oil	New	Kingfisher	N	1
G	118	Oil	New	Kingfisher	N	1
G	119	Oil	New	Kingfisher	N	1
G	120	Oil	Old	Canadian	N	1
G	121	Gas	Old	Canadian	N	1
G	122	Gas	Old	Canadian	N	1
G	123	Gas	Old	Canadian	N	1
G	124	Gas	Old	Canadian	N	1
G	125	Oil	Old	Canadian	N	1
G	126	Oil	Old	Canadian	N	1
G	127	Gas	old	Beaver	N	1
G	128	Gas	Old	Beaver	N	1
G	129	Gas	Old	Beaver	N	1
G	130	Gas	Old	Beaver	N	1
G	131	Gas	Old	Beaver	N	1
G	132	Oil	New	Beaver	N	1
G	133	Oil	New	Beaver	N	1
G	134	Oil	New	Beaver	N	1
G	135	Oil	New	Beaver	N	1
G	136	Oil	New	Beaver	N	1
G	137	Oil	New	Beaver	N	1
G	138	Oil	New	Beaver	N	1
G	139	Oil	New	Beaver	N	1
G	140	Oil	New	Beaver	N	1
G	141	Oil	New	Beaver	N	1
G	142	Oil	New	Beaver	N	1
G	143	Oil	New	Beaver	N	1
G	144	Oil	New	Beaver	N	1
G	145	Oil	New	Beaver	N	1
H	146	Gas	Old	Garfield	N	1
H	147	Gas	Old	Garfield	N	1
H	148	Gas	Old	Garfield	N	2
H	149	Gas	Old	Garfield	N	1
H	150	Gas	Old	Alfalfa	N	1
H	151	Gas	Old	Major	N	1
H	152	Gas	Old	Major	N	1
H	153	Gas	Old	Major	N	1
H	154	Gas	Old	Major	N	1
H	155	Gas	New	Major	N	1
H	156	Gas	Old	Major	N	1
H	157	Gas	Old	Major	N	1
H	158	Gas	Old	Major	N	1
H	159	Gas	New	Coal	N	1
H	160	Gas	New	Coal	N	1
H	161	Gas	New	Coal	N	1
H	162	Gas	New	Pittsburg	N	1
H	163	Gas	New	Hughes	N	1
H	164	Gas	New	Hughes	N	1
H	165	Gas	New	Hughes	N	1
H	166	Gas	New	Hughes	N	1
H	167	Gas	New	Hughes	N	4

Company Identifier	Site Identifier	Oil or Gas	New or Old	OK County	Site Has OK Air Permit? (Y/N)	Site Well Count
H	168	Gas	New	Hughes	N	4
H	169	Gas	New	Hughes	N	1
H	170	Gas	New	Hughes	N	1
H	171	Gas	New	Hughes	N	1
H	172	Gas	New	Hughes	N	1

Company ID	Site ID	Controller ID	Controller Make	Controller Model	Bleed Classification	Retrofit? (Y/N)	Process Condition	Annual Operating Factor	Actuator Make	Actuator Model	Actuations/ hour From Observation Or Other Company Information
A	1	Back-Pressure, sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99			
A	1	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99			
A	1	BP-Vent-Heater	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99			
A	1	Plunger Lift	IPS	Differential Controller	Intermittent	N	Pressure	0.99	Kimray	2" HPCV with pilot 30 HPG-D	0.29
A	2	Back-Pressure, sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	2	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	2	Plunger Lift	IPS	Differential Controller	Intermittent	N	Pressure	1.00	Kimray	2" HPCV with pilot 30 HPG-D	0.79
A	2	BP-Vent-Heater	Kimray	205-SMT-BP	Intermittent	N	Pressure	1.00			
A	3	Back-Pressure, sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	3	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	3	Plunger Lift	IPS	Differential Controller	Intermittent	N	Pressure	1.00	Kimray	2" HPCV with pilot 30 HPG-D	0.29
A	4	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	4		IPS	Differential Controller	Intermittent	N	Pressure	1.00	Kimray	2" HPCV with pilot 30 HPG-D	0.46
A	5	Back-Pressure, sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	5	BP-Vent-Heater	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	5	burner temp shut off	Kimray	T-12-M	Intermittent	N	temperature	1.00	Kimray	112 SMT	
A	5	Plunger Lift	IPS	Differential Controller	Intermittent	N	Pressure	1.00	Kimray	2" HPCV with pilot 30 HPG-D	0.17
A	5	temp controller	Kimray	T-12	Intermittent	N	temperature	1.00		1" motor valve IM 006 DA	
A	6	Back-Pressure, sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99			
A	6	BP-Vent-Heater	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99			
A	6	Scrubber dump	PCS	PCS 1000	Intermittent	N	timed	0.99	Kimray	1" 1400MSA-PO	0.04
A	7	Back-Pressure, sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	7	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	7	BP-Vent-Heater	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	8	Plunger Lift	IPS	Differential Controller	Intermittent	N	Pressure	0.99	Kimray	2" HPCV with pilot 30 HPG-D	0.96
A	8	Back-Pressure, sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99			
A	8	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99			
A	8	BP-Vent-Heater	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99			
A	9	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	9	Plunger Lift	IPS	Differential Controller	Intermittent	N	Pressure	1.00	Kimray	2" HPCV with pilot 30 HPG-D	0.13
A	10	Back-Pressure, sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	10	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	10	BP-Vent-Heater	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	11	Back-Pressure, sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	11	BP-Vent-Heater	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	11	Plunger Lift	IPS	Differential Controller	Intermittent	N	Pressure	1.00	Kimray	2" HPCV	0.04
A	12	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99			
A	13	Plunger Lift	IPS	Differential Controller	Intermittent	N	Pressure	1.00	Kimray	2" HPCV with pilot 30 HPG-D	1.13
A	13	BP-sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	13	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	14	BP-sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.95			
A	14	BP-Vent-Heater	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.95			

Company ID	Site ID	Controller ID	Controller Make	Controller Model	Bleed Classification	Retrofit? (Y/N)	Process Condition	Annual Operating Factor	Actuator Make	Actuator Model	Actuations/ hour From Observation Or Other Company Information
A	15	BP-sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	15	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	15	BP-Vent-Heater	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	15	Plunger Lift	IPS	Differential Controller	Intermittent	N	temperature	1.00	kimray	2" HPCV	0.17
A	16	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00			
A	17	BP-sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99			
A	17	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99			
A	17	Plunger Lift	TSC	JR w Murphy pressure switch	Intermittent	N	Pressure	0.99	kimray	2" HPCV	0.33
A	18	BP-sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.98			
A	18	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.98			
A	18	Plunger Lift	IPS	Differential Controller	Intermittent	N	Pressure	0.98	kimray	2" HPCV with pilot 30 HPG-D	0.38
A	19	BP-sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.88			
A	19	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.88			
A	19	BP-Vent-Heater	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.88			
A	20	Casing Intermitt valve	TSC	JR-Timer	Intermittent	N	Pressure	0.98	kimray	2" HPCV	0.50
A	20	BP-sales	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.98			
A	20	BP-Vent-Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.98			
A	20	BP-Vent-Heater	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.98			
B	21	GPU lvl 2	Invalco/FMC	CT Flextube	Intermittent	Y	Level	0.92	Kimray	1200 SMS PO	
B	21	GPU lvl 1	Invalco/FMC	CT Flextube	Intermittent	Y	Level	0.92	Kimray	1200 SMS PO	
B	21	GPU tmp 1	Kimray	T-12	Intermittent	N	Temperature	0.92	Kimray	112 SMT	
B	21	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.92	Unknown	Unknown	0.04
B	22	GPU lvl 1	Wellmark/Cemco	6900	Intermittent	Y	Level	0.91	Kimray	1400 SMA PO	
B	22	GPU lvl 2	Wellmark/Cemco	6900	Intermittent	Y	Level	0.91	Kimray	1400 SMA PO	
B	22	GPU tmp 1	Kimray	T-12	Intermittent	N	Temperature	0.91	Kimray	112 SMT	
B	22	GPU tmp 2	Kimray	T-12	Intermittent	N	Temperature	0.91	Same physical actuator as GPU tmp1	Same physical actuator as GPU tmp1	
B	22	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.91	Unknown	Unknown	0.04
B	23	compr pres 1	Kimray	30 PG	Intermittent	N	Pressure	0.90	Kimray	Unknown	
B	23	compr pres 2	Kimray	30 PG	Intermittent	N	Pressure	0.90	Kimray	Unknown	
B	23	compr flow 1	Kimray	PG IA/DA	Intermittent	N	Flow	0.90	Kimray	2200 SMT PO	
B	23	compr lvl 3	Murphy	LS200N	Intermittent	N	Level	0.90	murphy	LS200N	8
B	23	SEP lvl 1	Wellmark/Cemco	6900	Intermittent	Y	Level	0.90	Kimray	1400 SMA PO	
B	23	compr lvl 1	Murphy	LS200N	Intermittent	N	Level	0.90	murphy	LS200N	
B	23	compr lvl 2	Murphy	LS200N	Intermittent	N	Level	0.90	murphy	LS200N	
B	23	compr lvl 4	Murphy	LS200N	Intermittent	N	Level	0.90	murphy	LS200N	
B	23	GPU lvl 1	Wellmark/Cemco	6900	Intermittent	Y	Level	0.90	Kimray	1200 SMS PO	
B	23	GPU lvl 2	Wellmark/Cemco	6900	Intermittent	Y	Level	0.90	Kimray	1200 SMS PO	
B	23	GPU pres 2	Axelson	ESPHL	Intermittent	N	Pressure	0.90	not observed	not observed - Pressure-to-open diaphragm at wellhead	0.04
B	23	GPU pres 1	Axelson	ESPHL	Intermittent	N	Pressure	0.90	not observed	not observed - Pressure-to-open diaphragm at wellhead	0.04
B	23	GPU tmp 1	Kimray	T-12	Intermittent	N	Temperature	0.90	Kimray	112 SMT	
B	23	GPU tmp 2	Kimray	T-12	Intermittent	N	Temperature	0.90	Kimray	112 SMT	
B	24	sep pres 1	Kimray	220 SMT PO	Intermittent	N	Pressure	0.88	Kimray	Integral to controller	
B	24	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.88	Unknown	Unknown	0.04
B	25	compr lvl 3	Murphy	LS200N	Intermittent	N	Level	0.91	murphy	LS200N	60

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B	25	compr pres 1	Kimray	30 PG	Intermittent	N	Pressure	0.91	Kimray	Unknown	
B	25	compr lvl 1	Murphy	LS200N	Intermittent	N	Level	0.91	murphy	LS200N	
B	25	compr lvl 2	Murphy	LS200N	Intermittent	N	Level	0.91	murphy	LS200N	
B	25	compr lvl 4	Murphy	LS200N	Intermittent	N	Level	0.91	murphy	LS200N	
B	25	GPU lvl 1	Wellmark/Cemco	6900	Intermittent	Y	Level	0.91	Kimray	1200 SMS PO	
B	25	GPU lvl 2	Wellmark/Cemco	6900	Intermittent	Y	Level	0.91	Kimray	1200 SMS PO	
B	25	HT pres 1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.91	Kimray	Integral to controller	
B	25	HT pres 2	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.91	Kimray	Integral to controller	
B	25	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.91	Unknown	Unknown	0.04
B	25	GPU temp 1	Kimray	T-12	Intermittent	N	Temperature	0.91	Kimray	112 SMT	
B	26	Sep pres 1	Kimray	PG IA/DA	Intermittent	N	Backpressure	0.90	Kimray	2200 SMT PO	
B	26	Sep lvl 1	Wellmark/Cemco	6900	Intermittent	Y	Level	0.90	Kimray	1200 SMS PO	
B	26	Sep lvl 2	Wellmark/Cemco	6900	Intermittent	Y	Level	0.90	Kimray	1200 SMS PO	
B	26	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.90	Unknown	Unknown	0.04
B	27	GPU lvl 1	Invalco/FMC	CT Flextube	Intermittent	Y	Level	0.89	Kimray	1200 SMS PO	
B	27	GPU lvl 2	Invalco/FMC	CT Flextube	Intermittent	Y	Level	0.89	Kimray	1200 SMS PO	
B	27	GPU pres 3	Dyna-Trol	BXA-107	Intermittent	N	Pressure	0.89	not observed	not observed - Pressure-to-open diaphragm at wellhead	0.04
B	27	GPU temp 1	Kimray	T-12	Intermittent	N	Temperature	0.89	Kimray	112 SMT	
B	27	GPU temp 2	Kimray	T-12	Intermittent	N	Temperature	0.89	Kimray	112 SMT	
B	28	GPU lvl 1	Invalco/FMC	CT Flextube	Intermittent	Y	Level	0.90	Kimray	1200 SMS PO	
B	28	GPU lvl 2	Invalco/FMC	CT Flextube	Intermittent	Y	Level	0.90	Kimray	1200 SMS PO	
B	28	GPU temp 2	Kimray	T-12	Intermittent	N	Temperature	0.90	Unknown	Unknown	
B	28	GPU pres 2	Dyna-Trol	BXA-107	Intermittent	N	Pressure	0.90	not observed	not observed - Pressure-to-open diaphragm at wellhead	0.04
B	28	GPU temp 1	Kimray	T-12	Intermittent	N	Temperature	0.90	Kimray	112 SMT	
B	29	compr pres 1	Kimray	30 PG	Intermittent	N	Pressure	0.91	Kimray	Unknown	
B	29	GPU pres 3	Kimray	30 HPG-D	Intermittent	N	Pressure Reducing	0.91	Kimray	2150 SMT PB	
B	29	GPU pres 2	Kimray	PG IA/DA	Intermittent	N	Backpressure	0.91	Kimray	2200 SMT PO	
B	29	compr pres 2	Kimray	30 PG	Intermittent	N	Pressure	0.91	Kimray	2200 SMT PO	
B	29	compr flow 1	Kimray	30 PG	Intermittent	N	Flow	0.91	Kimray	1400 SMT PO	
B	29	compr lvl 1	Murphy	LS200N	Intermittent	N	Level	0.91	murphy	LS200N	
B	29	compr lvl 2	Murphy	LS200N	Intermittent	N	Level	0.91	murphy	LS200N	
B	29	compr lvl 3	Murphy	LS200N	Intermittent	N	Level	0.91	murphy	LS200N	
B	29	compr lvl 4	Murphy	LS200N	Intermittent	N	Level	0.91	murphy	LS200N	
B	29	GPU pres 1	Kimray	250 SGT BP	Intermittent	N	Backpressure	0.91	Kimray	Integral to controller	
B	29	GPU temp 1	Kimray	T-12	Intermittent	N	Temperature	0.91	Kimray	112 SMT	
B	29	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.91	Unknown	Unknown	0.04
B	30	GPU pres 3	Kimray	30 HPG-D	Intermittent	N	Pressure Reducing	0.89	Kimray	2150 SMT PB	
B	30	GPU pres 2	Kimray	PG IA/DA	Intermittent	N	Backpressure	0.89	Kimray	2200 SMT PO	
B	30	GPU pres 1	Kimray	250 SGT BP	Intermittent	N	Backpressure	0.89	Kimray	Integral to controller	
B	30	GPU temp 1	Kimray	T-12	Intermittent	N	Temperature	0.89	Kimray	112 SMT	
B	30	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.89	Unknown	Unknown	0.04
B	31	HT pres 1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.87	Kimray	Integral to controller	
B	31	GPU pres 1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.87	Kimray	Integral to controller	
B	31	GPU pres 2	Kimray	SP 230	Intermittent	N	Backpressure	0.87	Kimray	Integral to controller	
B	31	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.87	Unknown	Unknown	0.04

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B	32	GPU pres 1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.87	Kimray	Integral to controller	
B	32	GPU pres 2	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.87	Kimray	Integral to controller	
B	32	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.87	Unknown	Unknown	0.04
B	33	GPU pres 1	Kimray	Not available	Intermittent	N	Backpressure	0.91	Kimray	Integral to controller	
B	33	GPU pres 2	Kimray	Not available	Intermittent	N	Backpressure	0.91	Kimray	Integral to controller	
B	33	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.91	Unknown	Unknown	0.04
B	34	GPU pres 1	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	0.92	Kimray	Integral to controller	
B	34	GPU pres 2	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	0.92	Kimray	Integral to controller	
B	34	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.92	Unknown	Unknown	0.04
B	35	GPU pres 1	Kimray	Not available	Intermittent	N	Backpressure	0.91	Kimray	Integral to controller	
B	35	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.91	Unknown	Unknown	0.04
B	36	Mtr pres 1	Kimray	30 HPG-D	Intermittent	N	Pressure Reducing	0.92	Kimray	2400 SMT PB P0	
B	36	GPU pres 1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.92	Kimray	Integral to controller	
B	36	GPU pres 2	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.92	Kimray	Integral to controller	
B	36	HT pres 1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.92	Kimray	Integral to controller	
B	36	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.92	Unknown	Unknown	0.04
B	37	Wellhead pres 1	Kimray	30 HPG-D	Intermittent	N	Pressure Reducing	0.88	Kimray	30 IN FMT 600RF PB	140
B	37	Compr pres 2	Kimray	30 HPG-D	Intermittent	N	Pressure Reducing	0.88	Kimray	2200 SMT PO	
B	37	Compres pres 3	Kimray	30 HPG-D	Intermittent	N	Pressure Reducing	0.88	Kimray	2200 SMT PO	
B	37	Compr pres 1	Kimray	PG IA/DA	Intermittent	N	Backpressure	0.88	Kimray	2200 SMT PO	
B	37	Compr lvl 1	Murphy	LS200N	Intermittent	N	Level	0.88	murphy	LS200N	
B	37	Compr lvl 2	Murphy	LS200N	Intermittent	N	Level	0.88	murphy	LS200N	
B	37	Compr lvl 3	Murphy	LS200N	Intermittent	N	Level	0.88	murphy	LS200N	
B	37	Compr lvl 4	Murphy	LS200N	Intermittent	N	Level	0.88	murphy	LS200N	
B	37	GPU pres 1	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	0.88	Kimray	Integral to controller	
B	37	GPU pres 2	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	0.88	Kimray	Integral to controller	
B	37	Sep pres 1	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	0.88	Kimray	Integral to controller	
B	37	HT pres 1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.88	Kimray	Integral to controller	
B	37	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.88	Unknown	Unknown	0.04
B	38	Wellhead pres 1	Kimray	30 HPG-D	Intermittent	N	Pressure Reducing	0.87	Kimray	30 IN FMT 600RF PB	
B	38	Buyback pres 1	Kimray	Not available	Intermittent	N	Pressure Reducing	0.87	Kimray	Unknown	
B	38	Comp pres 1	Kimray	30 PG	Intermittent	N	Pressure	0.87	Kimray	2200 SMT PO	
B	38	Compr pres 2	Kimray	30 PG	Intermittent	N	Pressure	0.87	Kimray	2200 SMT PO	
B	38	Compr pres 3	Kimray	30 PG	Intermittent	N	Pressure	0.87	Kimray	2200 SMT PO	
B	38	Compr lvl 2	Murphy	LS200N	Intermittent	N	Level	0.87	murphy	LS200N	8
B	38	Compr lvl 1	Murphy	LS200N	Intermittent	N	Level	0.87	murphy	LS200N	
B	38	Compr lvl 3	Murphy	LS200N	Intermittent	N	Level	0.87	murphy	LS200N	
B	38	Compr lvl 4	Murphy	LS200N	Intermittent	N	Level	0.87	murphy	LS200N	
B	38	HT pres 1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.87	Kimray	Integral to controller	
B	38	Sep pres 1	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	0.87	Kimray	Integral to controller	
B	38	Sep pres 2	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	0.87	Kimray	Integral to controller	
B	38	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.87	Unknown	Unknown	0.04
B	39	Wellhead pres 1	Kimray	30 HPG-D	Intermittent	N	Pressure Reducing	0.87	Kimray	30 IN FMT 600RF PB	

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B	39	Compr pres 1	Kimray	30 PG	Intermittent	N	Pressure	0.87	Kimray	2200 SMT PO	
B	39	Compr pres 2	Kimray	30 PG	Intermittent	N	Pressure	0.87	Kimray	2200 SMT PO	
B	39	Compr pres 3	Kimray	30 PG	Intermittent	N	Pressure	0.87	Kimray	2200 SMT PO	
B	39	Compr lvl 2	Murphy	LS200N	Intermittent	N	Level	0.87	murphy	LS200N	8
B	39	Compr lvl 1	Murphy	LS200N	Intermittent	N	Level	0.87	murphy	LS200N	
B	39	Compr lvl 3	Murphy	LS200N	Intermittent	N	Level	0.87	murphy	LS200N	
B	39	Compr lvl 4	Murphy	LS200N	Intermittent	N	Level	0.87	murphy	LS200N	
B	39	HT pres 1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.87	Kimray	Integral to controller	
B	39	Sep pres 1	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	0.87	Kimray	Integral to controller	
B	39	Sep pres 2	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	0.87	Kimray	Integral to controller	
B	39	GPU pres	Not available	Not available	Intermittent	N	Pressure	0.87	Unknown	Unknown	0.04
C	40	1176	Fisher	i2p-100	Intermittent	N	Pressure	1.00	Kimray	2200 SMT PO	2.2
C	40		Kimray	330 SGT BP	Intermittent	N	Pressure	0.50	Kimray	330 SGT BP	
C	40	1177, 1178	Kimray	Gen II	Intermittent	N	Level	1.00	Kimray	250 SMA PB PO	4
C	40	1177, 1178	Kimray	Gen II	Intermittent	N	Level	1.00	Kimray	250 SMA PB PO	4
C	40	1179	Kimray	T-12	Intermittent	N	Temperature	0.33	Kimray	201P?	
C	41	1176	Fisher	i2p-100	Intermittent	N	Pressure	1.00	Kimray	2200 SMT PO	2.3
C	41		Kimray	330 SGT BP	Intermittent	N	Pressure	0.50	Kimray	330 SGT BP	
C	41	1177, 1178	Kimray	Gen II	Intermittent	N	Level	1.00	Kimray	250 SMA PB PO	
C	41	1177, 1178	Kimray	Gen II	Intermittent	N	Level	1.00	Kimray	250 SMA PB PO	
C	41	1179	Kimray	T-12	Intermittent	N	Temperature	0.33	Kimray	201P?	
C	42		Kimray	330 SGT BP	Intermittent	N	Pressure	1.00	Kimray	330 SGT BP	
C	42	1177, 1178	Kimray	Gen II	Intermittent	N	Level	1.00	Kimray	250 SMA PB PO	4
C	42	1177, 1178	Kimray	Gen II	Intermittent	N	Level	1.00	Kimray	250 SMA PB PO	4
C	42	1188	Omni Valve	Not available	Intermittent	N	Pressure	1.00	Omni Valve	Not available	0.04
C	42	1179	Kimray	T-12	Intermittent	N	Temperature	0.33	Kimray	112 SMT	
C	43		Kimray	330 SGT BP	Intermittent	N	Pressure	1.00	Kimray	330 SGT BP	
C	43	1177, 1178	Kimray	Gen II	Intermittent	N	Level	1.00	Kimray	250 SMA PB PO	6
C	43	1177, 1178	Kimray	Gen II	Intermittent	N	Level	1.00	Kimray	250 SMA PB PO	4
C	43	1188	Omni Valve	Not available	Intermittent	N	Pressure	1.00	Omni Valve	Not available	0.04
C	43	1179	Kimray	T-12	Intermittent	N	Temperature	0.33	Kimray	112 SMT	
C	44	1177, 1178	Kimray	Gen II	Intermittent	N	Level	1.00	Kimray	250 SMA PB PO	12
C	44	1188	Omni Valve	Not available	Intermittent	N	Pressure	1.00	Omni Valve	Not available	0.04
C	44	1177, 1178	Kimray	Gen II	Intermittent	N	Level	1.00	Kimray	250 SMA PB PO	4
C	44		Kimray	330 SGT BP	Intermittent	N	Pressure	1.00	Kimray	330 SGT BP	
C	44	1179	Kimray	T-12	Intermittent	N	Temperature	0.33	Kimray	112 SMT	
C	45	1193	Wellmark	6900	Intermittent	N	Level	1.00	Kimray	2200 SMT PO	
C	45	1193	Wellmark	6900	Intermittent	N	Level	1.00	Kimray	2200 SMT PO	
C	45	1195, 1196	Kimray	3FMT600RF	Intermittent	N	Pressure	1.00	Kimray	330 SGT BP	
C	45	1177, 1178	Kimray	Gen II	Intermittent	N	Level	1.00	Kimray	250 SMA PB PO	8
C	45	1177, 1178	Kimray	Gen II	Intermittent	N	Level	1.00	Kimray	250 SMA PB PO	
C	45	1188	Omni Valve	Not available	Intermittent	N	Pressure	1.00	Omni Valve	Not available	0.04
C	45	1179	Kimray	T-12	Intermittent	N	Temperature	0.33	Kimray	112 SMT	
C	46	1198	Norriseal	2SM36-BBDB-N	Intermittent	N	Level	1.00	Kimray	2200 SMT PO	
C	46		Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	Kimray	212 SGT BP	
C	47		Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	Kimray	212 SGT BP	
C	47	1205	Kimray	T-12	Intermittent	N	Temperature	0.40	Kimray		
C	48		Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	Kimray	212 SGT BP	
C	49	1219	Invalco	CTS-215	Continuous	N	Level	1.00	Kimray	2400 SMT PO	

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C	49	1217	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	0.33	Kimray	1400 SMT PO	
C	49		Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	Kimray	212 SGT BP	
C	49		Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	Kimray	212 SGT BP	
C	49	1223	Kimray	T-12	Intermittent	N	Temperature	1.00	Kimray	112 SMT	
C	49	1226	Fisher	i2p-100	Intermittent	N	Pressure	1.00	Kimray	2200 SMT PO	0.042
C	50		Kimray	230 SGT BP	Intermittent	N	Pressure	1.00	Kimray	230 SGT BP	
C	50		Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	Kimray	212 SGT BP	
C	50	1235	Fisher	i2p-100	Intermittent	N	Pressure	1.00	Kimray	2200 SMT PO	0.042
D	51	MV-Wellhead	Kimray	30 HPG-D	Intermittent	N	Pressure	0.98	Norriseal	2200	
D	51	AutoCycle Plunger Controller	Ferguson	AutoCycle Controller	Intermittent	N	Pressure	0.98	Norriseal	2200	0.50
D	51	BPR- Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.98	Kimray	Integral to controller	
D	51	BPR-Heater Treater	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.98	Kimray	Integral to controller	
D	52	BPV- HT	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	0.96	Kimray	Integral to controller	
D	53	MV-wellhead	Kimray	30 HPG-D	Intermittent	N	Pressure	0.99	Kimray	2400 SMT PO	
D	53	BPV-for production unit	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	53	AutoCycle Plunger Controller	Ferguson	AutoCycle Controller	Intermittent	N	Pressure	0.99		2400 SMT PO	0.33
D	53	Balanced Motor Valve On Production Unit	Kimray	212 SMA PO	Intermittent	N	Pressure	0.99	Kimray	NA	
D	53	Balanced Motor Valve On Production Unit	Kimray	212 SMA PO	Intermittent	N	Pressure	0.99	Kimray	NA	
D	54	MV- Flowline	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	4 in FMT 600 RF P	
D	54	BPV- Sales Line	Kimray	330 SGT BP	Intermittent	N	Flow	1.00	Kimray	Integral to controller	
D	54	BPV- Sep/FWKO	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	54	BPV- HT	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	55	BPV- Sales Line	Kimray	330 SGT BP	Intermittent	N	Flow	0.99	Kimray	Integral to controller	
D	55	BPV- Separator	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	55	BPV- HT	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	56	MV- FWKO	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	4 in FMT 600 RF P	
D	56	BPV- Sales Line	Kimray	330 SGT BP	Intermittent	N	Flow	1.00	Kimray	Integral to controller	
D	56	BPV- Sep/FWKO	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	56	BPV- HT	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	57	BPV- HT	Kimray	230 SGT-BP-D	Intermittent	N	Flow	0.99	Kimray	Integral to controller	
D	57	BPV-Sales Line	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	58	BPR- Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	58	AutoCycle Plunger Controller	Ferguson	AutoCycle Controller	Intermittent	N	Pressure	0.99	Kimray	2400 SMT PO	0.33
D	58	BPR-Heater Treater	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	59	MV-Wellhead	Kimray	30 HPG-D	Intermittent	N	Pressure	0.99	Kimray	2400 SMT PO	
D	59	Level Controller on Production Unit	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	0.99	Wellmark	NA	
D	59	AutoCycle Plunger Controller	Ferguson	AutoCycle Controller	Intermittent	N	Pressure	0.99		2400 SMT PO	0.25
D	60	MV- FWKO	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	4 in FMT 600 RF P	
D	60	MV- Plunger	Multi	Timax EZ	Intermittent	N	Pressure	1.00	Kimray	4 in FMT 600 RF P	
D	60	MV- Comp 1	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2150 SMTPR	
D	60	MV- Comp 2	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2150 SMTPR	
D	60	BPV- Sales Line	Kimray	330 SGT BP	Intermittent	N	Flow	1.00	Kimray	Integral to controller	
D	60	LC- Comp 1	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	

Company ID	Site ID	Controller ID	Controller Make	Controller Model	Bleed Classification	Retrofit? (Y/N)	Process Condition	Annual Operating Factor	Actuator Make	Actuator Model	Actuations/ hour From Observation Or Other Company Information
D	60	LC- Comp 2	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	
D	60	LC- Comp 3	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	
D	60	LC- Comp 4	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	
D	60	BPV- FWKO	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	60	BPV- Separator	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	60	BPV- HT	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	61	MV- FWKO	Kimray	30 HPG-D	Intermittent	N	Pressure	0.99	Kimray	4 in FMT 600 RF P	
D	61	MV- Comp 1	Kimray	30 HPG-D	Intermittent	N	Pressure	0.99	Kimray	2150 SMTPR	
D	61	MV- Comp 2	Kimray	30 HPG-D	Intermittent	N	Pressure	0.99	Kimray	2150 SMTPR	
D	61	BPV- Sales Line	Kimray	330 SGT BP	Intermittent	N	Flow	0.99	Kimray	Integral to controller	
D	61	LC- Comp 4	Murphy	LS200N	Intermittent	N	Level	0.99	Norriseal	2200/2220	
D	61	LC- Comp 1	Murphy	LS200N	Intermittent	N	Level	0.99	Murphy	NA	
D	61	LC- Comp 2	Murphy	LS200N	Intermittent	N	Level	0.99	Murphy	NA	
D	61	LC- Comp 3	Murphy	LS200N	Intermittent	N	Level	0.99	Murphy	NA	
D	61	BPV- FWKO	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	61	BPV- Separator	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	61	BPV- HT	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	62	BPV- Sales Line	Kimray	330 SGT BP	Intermittent	N	Flow	0.99	Kimray	Integral to controller	
D	62	BPV- Separator	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	62	BPV- HT	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	63	BPV- Sales Line	Kimray	330 SGT BP	Intermittent	N	Flow	0.99	Kimray	Integral to controller	
D	63	BPV- Separator	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	63	BPV- HT	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	64	MV-Wellhead	Kimray	30 HPG-D	Intermittent	N	Pressure	0.99	Kimray	2400 SMT PO	
D	64	BPR- Separator	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	64	AutoCycle Plunger Controller	Ferguson	AutoCycle Controller	Intermittent	N	Pressure	0.99	Kimray	2400 SMT PO	0.25
D	64	BPR-Heater Treater	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.99	Kimray	Integral to controller	
D	65	MV- FWKO	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	4 in FMT 600 RF P	
D	65	MV- Plunger	Multi	Timax EZ	Intermittent	N	Pressure	1.00	Kimray	4 in FMT 600 RF P	
D	65	MV- Comp 1	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2150 SMTPR	
D	65	MV- Comp 2	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2150 SMTPR	
D	65	BPV- Sales Line	Kimray	330 SGT BP	Intermittent	N	Flow	1.00	Kimray	Integral to controller	
D	65	LC- Comp 4	Murphy	LS200N	Intermittent	N	Level	1.00	Norriseal	2200/2220	
D	65	BPV- FWKO	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	65	BPV- Separator	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	65	LC- Comp 1	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	
D	65	LC- Comp 2	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	
D	65	LC- Comp 3	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	
D	65	BPV- HT	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	66	MV- FWKO	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	4 in FMT 600 RF P	
D	66	MV- Comp 1	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2150 SMTPR	
D	66	MV- Comp 2	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2150 SMTPR	
D	66	BPV- Sales Line	Kimray	330 SGT BP	Intermittent	N	Flow	1.00	Kimray	Integral to controller	
D	66	BPV- Separator	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	66	LC- Comp 1	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	
D	66	LC- Comp 2	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	
D	66	LC- Comp 3	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	
D	66	LC- Comp 4	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	

Company ID	Site ID	Controller ID	Controller Make	Controller Model	Bleed Classification	Retrofit? (Y/N)	Process Condition	Annual Operating Factor	Actuator Make	Actuator Model	Actuations/ hour From Observation Or Other Company Information
D	66	BPV- FWKO	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	66	BPV- HT	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	67	MV- Plunger	Multi	Timax EZ	Intermittent	N	Pressure	0.98	Kimray	4 in FMT 600 RF P	
D	67	MV- FWKO	Kimray	30 HPG-D	Intermittent	N	Pressure	0.98	Kimray	4 in FMT 600 RF P	
D	67	MV- Comp 1	Kimray	30 HPG-D	Intermittent	N	Pressure	0.98	Kimray	2150 SMTPR	
D	67	MV- Comp 2	Kimray	30 HPG-D	Intermittent	N	Pressure	0.98	Kimray	2150 SMTPR	
D	67	BPV- Sales Line	Kimray	330 SGT BP	Intermittent	N	Flow	0.98	Kimray	Integral to controller	
D	67	LC- Comp 4	Murphy	LS200N	Intermittent	N	Level	0.98	Norriseal	2200/2220	
D	67	LC- Comp 1	Murphy	LS200N	Intermittent	N	Level	0.98	Murphy	NA	
D	67	LC- Comp 2	Murphy	LS200N	Intermittent	N	Level	0.98	Murphy	NA	
D	67	LC- Comp 3	Murphy	LS200N	Intermittent	N	Level	0.98	Murphy	NA	
D	67	BPV- Separator	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	0.98	Kimray	Integral to controller	
D	67	BPV- HT	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.98	Kimray	Integral to controller	
D	68	BPV with external sensor line on HT	Invalco	507	Intermittent	N	Pressure	0.98	Invalco	NA	
D	68	BPR- Sep	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.98	Kimray	Integral to controller	
D	68	AutoCycle Plunger Controller	Ferguson	AutoCycle Controller	Intermittent	N	Pressure	0.98	Kimray	2400 SMT PO	0.25
D	69	AutoCycle Plunger Controller	Ferguson	AutoCycle Controller	Intermittent	N	Pressure	0.98	Kimray	2400 SMT PO	
D	69	MV-wellhead	Kimray	30 HPG-D	Intermittent	N	Pressure	0.98	Kimray	2400 SMT PO	
D	69	BPR-Sep	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.98	Kimray	Integral to controller	
D	69	BPR-HT	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.98	Kimray	Integral to controller	
D	70	MV- Comp 1	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2150 SMTPR	
D	70	MV- Comp 2	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2150 SMTPR	
D	70	BPV- Sales Line	Kimray	330 SGT BP	Intermittent	N	Flow	1.00	Kimray	Integral to controller	
D	70	LC- Comp 4	Murphy	LS200N	Intermittent	N	Level	1.00	Norriseal	2200/2220	
D	70	LC- Comp 1	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	
D	70	LC- Comp 2	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	
D	70	LC- Comp 3	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	NA	
D	70	BPV- Separator	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
D	70	BPV- HT	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	Kimray	Integral to controller	
E	71	Oil level	Wellmark	6900	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	71	Water level	Wellmark	2001NB	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	71	Oil level	Wellmark	6900	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	71	Water level	Wellmark	2001NB	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	71	hi/low temp temperature controller	Kimray	T-12	Intermittent	N	temperature	1.00	Kimray	112 SMT DAB	
E	71	hi/low temp temperature controller	Kimray	T-12	Intermittent	N	temperature	1.00	Kimray	112 SMT DAB	
E	71	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	71	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	71	liquid dump flare	Wellmark	Snaptrol ST2TP	Intermittent	N	level	1.00	Sandpiper	S1F	0.0059
E	72	Oil level	Wellmark	6900	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	72	Water level	Wellmark	2001NB	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	72	hi/low temp temperature controller	Kimray	T-12	Intermittent	N	temperature	1.00	Kimray	112 SMT DAB	
E	72	high/low emergency well	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007

Company ID	Site ID	Controller ID	Controller Make	Controller Model	Bleed Classification	Retrofit? (Y/N)	Process Condition	Annual Operating Factor	Actuator Make	Actuator Model	Actuations/ hour From Observation Or Other Company Information
		shut-in controller									
E	73	Oil level	Wellmark	6900	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	73	Water level	Wellmark	2001NB	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	73	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	73	liquid dump flare	Wellmark	Snaptrol ST2TP	Intermittent	N	level	1.00	Kimray	(2) 112 SMT DAB	0.0059
E	74	Oil level	Wellmark	6900	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	74	Water level	Wellmark	2001NB	Intermittent	N	level	1.00	Kimray	2400 SMA PO	
E	74	Oil level	Wellmark	6900	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	74	Water level	Wellmark	2001NB	Intermittent	N	level	1.00	Kimray	2400 SMA PO	
E	74	hi/low temp temperature controller	Kimray	T-12	Intermittent	N	temperature	1.00	Kimray	112 SMT DAB	
E	74	hi/low temp temperature controller	Kimray	T-12	Intermittent	N	temperature	1.00	Kimray	112 SMT DAB	
E	74	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	74	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	74	liquid dump flare	Wellmark	Snaptrol ST2TP	Intermittent	N	level	1.00	Sandpiper	S1F	0.0059
E	75	Oil level	Wellmark	6900	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	75	Water level	Wellmark	2001NB	Intermittent	N	level	1.00	Kimray	2400 SMA PO	
E	75	Oil level	Wellmark	6900	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	75	Water level	Wellmark	2001NB	Intermittent	N	level	1.00	Kimray	2400 SMA PO	
E	75	hi/low temp temperature controller	Kimray	T-12	Intermittent	N	temperature	1.00	Kimray	112 SMT DAB	
E	75	hi/low temp temperature controller	Kimray	T-12	Intermittent	N	temperature	1.00	Kimray	112 SMT DAB	
E	75	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	75	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	75	liquid dump flare	Wellmark	Snaptrol ST2TP	Intermittent	N	level	1.00	Sandpiper	S1F	0.0059
E	76	Water level	Wellmark	2001NB	Intermittent	N	level	1.00	Kimray	2400 SMA PO	
E	76	Oil level	Wellmark	6900	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	76	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	76	liquid dump flare	Wellmark	Snaptrol ST2TP	Intermittent	N	level	1.00	Sandpiper	S1F	0.0059
E	77	Oil level	Wellmark	6900	continuous	N	level	1.00	Kimray	2400 SMA PO	
E	77	Water level	Wellmark	2001NB	continuous	N	level	1.00	Kimray	2401 SMA PO	
E	77	Oil level	Wellmark	6900	continuous	N	level	1.00	Kimray	2400 SMA PO	
E	77	Water level	Wellmark	6900	continuous	N	level	1.00	Kimray	2400 SMA PO	
E	77	Oil level	Wellmark	6900	continuous	N	level	1.00	Kimray	2400 SMA PO	
E	77	Water level	Wellmark	2001NB	continuous	N	level	1.00	Kimray	2401 SMA PO	
E	77	hi/low temp temperature controller	Kimray	T-12	Intermittent	N	temperature	1.00	Kimray	112 SMT DAB	
E	77	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	77	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	77	high/low emergency well	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007

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		shut-in controller									
E	78	Oil level	Wellmark	6900	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	78	Water level	Wellmark	2001NB	Intermittent	N	level	1.00	Kimray	2400 SMA PO	
E	78	Oil level	Wellmark	6900	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	78	Water level	Wellmark	2001NB	Intermittent	N	level	1.00	Kimray	2400 SMA PO	
E	78	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	78	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	78	liquid dump flare	Wellmark	Snaptrol ST2TP	Intermittent	N	level	1.00	Sandpiper	S1F	0.0059
E	79	Oil level	Wellmark	6900	Intermittent	Y	level	1.00	Kimray	2400 SMA PO	
E	79	Water level	Wellmark	2001NB	Intermittent	N	level	1.00	Kimray	2400 SMA PO	
E	79	hi/low temp temperature controller	Kimray	T-12	Intermittent	N	temperature	1.00	Kimray	112 SMT DAB	
E	79	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	80	Oil level	Wellmark	6900	continuous	N	level	1.00	Kimray	2401 SMA PO	
E	80	Water level	Wellmark	2001NB	continuous	N	level	1.00	Kimray	2401 SMA PO	
E	80	Oil level	Wellmark	6900	continuous	N	level	1.00	Kimray	2401 SMA PO	
E	80	Water level	Wellmark	2001NB	continuous	N	level	1.00	Kimray	2401 SMA PO	
E	80	Oil level	Wellmark	6900	continuous	N	level	1.00	Kimray	2401 SMA PO	
E	80	Water level	Wellmark	2001NB	continuous	N	level	1.00	Kimray	2401 SMA PO	
E	80	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	80	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	80	high/low emergency well shut-in controller	Axelson	300	Intermittent	N	Pressure	1.00	FMC Tech	130	0.0007
E	80	liquid dump flare	Wellmark	Snaptrol ST2TP	Intermittent	N	level	1.00	Sandpiper	S1F	0.0059
F	91	2	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.95	self contained		-
F	91	1	Kimray	30 HPG-D	Intermittent	N	Pressure	0.95	Kimray	2200 SMT PO	0.291
F	91	1	Ferguson Beauregard	Not available	Intermittent	N	Pressure	0.95	Kimray	2200 SMT PO	0.291
F	92	1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.85	self contained		-
F	92	2	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.85	self contained		-
F	93	2	Kimray	430 SGT	Intermittent	N	Backpressure	0.71	self contained		30
F	93	7	Kimray	2PGOA	Intermittent	N	Level	0.71	Kimray	1400 SMA FC	-
F	93	5	Wellmark	Snaptrol ST2TP-104	Intermittent	N	Level	0.71	Kimray	1400 SMA FC	-
F	93	6	Wellmark	Snaptrol ST2TP-104	Intermittent	N	Level	0.71	Kimray	1400 SMA FC	-
F	93	3	Kimray	230 SGT BPD	Intermittent	N	Backpressure	0.71	Self contained		-
F	93	4	Kimray	230 SGT BPD	Intermittent	N	Backpressure	0.71			-
F	93	1	FMC	PN 38	Intermittent	N	Pressure	0.71	self contained		0.0001
F	94	2	Kimray	430 SGT	Intermittent	N	Backpressure	0.75	self contained		-
F	94	7	Kimray	2PGOA	Intermittent	N	Level	0.75	Kimray	1400 SMA FC	-
F	94	5	Wellmark	Snaptrol ST2TP-104	Intermittent	N	Level	0.75	Kimray	1400 SMA FC	-
F	94	6	Wellmark	Snaptrol ST2TP-104	Intermittent	N	Level	0.75	Kimray	1400 SMA FC	-
F	94	3	Kimray	230 SGT BPD	Intermittent	N	Backpressure	0.75	Self contained		-
F	94	4	Kimray	230 SGT BPD	Intermittent	N	Backpressure	0.75			-
F	94	1	FMC	PN 38	Intermittent	N	Pressure	0.75	self contained		0.0001
F	95	2	Kimray	430 SGT-PD	Intermittent	N	Backpressure	0.99	self contained		8

Company ID	Site ID	Controller ID	Controller Make	Controller Model	Bleed Classification	Retrofit? (Y/N)	Process Condition	Annual Operating Factor	Actuator Make	Actuator Model	Actuations/ hour From Observation Or Other Company Information
F	95	4	Hytork	186 XL186SR20	Intermittent	N	Pressure	0.99			-
F	95	3	Kimray	230 SGT BPD	Intermittent	N	Backpressure	0.99	Self contained		-
F	95	1	FMC	PN 38	Intermittent	N	Pressure	0.99	self contained		0.0001
F	96	1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.98	Self contained		-
F	97	2	Kimray	430 SGT BP	Intermittent	N	Backpressure	0.96	Self contained		-
F	97	1	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	0.96	Self contained		-
F	97	4	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	0.96	Two Kimray actuators	both are 112 SMT	
F	97	5	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	0.96	Two Kimray actuators	both are 112 SMT	
F	98	2	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2200 SMT PO	
F	98	4	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2150 SMT PB	
F	98	3	Kimray	212 SGT-BP	Intermittent	N	Backpressure	1.00	Self contained		
F	98	1	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	1.00	Self contained		
F	98	5	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	1.00	Two Kimray actuators	both are 112 SMT	
F	98	6	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	1.00	Two Kimray actuators	both are 112 SMT	
F	99	5	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2200 SMT PO	
F	99	1	Not available	13M	Intermittent	N	Pressure	1.00	Kimray	2400 SMT PB PO	
F	99	6	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	1.00	Self Contained		
F	99	7	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	1.00	Self Contained		
F	99	8	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	1.00	Two Kimray actuators	both are 112 SMT	
F	99	9	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	1.00	Two Kimray actuators	both are 112 SMT	
F	100	1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.82	Self Contained		
F	100	3	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.82			
F	100	2	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.82			
F	101	2	Kimray	30 HPG-D	Intermittent	N	Pressure	0.99	Kimray	2150 SMT PB	
F	101	1	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	0.99	Self Contained		
F	102	5	Kimray	30 HPG PR-D	Intermittent	N	Pressure	0.98	Unreadable (not Kimray)		0.416
F	102	5	Fisher	Not available	Intermittent	N	Pressure	0.98	Unreadable (not Kimray)		0.416
F	102	1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.98	Self Contained		
F	102	2	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.98	Self Contained		
F	102	3	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.98	Self Contained		
F	103	1	Kimray	30 HPG PP	Intermittent	N	Pressure/Plunger lift	0.99	Kimray	2200 SMT PO	
F	103	1	Ferguson Beauregard	Not available	Intermittent	N	Pressure/Plunger lift	0.99	Kimray	2200 SMT PO	
F	103	5	Wellmark	W-1200DV0-FL	Intermittent	N	Level	0.99	Kimray	1400 SMT PO	
F	103	2	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.99	Self Contained		
F	103	3	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.99	Self Contained		
F	103	4	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.99	Self Contained		
F	104	2	Fisher	Not available	Intermittent	N	Pressure	1.00			
F	104	1	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	1.00	Self Contained		
F	105	1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	1.00	Self Contained		
F	106	3	Kimray	30 HPG-D	Intermittent	N	Pressure	0.99	Kimray	2200 SMT PO	

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F	106	2	Kimray	30 HPG-D	Intermittent	N	Pressure	0.99	Kimray	no tag	
F	106	1	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.99	Self Contained		
F	106	4	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	0.99	Two Kimray actuators	both are 112 SMT	
F	106	5	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	0.99	Two Kimray actuators	both are 112 SMT	
F	107	1	Kimray	30 HPG-D	Intermittent	N	Pressure/Plunger lift	0.91	Kimray	2200 SMT PO	
F	107	1	Ferguson Beauregard	Not available	Intermittent	N	Pressure/Plunger lift	0.91	Kimray	2200 SMT PO	
F	107	6	Kimray	230 SGT PR	Intermittent	N	Backpressure	0.91	Self Contained		
F	107	2	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.91	Self Contained		
F	107	3	Kimray	212 SGT-BP	Intermittent	N	Backpressure	0.91	Self Contained		
F	108	3	Not available	Not available	Intermittent	N	Pressure	1.00	Kimray	2400 SMT PB PO	
F	108	6	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2200 SMT PO	
F	108	1	Kimray	T-12	Intermittent	N	Temperature	1.00	Kimray		
F	108	2	Kimray	T-12	Intermittent	N	Temperature	1.00	Kimray		
F	108	7	Kimray	212 SGT-BP	Intermittent	N	Backpressure	1.00	Self contained		
F	108	4	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	1.00	Two Kimray actuators	both are 112 SMT	
F	108	5	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	1.00	Two Kimray actuators	both are 112 SMT	
F	108	8	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	1.00	Self contained		
F	108	9	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	1.00	Self contained		
F	109	4	Kimray	430 SGT BP	Intermittent	N	Pressure	0.47	self contained		
F	109	5	Kimray	230 SGT-BP-D	Intermittent	N	Backpressure	0.47	self contained		
F	109	3	FMC	PN 38	Intermittent	N	Pressure	0.47	self contained		0.0001
F	109	1	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	0.47	Two Kimray actuators	both are 112 SMT	
F	109	2	Wellmark	Snaptrol ST2TP	Intermittent	N	Level	0.47	Two Kimray actuators	both are 112 SMT	
F	110	1	Kimray	30 HPG-D	Intermittent	N	Pressure/Plunger lift	1.00	Kimray	2200 SMT PO	
F	110	1	Ferguson Beauregard	Not available	Intermittent	N	Pressure/Plunger lift	1.00	Kimray	2200 SMT PO	
F	110	2	Kimray	212 SGT-BP	Intermittent	N	Backpressure	1.00	Self Contained		
F	110	3	Kimray	212 SGT-BP	Intermittent	N	Backpressure	1.00	Self Contained		
G	111	WH pres 1	Kimray	30 HPG	Intermittent	N	Pressure	0.92	Kimray	2200 SMT	0.083
G	111	WH Flow	EDI	TSC-JR	Intermittent	N	Flow	0.92	Kimray	2200 SMT	0.083
G	112	Sales pres	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	112	sep pres 1	Kimray	312 FGT PR	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	113	Sales press	Kimray	312 FGT PR	Intermittent	N	Pressure	0.90	Kimray	Integral to controller	
G	113	sep pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	113	HT tmp 1	Kimray	T-12	Intermittent	N	Temperature	0.90	Kimray	112 SMT	
G	114	Sales pres 1	Kimray	312 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	114	HT pres	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	114	HT pres 1	Kimray	212 FGT B	Intermittent	N	Pressure	0.90	Kimray	Integral to controller	0.042
G	115	HT pres	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	115	sep pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	0.042
G	116	HT pres	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral with Controller	

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G	116	Sep pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral with Controller	
G	116	Sep pres 2	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral with Controller	
G	116	HT tmp 1	Kimray	T-12	Intermittent	N	Temperature	0.90	Kimray	112 SMT	
G	116	Sep pres 3	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.91	Kimray	Integral with Controller	0.042
G	116	Sep pres 4	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.90	Kimray	Integral with Controller	0.042
G	117	HT pres	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	117	sep pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	118	Sales pres	Kimray	312 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	118	HT pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	118	HT pres 2	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	0.042
G	119	GPU pres	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	119	GPU pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	119	sep pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	0.042
G	119	GPU pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	0.042
G	120	WH pres	EDI	TSC-JR	Intermittent	N	Flow	0.92	Kimray	2200 SMT	0.167
G	120	WH Flow	Kimray	30 HPG	Intermittent	N	Pressure	0.92	Kimray	2200 SMT	0.167
G	121	WH Flow	TSI	Timekeeper SE	Intermittent	N	Flow	0.90	Kimray	2200 SMT	0.042
G	121	WH pres	Kimray	30 HPG	Intermittent	N	Pressure	0.90	Kimray	2200 SMT	0.042
G	121	Sep pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.90	Kimray	Integral with controller	0.042
G	121	Sep pres 2	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.90	Kimray	Integral with controller	0.042
G	122	GPU lvl 1	Invalco/FMC	CT Flextube	Continuous	N	Level	0.92	CE NATCO	NFDSA 130-424	0.167
G	122	HW pres 1	Kimray	30 HPG	Intermittent	N	Pressure	0.92	Kimray	2200 SMT	0.167
G	122	WH Flow	Ferguson Beauregard	Not available	Intermittent	N	Flow	0.92	Kimray	2200 SMT	0.167
G	123	WH pres	Kimray	30 HPG	Intermittent	N	Pressure	0.92	Kimray	2200 SMT	0.042
G	124	WH pres 1	Kimray	30 HPG	Intermittent	N	Pressure	0.92	Kimray	2200 SMT	0.167
G	124	WH Flow	ILS	TSC-JR	Intermittent	N	Flow	0.92	Kimray	2200 SMT	0.167
G	125	WH pres	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral with controller	
G	126	WH pres 1	Weatherford	CEO	Intermittent	N	Flow	0.92	Kimray	2200 SMT	0.167
G	126	WH Flow	Kimray	30 HPG	Intermittent	N	Pressure	0.92	Kimray	2200 SMT	0.167
G	127	sep Lvl 1	Wellmark/Cemco	6900 Snap	Continuous	N	Level	0.92	Kimray	1400SMA	0.250
G	127	Well Head	Innovative	Protech 22	Intermittent	N	Flow	0.92	Kimray	2200SMT	0.250
G	128	compr pres 1	Kimray	30 PG	Intermittent	N	Pressure	0.90	Kimray	2400 smt	
G	128	compr lvl 1	Murphy	LS200NDVO	Intermittent	N	Level	0.90	murphy	DVU 2120	
G	128	compr lvl 2	Murphy	LS200NDVO	Intermittent	N	Level	0.90	murphy	DVU 2120	
G	128	compr lvl 3	Murphy	LS200NDVO	Intermittent	N	Level	0.90	murphy	DVU 2120	
G	129	SEP lvl 2	Wellmark/Cemco	6900 Snap	Continuous	N	Level	0.90	Kimray	1400 SMS	0.250
G	129	SEP lvl 1	Wellmark/Cemco	6900 Snap	Continuous	N	Level	0.91	Kimray	1400 SMT	0.250
G	129	Well Head	PCS	2000	Intermittent	N	Pressure	0.92	Kimray	2200 SMT	0.250
G	130	GPU lvl 1	CEMCO	6900	Continuous	N	Level	0.92	Invalco	STD 120	0.250
G	130	GPU lvl 2	CEMCO	6900	Continuous	N	Level	0.92	Invalco	STD 120	0.250
G	130	GPU pres	Multi	Timax EZ	Intermittent	N	Flow	0.92	Kimray	2200SMT	0.250
G	130	GPU tmp 1	Kimray	T-12	Intermittent	N	Temperature	0.92	Kimray	112 SMT	0.250
G	130	GPU tmp 2	Kimray	T-12	Intermittent	N	Temperature	0.92	Same physical actuator as GPU tmp1	112 SMT	0.250
G	131	GPU lvl 2	Wellmark/Cemco	6900	Continuous	N	Level	0.92	Kimray	1400SMA	
G	131	GPU lvl 1	Wellmark/Cemco	6900	Continuous	N	Level	0.92	Kimray	1400SMA	
G	131	GPU tmp 1	Kimray	T-12	Intermittent	N	Temperature	0.92	Kimray	112 SMT	

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G	131	GPU tmp 2	Kimray	T-12	Intermittent	N	Temperature	0.92	Kimray	112 SMT	
G	132	Sep pres	Kimray	330 SGT BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	133	Sep pres 2	Kimray	30 HPG	Intermittent	N	Pressure	0.92	Kimray	2100 SMT	
G	133	sep pres 1	Kimray	330 SGT BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	133	compr lvl 1	Murphy	LS200NDVO	Intermittent	N	Level	0.92	murphy	DVU 2115	
G	133	compr lvl 2	Snaptrol	7400 Micro Switch	Intermittent	N	Level	0.92	Kimray	112 SMT	
G	134	compr pres 1	Kimray	30 PG	Intermittent	N	Pressure	0.92	Kimray	2200 SMT	
G	134	SEP Press 2	Kimray	312 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	134	sep pres 1	Kimray	312 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	134	compr lvl 1	Murphy	LS200NDVO	Intermittent	N	Level	0.92	murphy	DVU 2215	
G	134	compr lvl 2	Snaptrol	3T2TP	Intermittent	N	Level	0.92	Kimray	112 SMT	
G	135	sep pres 1	Kimray	312 SGT-BP	Intermittent	N	Pressure	0.09	Kimray	Integral to controller	
G	136	Sep pres 1	Kimray	330 SGT BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	0.042
G	137	compr pres 1	Kimray	30 PG	Intermittent	N	Pressure	0.92	Kimray	2200 SMT	
G	137	compr lvl 1	Murphy	LS200NDVO	Intermittent	N	Level	0.92	Murphy	DVU 2115	
G	137	sep pres 1	Kimray	220 SMT PO	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	137	compr lvl 2	Snaptrol	7400 Micro Switch	Intermittent	N	Level	0.92	Kimray	112 SMT	
G	138	compr pres 1	Kimray	30 HPG	Intermittent	N	Pressure	0.92	Kimray	2150 SMT	
G	138	sep pres 1	Kimray	330 SGT BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	139	Sep pres 1	Kimray	30 PG	Intermittent	N	Pressure	0.92	Kimray	2150 SMT	
G	139	sep pres 1	Kimray	330 SGT BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	140	GPU pres	Kimray	30 PG	Intermittent	N	Pressure	0.92	Kimray	2150 SMT	
G	140	compr pres 1	Kimray	330 SGT BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	140	sep pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	0.042
G	141	Sep pres 2	Kimray	30 PG	Intermittent	N	Pressure	0.92	Kimray	2150 SMT	
G	141	sep pres 1	Kimray	312 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	142	Sep pres	Kimray	30 PG	Intermittent	N	Pressure	0.92	Kimray	2150 SMT	
G	142	compr pres 1	Kimray	312 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	142	sep pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	143	Sep pres 1	Kimray	30 PG	Intermittent	N	Pressure	0.92	Kimray	2150 SMT	
G	143	GPU pres	Kimray	312 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	143	GPU pres 1	Kimray	312 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	143	compr lvl 1	Murphy	LI 200 NDVO	Intermittent	N	Level	0.92	murphy	DVU 2115	
G	143	compr lvl 2	Murphy	LI 200 NDVO	Intermittent	N	Level	0.92	murphy	DVU 2115	
G	144	compr pres 1	Kimray	30 PG	Intermittent	N	Pressure	0.90	Kimray	2150 SMT	
G	144	compr pres 2	Kimray	30 PG	Intermittent	N	Pressure	0.90	Kimray	2150 SMT	
G	144	GPU pres	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	144	GPU pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	144	GPU pres	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.88	Kimray	Integral to controller	
G	144	HT tmp 1	Kimray	T-12	Intermittent	N	Temperature	0.90	Kimray	112 SMT	
G	144	sep pres 1	Snaptrol	7400 Micro Switch	Intermittent	N	Level	0.88	Kimray	112 SMT	
G	145	Sep pres 3	Kimray	30 PG	Intermittent	N	Pressure	0.92	Kimray	2150 SMT	
G	145	sep pres 1	Kimray	212 SGT-BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	
G	145	HT tmp 1	Kimray	T-12	Intermittent	N	Temperature	0.92	Kimray	112 SMT	
G	145	Sep pres 2	Kimray	330 SGT BP	Intermittent	N	Pressure	0.92	Kimray	Integral to controller	0.042
H	146	1	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	146	2	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	147	1	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	147	2	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	

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H	148	3	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	148	4	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	148	6	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	148	5	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	148	7	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	148	2	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	149	1	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	149	2	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	149	3	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	150	3 - plunger	Mega Systems	Mega Systems	Intermittent	N	Pressure	1.00	Kimray	2200 SMT	0.75
H	150	1	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	150	2 - plunger	Kimray	212 SGT-PR	Intermittent	N	Pressure	1.00	NA	NA	0.75
H	151	2	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	152	1	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	152	2	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	152	3	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	153	1	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	153	2	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	153	3	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	153	4	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	154	3 - plunger	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2200 SMT	0.67
H	154	4 - plunger	Not available	Not available	Intermittent	N	Pressure	1.00	NA	NA	0.67
H	155	2	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	155	4	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	155	1	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	155	3	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	156	5 - plunger	Mega Systems	Mega Systems	Intermittent	N	Pressure	1.00	Kimray	2200 SMT	0.49
H	156	1	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	156	2	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	156	3	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	157	1	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	157	2	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	157	3	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	158	1	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	158	2	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	158	3	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	158	4	Kimray	212 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	159	2	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	NA	NA	
H	159	1	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	160	2	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2200 SMT	
H	160	1	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	161	4	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	LS200N	
H	161	5	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	LS200N	
H	161	6	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	LS200N	
H	161	7	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	LS200N	
H	161	2	Norriseal	2SM60-TRDA-BA	Intermittent	N	Level	1.00	Kimray	312 SMA PB PO	
H	161	3	Norriseal	2SM60-TRDA-BA	Intermittent	N	Level	1.00	Kimray	312 SMA PB PO	
H	161	1	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	162	7 - plunger	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2200 SMT	1

Company ID	Site ID	Controller ID	Controller Make	Controller Model	Bleed Classification	Retrofit? (Y/N)	Process Condition	Annual Operating Factor	Actuator Make	Actuator Model	Actuations/ hour From Observation Or Other Company Information
H	162	3	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	LS200N	
H	162	4	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	LS200N	
H	162	5	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	LS200N	
H	162	6	Murphy	LS200N	Intermittent	N	Level	1.00	Murphy	LS200N	
H	162	8 - plunger	Integrated Production Services	Not available	Intermittent	N	Pressure	1.00	NA	NA	1
H	162	1	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	162	2	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	163	1	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	163	2	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	164	1	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	165	1	Kimray	212 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	166	1	Kimray	330 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	166	2	Norriseal	2SM60-TRDA-BA	Intermittent	N	Level	1.00	Kimray	312 SMA PB PO	
H	166	3	Norriseal	2SM60-TRDA-BA	Intermittent	N	Level	1.00	Kimray	312 SMA PB PO	
H	167	1	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	167	2	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	168	1	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	169	1	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	170	1	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	171	1	Kimray	230 SGT-BP-D	Intermittent	N	Pressure	1.00	NA	NA	
H	172	2 - plunger	Kimray	30 HPG-D	Intermittent	N	Pressure	1.00	Kimray	2400 SMT PB PO	1.33
H	172	4	Kimray	312 SGT-BP	Intermittent	N	Pressure	1.00	NA	NA	
H	172	1 - plunger	Integrated Production Services	Not available	Intermittent	N	Pressure	1.00	NA	NA	1.33

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
A	1	Back-Pressure, sales	0.13	1,119	0.11	0.00122	0.0053
A	1	BP-Vent-Separator	0.13	1,119	0.11	0.00122	0.0053
A	1	BP-Vent-Heater	0.08	711	0.07	0.00078	0.0034
A	1	Plunger Lift	0.06	552	0.05	0.00060	0.0026
A	2	Back-Pressure, sales	0.16	1,392	0.14	0.00090	0.0040
A	2	BP-Vent-Separator	0.16	1,392	0.14	0.00090	0.0040
A	2	Plunger Lift	0.16	1,372	0.14	0.00089	0.0039
A	2	BP-Vent-Heater	0.07	631	0.06	0.00041	0.0018
A	3	Back-Pressure, sales	0.14	1,217	0.13	0.00037	0.0016
A	3	BP-Vent-Separator	0.14	1,217	0.13	0.00037	0.0016
A	3	Plunger Lift	0.08	697	0.08	0.00021	0.0009
A	4	BP-Vent-Separator	0.13	1,155	0.11	0.00114	0.0050
A	4		0.08	742	0.07	0.00074	0.0032
A	5	Back-Pressure, sales	0.13	1,105	0.10	0.00179	0.0078
A	5	BP-Vent-Heater	0.13	1,105	0.10	0.00179	0.0078
A	5	burner temp shut off	0.06	494	0.04	0.00080	0.0035
A	5	Plunger Lift	0.06	484	0.04	0.00078	0.0034
A	5	temp controller	0.05	435	0.04	0.00070	0.0031
A	6	Back-Pressure, sales	0.16	1,353	0.13	0.00149	0.0065
A	6	BP-Vent-Heater	0.16	1,353	0.13	0.00149	0.0065
A	6	Scrubber dump	0.03	239	0.02	0.00026	0.0011
A	7	Back-Pressure, sales	0.14	1,230	0.12	0.00159	0.0069
A	7	BP-Vent-Separator	0.14	1,230	0.12	0.00159	0.0069
A	7	BP-Vent-Heater	0.07	631	0.06	0.00081	0.0036
A	8	Plunger Lift	0.15	1,340	0.13	0.00121	0.0052
A	8	Back-Pressure, sales	0.10	847	0.08	0.00076	0.0033
A	8	BP-Vent-Separator	0.10	847	0.08	0.00076	0.0033
A	8	BP-Vent-Heater	0.07	588	0.06	0.00053	0.0023
A	9	BP-Vent-Separator	0.17	1,479	0.14	0.00152	0.0067
A	9	Plunger Lift	0.05	404	0.04	0.00042	0.0018
A	10	Back-Pressure, sales	0.13	1,180	0.13	0.00050	0.0022
A	10	BP-Vent-Separator	0.13	1,180	0.13	0.00050	0.0022
A	10	BP-Vent-Heater	0.07	656	0.07	0.00028	0.0012
A	11	Back-Pressure, sales	0.10	906	0.08	0.00128	0.0056
A	11	BP-Vent-Heater	0.10	906	0.08	0.00128	0.0056
A	11	Plunger Lift	0.03	275	0.03	0.00039	0.0017
A	12	BP-Vent-Separator	0.08	674	0.06	0.00098	0.0043
A	13	Plunger Lift	0.20	1,765	0.18	0.00144	0.0063
A	13	BP-sales	0.10	843	0.08	0.00069	0.0030
A	13	BP-Vent-Separator	0.10	843	0.08	0.00069	0.0030
A	14	BP-sales	0.09	742	0.08	0.00081	0.0034
A	14	BP-Vent-Heater	0.07	576	0.06	0.00063	0.0026

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
A	15	BP-sales	0.09	781	0.07	0.00099	0.0043
A	15	BP-Vent-Separator	0.09	781	0.07	0.00099	0.0043
A	15	BP-Vent-Heater	0.07	631	0.06	0.00080	0.0035
A	15	Plunger Lift	0.05	459	0.04	0.00058	0.0025
A	16	BP-Vent-Separator	0.10	906	0.08	0.00173	0.0076
A	17	BP-sales	0.11	921	0.09	0.00135	0.0059
A	17	BP-Vent-Separator	0.11	921	0.09	0.00135	0.0059
A	17	Plunger Lift	0.08	657	0.06	0.00096	0.0042
A	18	BP-sales	0.09	802	0.08	0.00067	0.0029
A	18	BP-Vent-Separator	0.09	802	0.08	0.00067	0.0029
A	18	Plunger Lift	0.08	720	0.07	0.00060	0.0026
A	19	BP-sales	0.14	1,060	0.11	0.00220	0.0085
A	19	BP-Vent-Separator	0.14	1,060	0.11	0.00220	0.0085
A	19	BP-Vent-Heater	0.07	577	0.06	0.00120	0.0046
A	20	Casing Intermitt valve	0.11	912	0.08	0.00178	0.0076
A	20	BP-sales	0.10	863	0.08	0.00168	0.0072
A	20	BP-Vent-Separator	0.10	863	0.08	0.00168	0.0072
A	20	BP-Vent-Heater	0.08	668	0.06	0.00130	0.0056
B	21	GPU lvl 2	0.22	1,766	0.19	0.00201	0.0081
B	21	GPU lvl 1	0.22	1,737	0.18	0.00198	0.0079
B	21	GPU tmp 1	0.09	737	0.08	0.00084	0.0034
B	21	GPU pres	0.05	422	0.04	0.00048	0.0019
B	22	GPU lvl 1	0.24	1,900	0.19	0.00304	0.0121
B	22	GPU lvl 2	0.24	1,876	0.19	0.00300	0.0120
B	22	GPU tmp 1	0.09	733	0.07	0.00117	0.0047
B	22	GPU tmp 2	0.09	733	0.07	0.00117	0.0047
B	22	GPU pres	0.05	420	0.04	0.00067	0.0027
B	23	compr pres 1	2.09	16,490	1.66	0.02737	0.1080
B	23	compr pres 2	2.09	16,490	1.66	0.02737	0.1080
B	23	compr flow 1	1.16	9,138	0.92	0.01516	0.0599
B	23	compr lvl 3	0.47	3,673	0.37	0.00610	0.0241
B	23	SEP lvl 1	0.35	2,750	0.28	0.00456	0.0180
B	23	compr lvl 1	0.25	1,937	0.20	0.00321	0.0127
B	23	compr lvl 2	0.25	1,937	0.20	0.00321	0.0127
B	23	compr lvl 4	0.25	1,937	0.20	0.00321	0.0127
B	23	GPU lvl 1	0.24	1,860	0.19	0.00309	0.0122
B	23	GPU lvl 2	0.24	1,860	0.19	0.00309	0.0122
B	23	GPU pres 2	0.16	1,287	0.13	0.00214	0.0084
B	23	GPU pres 1	0.16	1,235	0.12	0.00205	0.0081
B	23	GPU tmp 1	0.04	304	0.03	0.00050	0.0020
B	23	GPU tmp 2	0.04	304	0.03	0.00050	0.0020
B	24	sep pres 1	0.12	965	0.11	0.00093	0.0036

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
B	24	GPU pres	0.05	408	0.05	0.00039	0.0015
B	25	compr lvl 3	3.32	26,486	2.57	0.04931	0.1964
B	25	compr pres 1	2.09	16,646	1.62	0.03099	0.1235
B	25	compr lvl 1	0.25	1,956	0.19	0.00364	0.0145
B	25	compr lvl 2	0.25	1,956	0.19	0.00364	0.0145
B	25	compr lvl 4	0.25	1,956	0.19	0.00364	0.0145
B	25	GPU lvl 1	0.24	1,893	0.18	0.00352	0.0140
B	25	GPU lvl 2	0.24	1,893	0.18	0.00352	0.0140
B	25	HT pres 1	0.11	871	0.08	0.00162	0.0065
B	25	HT pres 2	0.11	871	0.08	0.00162	0.0065
B	25	GPU pres	0.05	420	0.04	0.00078	0.0031
B	25	GPU temp 1	0.05	390	0.04	0.00073	0.0029
B	26	Sep pres 1	1.16	9,071	1.08	0.00202	0.0079
B	26	Sep lvl 1	0.35	2,762	0.33	0.00062	0.0024
B	26	Sep lvl 2	0.35	2,754	0.33	0.00061	0.0024
B	26	GPU pres	0.05	413	0.05	0.00009	0.0004
B	27	GPU lvl 1	0.22	1,743	0.19	0.00166	0.0065
B	27	GPU lvl 2	0.22	1,705	0.19	0.00162	0.0063
B	27	GPU pres 3	0.07	569	0.06	0.00054	0.0021
B	27	GPU temp 1	0.07	526	0.06	0.00050	0.0020
B	27	GPU temp 2	0.07	526	0.06	0.00050	0.0020
B	28	GPU lvl 1	0.35	2,736	0.32	0.00078	0.0031
B	28	GPU lvl 2	0.35	2,736	0.32	0.00078	0.0031
B	28	GPU temp 2	0.09	696	0.08	0.00020	0.0008
B	28	GPU pres 2	0.07	576	0.07	0.00016	0.0007
B	28	GPU temp 1	0.06	459	0.05	0.00013	0.0005
B	29	compr pres 1	2.09	16,627	1.84	0.01324	0.0527
B	29	GPU pres 3	1.20	9,598	1.06	0.00764	0.0304
B	29	GPU pres 2	1.16	9,214	1.02	0.00734	0.0292
B	29	compr pres 2	1.16	9,214	1.02	0.00734	0.0292
B	29	compr flow 1	0.34	2,701	0.30	0.00215	0.0086
B	29	compr lvl 1	0.25	1,953	0.22	0.00156	0.0062
B	29	compr lvl 2	0.25	1,953	0.22	0.00156	0.0062
B	29	compr lvl 3	0.25	1,953	0.22	0.00156	0.0062
B	29	compr lvl 4	0.25	1,953	0.22	0.00156	0.0062
B	29	GPU pres 1	0.10	809	0.09	0.00064	0.0026
B	29	GPU temp 1	0.09	732	0.08	0.00058	0.0023
B	29	GPU pres	0.05	420	0.05	0.00033	0.0013
B	30	GPU pres 3	1.20	9,396	1.05	0.00945	0.0369
B	30	GPU pres 2	1.16	9,021	1.01	0.00907	0.0354
B	30	GPU pres 1	0.10	792	0.09	0.00080	0.0031
B	30	GPU temp 1	0.09	717	0.08	0.00072	0.0028

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
B	30	GPU pres	0.05	411	0.05	0.00041	0.0016
B	31	HT pres 1	0.12	954	0.09	0.00209	0.0080
B	31	GPU pres 1	0.09	720	0.07	0.00158	0.0060
B	31	GPU pres 2	0.09	661	0.07	0.00145	0.0055
B	31	GPU pres	0.05	404	0.04	0.00088	0.0034
B	32	GPU pres 1	0.10	775	0.09	0.00127	0.0048
B	32	GPU pres 2	0.09	717	0.08	0.00117	0.0045
B	32	GPU pres	0.05	402	0.04	0.00066	0.0025
B	33	GPU pres 1	0.12	992	0.10	0.00145	0.0058
B	33	GPU pres 2	0.12	992	0.10	0.00145	0.0058
B	33	GPU pres	0.05	420	0.04	0.00061	0.0024
B	34	GPU pres 1	0.10	814	0.09	0.00092	0.0037
B	34	GPU pres 2	0.10	814	0.09	0.00092	0.0037
B	34	GPU pres	0.05	422	0.05	0.00048	0.0019
B	35	GPU pres 1	0.08	624	0.07	0.00045	0.0018
B	35	GPU pres	0.05	418	0.05	0.00030	0.0012
B	36	Mtr pres 1	1.20	9,658	1.04	0.01091	0.0437
B	36	GPU pres 1	0.12	937	0.10	0.00106	0.0042
B	36	GPU pres 2	0.12	937	0.10	0.00106	0.0042
B	36	HT pres 1	0.10	814	0.09	0.00092	0.0037
B	36	GPU pres	0.05	422	0.05	0.00048	0.0019
B	37	Wellhead pres 1	47	361,183	41.29	0.34868	1.3452
B	37	Compr pres 2	1.16	8,923	1.02	0.00861	0.0332
B	37	Compres pres 3	1.16	8,923	1.02	0.00861	0.0332
B	37	Compr pres 1	1.16	8,923	1.02	0.00861	0.0332
B	37	Compr lvl 1	0.25	1,892	0.22	0.00183	0.0070
B	37	Compr lvl 2	0.25	1,892	0.22	0.00183	0.0070
B	37	Compr lvl 3	0.25	1,892	0.22	0.00183	0.0070
B	37	Compr lvl 4	0.25	1,892	0.22	0.00183	0.0070
B	37	GPU pres 1	0.20	1,527	0.17	0.00147	0.0057
B	37	GPU pres 2	0.20	1,527	0.17	0.00147	0.0057
B	37	Sep pres 1	0.20	1,527	0.17	0.00147	0.0057
B	37	HT pres 1	0.12	960	0.11	0.00093	0.0036
B	37	GPU pres	0.05	406	0.05	0.00039	0.0015
B	38	Wellhead pres 1	2.33	17,784	2.06	0.01739	0.0662
B	38	Buyback pres 1	2.09	15,918	1.84	0.01557	0.0593
B	38	Comp pres 1	1.21	9,188	1.06	0.00898	0.0342
B	38	Compr pres 2	1.21	9,188	1.06	0.00898	0.0342
B	38	Compr pres 3	1.21	9,188	1.06	0.00898	0.0342
B	38	Compr lvl 2	0.47	3,546	0.41	0.00347	0.0132
B	38	Compr lvl 1	0.25	1,870	0.22	0.00183	0.0070
B	38	Compr lvl 3	0.25	1,870	0.22	0.00183	0.0070

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
B	38	Compr lvl 4	0.25	1,870	0.22	0.00183	0.0070
B	38	HT pres 1	0.12	949	0.11	0.00093	0.0035
B	38	Sep pres 1	0.12	949	0.11	0.00093	0.0035
B	38	Sep pres 2	0.12	949	0.11	0.00093	0.0035
B	38	GPU pres	0.05	402	0.05	0.00039	0.0015
B	39	Wellhead pres 1	2.33	17,784	2.06	0.01739	0.0662
B	39	Compr pres 1	1.21	9,188	1.06	0.00898	0.0342
B	39	Compr pres 2	1.21	9,188	1.06	0.00898	0.0342
B	39	Compr pres 3	1.21	9,188	1.06	0.00898	0.0342
B	39	Compr lvl 2	0.47	3,546	0.41	0.00347	0.0132
B	39	Compr lvl 1	0.25	1,870	0.22	0.00183	0.0070
B	39	Compr lvl 3	0.25	1,870	0.22	0.00183	0.0070
B	39	Compr lvl 4	0.25	1,870	0.22	0.00183	0.0070
B	39	HT pres 1	0.12	949	0.11	0.00093	0.0035
B	39	Sep pres 1	0.12	949	0.11	0.00093	0.0035
B	39	Sep pres 2	0.12	949	0.11	0.00093	0.0035
B	39	GPU pres	0.05	402	0.05	0.00039	0.0015
C	40	1176	0.42	3,678	0.33	0.00455	0.0199
C	40		0.35	1,523	0.27	0.00377	0.0083
C	40	1177, 1178	0.11	969	0.09	0.00120	0.0053
C	40	1177, 1178	0.11	969	0.09	0.00120	0.0053
C	40	1179	0.04	106	0.03	0.00040	0.0006
C	41	1176	0.45	3,904	0.35	0.00483	0.0212
C	41		0.35	1,523	0.27	0.00377	0.0083
C	41	1177, 1178	0.10	886	0.08	0.00110	0.0048
C	41	1177, 1178	0.10	886	0.08	0.00110	0.0048
C	41	1179	0.04	106	0.03	0.00040	0.0006
C	42		0.35	3,046	0.27	0.00377	0.0165
C	42	1177, 1178	0.11	969	0.09	0.00120	0.0053
C	42	1177, 1178	0.11	969	0.09	0.00120	0.0053
C	42	1188	0.11	924	0.08	0.00114	0.0050
C	42	1179	0.04	106	0.03	0.00040	0.0006
C	43		0.35	3,046	0.27	0.00377	0.0165
C	43	1177, 1178	0.15	1,342	0.12	0.00166	0.0073
C	43	1177, 1178	0.11	969	0.09	0.00120	0.0053
C	43	1188	0.11	924	0.08	0.00114	0.0050
C	43	1179	0.04	106	0.03	0.00040	0.0006
C	44	1177, 1178	0.12	1,011	0.09	0.00125	0.0055
C	44	1188	0.11	924	0.08	0.00114	0.0050
C	44	1177, 1178	0.06	486	0.04	0.00060	0.0026
C	44		0.04	366	0.03	0.00045	0.0020
C	44	1179	0.04	106	0.03	0.00040	0.0006

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
C	45	1193	0.82	7,187	0.62	0.01135	0.0497
C	45	1193	0.82	7,187	0.62	0.01135	0.0497
C	45	1195, 1196	0.24	2,112	0.18	0.00334	0.0146
C	45	1177, 1178	0.20	1,748	0.15	0.00276	0.0121
C	45	1177, 1178	0.11	986	0.09	0.00156	0.0068
C	45	1188	0.11	924	0.08	0.00146	0.0064
C	45	1179	0.04	106	0.03	0.00051	0.0007
C	46	1198	0.74	6,504	0.57	0.01478	0.0648
C	46		0.12	1,074	0.09	0.00244	0.0107
C	47		0.12	1,074	0.09	0.00108	0.0047
C	47	1205	0.12	426	0.10	0.00107	0.0019
C	48		0.12	1,074	0.09	0.00183	0.0080
C	49	1219	36	312,701	28.24	0.54911	2.4051
C	49	1217	0.17	502	0.14	0.00267	0.0039
C	49		0.07	614	0.06	0.00108	0.0047
C	49		0.07	614	0.06	0.00108	0.0047
C	49	1223	0.05	438	0.04	0.00077	0.0034
C	49	1226	0.03	287	0.03	0.00050	0.0022
C	50		0.07	614	0.06	0.00065	0.0029
C	50		0.07	614	0.06	0.00065	0.0029
C	50	1235	0.03	263	0.03	0.00028	0.0012
D	51	MV-Wellhead	1.08	9,302	0.88	0.01048	0.0451
D	51	AutoCycle Plunger Controller	0.18	1,550	0.15	0.00175	0.0075
D	51	BPR- Separator	0.14	1,173	0.11	0.00132	0.0057
D	51	BPR-Heater Treater	0.08	707	0.07	0.00080	0.0034
D	52	BPV- HT	0.06	547	0.04	0.00200	0.0084
D	53	MV-wellhead	0.84	7,284	0.68	0.01020	0.0442
D	53	BPV-for production unit	0.14	1,192	0.11	0.00167	0.0072
D	53	AutoCycle Plunger Controller	0.11	910	0.08	0.00127	0.0055
D	53	Balanced Motor Valve On Production Unit	0.07	589	0.05	0.00082	0.0036
D	53	Balanced Motor Valve On Production Unit	0.07	589	0.05	0.00082	0.0036
D	54	MV- Flowline	1.80	15,798	1.45	0.01760	0.0771
D	54	BPV- Sales Line	0.66	5,793	0.53	0.00645	0.0283
D	54	BPV- Sep/FWKO	0.21	1,841	0.17	0.00205	0.0090
D	54	BPV- HT	0.10	843	0.08	0.00094	0.0041
D	55	BPV- Sales Line	0.34	2,978	0.26	0.00349	0.0151
D	55	BPV- Separator	0.12	1,010	0.09	0.00118	0.0051
D	55	BPV- HT	0.06	564	0.05	0.00066	0.0029
D	56	MV- FWKO	1.77	15,520	1.67	0.00836	0.0366
D	56	BPV- Sales Line	0.47	4,076	0.44	0.00220	0.0096
D	56	BPV- Sep/FWKO	0.15	1,342	0.14	0.00072	0.0032
D	56	BPV- HT	0.08	706	0.08	0.00038	0.0017

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
D	57	BPV- HT	0.09	819	0.07	0.00137	0.0059
D	57	BPV-Sales Line	0.09	782	0.07	0.00130	0.0056
D	58	BPR- Separator	0.13	1,167	0.11	0.00179	0.0078
D	58	AutoCycle Plunger Controller	0.10	905	0.08	0.00139	0.0060
D	58	BPR-Heater Treater	0.08	711	0.06	0.00109	0.0047
D	59	MV-Wellhead	0.82	7,062	0.64	0.01086	0.0470
D	59	Level Controller on Production Unit	0.20	1,751	0.16	0.00269	0.0117
D	59	AutoCycle Plunger Controller	0.09	744	0.07	0.00114	0.0050
D	60	MV- FWKO	1.77	15,478	1.43	0.01635	0.0714
D	60	MV- Plunger	1.76	15,415	1.42	0.01628	0.0711
D	60	MV- Comp 1	0.72	6,323	0.58	0.00668	0.0292
D	60	MV- Comp 2	0.72	6,323	0.58	0.00668	0.0292
D	60	BPV- Sales Line	0.59	5,135	0.47	0.00542	0.0237
D	60	LC- Comp 1	0.23	2,028	0.19	0.00214	0.0094
D	60	LC- Comp 2	0.23	2,028	0.19	0.00214	0.0094
D	60	LC- Comp 3	0.23	2,028	0.19	0.00214	0.0094
D	60	LC- Comp 4	0.23	2,028	0.19	0.00214	0.0094
D	60	BPV- FWKO	0.20	1,773	0.16	0.00187	0.0082
D	60	BPV- Separator	0.19	1,649	0.15	0.00174	0.0076
D	60	BPV- HT	0.09	829	0.08	0.00088	0.0038
D	61	MV- FWKO	1.69	14,632	1.20	0.02550	0.1101
D	61	MV- Comp 1	0.81	7,013	0.58	0.01222	0.0528
D	61	MV- Comp 2	0.81	7,013	0.58	0.01222	0.0528
D	61	BPV- Sales Line	0.35	3,046	0.25	0.00531	0.0229
D	61	LC- Comp 4	0.21	1,787	0.15	0.00311	0.0134
D	61	LC- Comp 1	0.19	1,624	0.13	0.00283	0.0122
D	61	LC- Comp 2	0.19	1,624	0.13	0.00283	0.0122
D	61	LC- Comp 3	0.19	1,624	0.13	0.00283	0.0122
D	61	BPV- FWKO	0.12	1,041	0.09	0.00181	0.0078
D	61	BPV- Separator	0.12	1,028	0.08	0.00179	0.0077
D	61	BPV- HT	0.12	1,016	0.08	0.00177	0.0076
D	62	BPV- Sales Line	0.39	3,391	0.29	0.00625	0.0271
D	62	BPV- Separator	0.15	1,326	0.11	0.00245	0.0106
D	62	BPV- HT	0.08	685	0.06	0.00126	0.0055
D	63	BPV- Sales Line	0.34	2,966	0.26	0.00358	0.0155
D	63	BPV- Separator	0.12	1,018	0.09	0.00123	0.0053
D	63	BPV- HT	0.07	636	0.06	0.00077	0.0033
D	64	MV-Wellhead	0.87	7,500	0.67	0.01211	0.0525
D	64	BPR- Separator	0.14	1,179	0.11	0.00190	0.0083
D	64	AutoCycle Plunger Controller	0.09	754	0.07	0.00122	0.0053
D	64	BPR-Heater Treater	0.08	711	0.06	0.00115	0.0050
D	65	MV- FWKO	1.62	14,151	1.38	0.01146	0.0502

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
D	65	MV- Plunger	1.61	14,094	1.38	0.01141	0.0500
D	65	MV- Comp 1	0.85	7,419	0.73	0.00601	0.0263
D	65	MV- Comp 2	0.85	7,419	0.73	0.00601	0.0263
D	65	BPV- Sales Line	0.59	5,149	0.50	0.00417	0.0183
D	65	LC- Comp 4	0.19	1,696	0.17	0.00137	0.0060
D	65	BPV- FWKO	0.19	1,654	0.16	0.00134	0.0059
D	65	BPV- Separator	0.19	1,654	0.16	0.00134	0.0059
D	65	LC- Comp 1	0.19	1,646	0.16	0.00133	0.0058
D	65	LC- Comp 2	0.19	1,646	0.16	0.00133	0.0058
D	65	LC- Comp 3	0.19	1,646	0.16	0.00133	0.0058
D	65	BPV- HT	0.07	656	0.06	0.00053	0.0023
D	66	MV- FWKO	2.01	17,573	1.73	0.01310	0.0574
D	66	MV- Comp 1	1.08	9,422	0.93	0.00703	0.0308
D	66	MV- Comp 2	1.08	9,422	0.93	0.00703	0.0308
D	66	BPV- Sales Line	0.56	4,934	0.49	0.00368	0.0161
D	66	BPV- Separator	0.19	1,654	0.16	0.00123	0.0054
D	66	LC- Comp 1	0.19	1,646	0.16	0.00123	0.0054
D	66	LC- Comp 2	0.19	1,646	0.16	0.00123	0.0054
D	66	LC- Comp 3	0.19	1,646	0.16	0.00123	0.0054
D	66	LC- Comp 4	0.19	1,646	0.16	0.00123	0.0054
D	66	BPV- FWKO	0.17	1,529	0.15	0.00114	0.0050
D	66	BPV- HT	0.10	868	0.09	0.00065	0.0028
D	67	MV- Plunger	2.15	18,452	1.61	0.02374	0.1017
D	67	MV- FWKO	2.01	17,188	1.50	0.02211	0.0947
D	67	MV- Comp 1	0.81	6,955	0.61	0.00895	0.0383
D	67	MV- Comp 2	0.81	6,955	0.61	0.00895	0.0383
D	67	BPV- Sales Line	0.29	2,516	0.22	0.00324	0.0139
D	67	LC- Comp 4	0.25	2,140	0.19	0.00275	0.0118
D	67	LC- Comp 1	0.22	1,913	0.17	0.00246	0.0105
D	67	LC- Comp 2	0.22	1,913	0.17	0.00246	0.0105
D	67	LC- Comp 3	0.22	1,913	0.17	0.00246	0.0105
D	67	BPV- Separator	0.09	764	0.07	0.00098	0.0042
D	67	BPV- HT	0.09	764	0.07	0.00098	0.0042
D	68	BPV with external sensor line on HT	9	79,583	7.50	0.11247	0.4818
D	68	BPR- Sep	0.11	947	0.09	0.00134	0.0057
D	68	AutoCycle Plunger Controller	0.07	602	0.06	0.00085	0.0036
D	69	AutoCycle Plunger Controller	1.02	8,776	0.79	0.01519	0.0651
D	69	MV-wellhead	0.84	7,212	0.65	0.01248	0.0535
D	69	BPR-Sep	0.14	1,190	0.11	0.00206	0.0088
D	69	BPR-HT	0.08	703	0.06	0.00122	0.0052
D	70	MV- Comp 1	0.72	6,341	0.60	0.00673	0.0295
D	70	MV- Comp 2	0.72	6,341	0.60	0.00673	0.0295

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
D	70	BPV- Sales Line	0.54	4,720	0.45	0.00501	0.0219
D	70	LC- Comp 4	0.23	2,034	0.19	0.00216	0.0094
D	70	LC- Comp 1	0.23	2,034	0.19	0.00216	0.0094
D	70	LC- Comp 2	0.23	2,034	0.19	0.00216	0.0094
D	70	LC- Comp 3	0.23	2,034	0.19	0.00216	0.0094
D	70	BPV- Separator	0.20	1,741	0.16	0.00185	0.0081
D	70	BPV- HT	0.10	893	0.08	0.00095	0.0041
E	71	Oil level	0.38	3,316	0.31	0.00371	0.0162
E	71	Water level	0.38	3,316	0.31	0.00371	0.0162
E	71	Oil level	0.38	3,316	0.31	0.00371	0.0162
E	71	Water level	0.38	3,316	0.31	0.00371	0.0162
E	71	hi/low temp temperature controller	0.05	419	0.04	0.00047	0.0021
E	71	hi/low temp temperature controller	0.05	419	0.04	0.00047	0.0021
E	71	high/low emergency well shut-in controller	0.03	235	0.02	0.00026	0.0011
E	71	high/low emergency well shut-in controller	0.03	235	0.02	0.00026	0.0011
E	71	liquid dump flare	0.03	232	0.02	0.00026	0.0011
E	72	Oil level	0.38	3,332	0.30	0.00369	0.0162
E	72	Water level	0.38	3,332	0.30	0.00369	0.0162
E	72	hi/low temp temperature controller	0.05	451	0.04	0.00050	0.0022
E	72	high/low emergency well shut-in controller	0.03	235	0.02	0.00026	0.0011
E	73	Oil level	0.38	3,348	0.31	0.00333	0.0146
E	73	Water level	0.38	3,348	0.31	0.00333	0.0146
E	73	high/low emergency well shut-in controller	0.03	235	0.02	0.00023	0.0010
E	73	liquid dump flare	0.03	224	0.02	0.00022	0.0010
E	74	Oil level	0.38	3,316	0.32	0.00292	0.0128
E	74	Water level	0.38	3,316	0.32	0.00292	0.0128
E	74	Oil level	0.38	3,316	0.32	0.00292	0.0128
E	74	Water level	0.38	3,316	0.32	0.00292	0.0128
E	74	hi/low temp temperature controller	0.05	419	0.04	0.00037	0.0016
E	74	hi/low temp temperature controller	0.05	419	0.04	0.00037	0.0016
E	74	high/low emergency well shut-in controller	0.03	235	0.02	0.00021	0.0009
E	74	high/low emergency well shut-in controller	0.03	235	0.02	0.00021	0.0009
E	74	liquid dump flare	0.03	232	0.02	0.00020	0.0009
E	75	Oil level	0.38	3,316	0.31	0.00282	0.0123
E	75	Water level	0.38	3,316	0.31	0.00282	0.0123
E	75	Oil level	0.38	3,291	0.31	0.00280	0.0122
E	75	Water level	0.38	3,291	0.31	0.00280	0.0122
E	75	hi/low temp temperature controller	0.04	370	0.04	0.00031	0.0014
E	75	hi/low temp temperature controller	0.04	370	0.04	0.00031	0.0014
E	75	high/low emergency well shut-in controller	0.03	235	0.02	0.00020	0.0009
E	75	high/low emergency well shut-in controller	0.03	235	0.02	0.00020	0.0009
E	75	liquid dump flare	0.03	232	0.02	0.00020	0.0009

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
E	76	Water level	0.74	6,440	0.59	0.00705	0.0309
E	76	Oil level	0.38	3,332	0.31	0.00364	0.0160
E	76	high/low emergency well shut-in controller	0.03	235	0.02	0.00026	0.0011
E	76	liquid dump flare	0.03	232	0.02	0.00025	0.0011
E	77	Oil level	21	182,123	16.82	0.18459	0.8085
E	77	Water level	21	182,123	16.82	0.18459	0.8085
E	77	Oil level	21	182,123	16.82	0.18459	0.8085
E	77	Water level	21	182,123	16.82	0.18459	0.8085
E	77	Oil level	21	182,123	16.82	0.18459	0.8085
E	77	Water level	21	182,123	16.82	0.18459	0.8085
E	77	hi/low temp temperature controller	0.05	451	0.04	0.00046	0.0020
E	77	high/low emergency well shut-in controller	0.03	235	0.02	0.00024	0.0010
E	77	high/low emergency well shut-in controller	0.03	235	0.02	0.00024	0.0010
E	77	high/low emergency well shut-in controller	0.03	235	0.02	0.00024	0.0010
E	78	Oil level	0.38	3,332	0.30	0.00436	0.0191
E	78	Water level	0.38	3,332	0.30	0.00436	0.0191
E	78	Oil level	0.38	3,332	0.30	0.00436	0.0191
E	78	Water level	0.38	3,332	0.30	0.00436	0.0191
E	78	high/low emergency well shut-in controller	0.03	235	0.02	0.00031	0.0013
E	78	high/low emergency well shut-in controller	0.03	235	0.02	0.00031	0.0013
E	78	liquid dump flare	0.03	232	0.02	0.00030	0.0013
E	79	Oil level	0.38	3,316	0.35	0.00062	0.0027
E	79	Water level	0.38	3,316	0.35	0.00062	0.0027
E	79	hi/low temp temperature controller	0.05	419	0.04	0.00008	0.0003
E	79	high/low emergency well shut-in controller	0.03	235	0.02	0.00004	0.0002
E	80	Oil level	21	182,123	16.96	0.17912	0.7845
E	80	Water level	21	182,123	16.96	0.17912	0.7845
E	80	Oil level	21	182,123	16.96	0.17912	0.7845
E	80	Water level	21	182,123	16.96	0.17912	0.7845
E	80	Oil level	21	182,123	16.96	0.17912	0.7845
E	80	Water level	21	182,123	16.96	0.17912	0.7845
E	80	high/low emergency well shut-in controller	0.03	235	0.02	0.00023	0.0010
E	80	high/low emergency well shut-in controller	0.03	235	0.02	0.00023	0.0010
E	80	high/low emergency well shut-in controller	0.03	235	0.02	0.00023	0.0010
E	80	liquid dump flare	0.03	232	0.02	0.00023	0.0010
F	91	2	0.08	686	0.07	0.00068	0.0028
F	91	1	0.08	683	0.07	0.00068	0.0028
F	91	1	0.08	683	0.07	0.00068	0.0028
F	92	1	0.09	671	0.06	0.00179	0.0067
F	92	2	0.09	671	0.06	0.00179	0.0067
F	93	2	12	72,876	9.00	0.14573	0.4536
F	93	7	0.39	2,410	0.30	0.00482	0.0150

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
F	93	5	0.39	2,399	0.30	0.00480	0.0149
F	93	6	0.39	2,399	0.30	0.00480	0.0149
F	93	3	0.22	1,364	0.17	0.00273	0.0085
F	93	4	0.19	1,175	0.15	0.00235	0.0073
F	93	1	0.04	237	0.03	0.00047	0.0015
F	94	2	1.64	10,851	1.28	0.01916	0.0633
F	94	7	0.39	2,556	0.30	0.00451	0.0149
F	94	5	0.39	2,544	0.30	0.00449	0.0148
F	94	6	0.39	2,544	0.30	0.00449	0.0148
F	94	3	0.28	1,852	0.22	0.00327	0.0108
F	94	4	0.24	1,602	0.19	0.00283	0.0093
F	94	1	0.04	251	0.03	0.00044	0.0015
F	95	2	3.03	26,147	2.17	0.06141	0.2654
F	95	4	1.84	15,898	1.32	0.03734	0.1614
F	95	3	0.20	1,769	0.15	0.00416	0.0180
F	95	1	0.04	317	0.03	0.00075	0.0032
F	96	1	0.10	832	0.08	0.00080	0.0034
F	97	2	1.35	11,368	1.03	0.01679	0.0706
F	97	1	0.18	1,540	0.14	0.00227	0.0096
F	97	4	0.03	288	0.03	0.00043	0.0018
F	97	5	0.03	217	0.02	0.00032	0.0013
F	98	2	1.68	14,719	1.33	0.02223	0.0972
F	98	4	1.45	12,675	1.14	0.01914	0.0837
F	98	3	0.17	1,461	0.13	0.00221	0.0096
F	98	1	0.16	1,413	0.13	0.00213	0.0093
F	98	5	0.03	300	0.03	0.00045	0.0020
F	98	6	0.03	300	0.03	0.00045	0.0020
F	99	5	0.90	7,851	0.72	0.01059	0.0463
F	99	1	0.77	6,733	0.62	0.00908	0.0397
F	99	6	0.18	1,539	0.14	0.00208	0.0091
F	99	7	0.18	1,539	0.14	0.00208	0.0091
F	99	8	0.03	300	0.03	0.00040	0.0018
F	99	9	0.03	300	0.03	0.00040	0.0018
F	100	1	0.10	743	0.08	0.00172	0.0061
F	100	3	0.10	739	0.08	0.00171	0.0061
F	100	2	0.07	535	0.06	0.00124	0.0044
F	101	2	0.81	7,068	0.67	0.00853	0.0370
F	101	1	0.09	779	0.07	0.00094	0.0041
F	102	5	0.09	792	0.07	0.00121	0.0052
F	102	5	0.09	792	0.07	0.00121	0.0052
F	102	1	0.08	673	0.06	0.00103	0.0044
F	102	2	0.08	673	0.06	0.00103	0.0044

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
F	102	3	0.08	648	0.06	0.00099	0.0043
F	103	1	0.82	7,047	0.66	0.00983	0.0424
F	103	1	0.82	7,047	0.66	0.00983	0.0424
F	103	5	0.24	2,071	0.19	0.00289	0.0125
F	103	2	0.09	774	0.07	0.00108	0.0047
F	103	3	0.09	774	0.07	0.00108	0.0047
F	103	4	0.09	774	0.07	0.00108	0.0047
F	104	2	1.36	11,888	1.22	0.00866	0.0378
F	104	1	0.06	533	0.05	0.00039	0.0017
F	105	1	0.08	723	0.07	0.00096	0.0042
F	106	3	0.99	8,546	0.75	0.01336	0.0579
F	106	2	0.98	8,473	0.75	0.01325	0.0574
F	106	1	0.10	902	0.08	0.00141	0.0061
F	106	4	0.03	293	0.03	0.00046	0.0020
F	106	5	0.03	293	0.03	0.00046	0.0020
F	107	1	0.72	5,715	0.62	0.00506	0.0201
F	107	1	0.72	5,715	0.62	0.00506	0.0201
F	107	6	0.09	725	0.08	0.00064	0.0025
F	107	2	0.09	724	0.08	0.00064	0.0025
F	107	3	0.09	724	0.08	0.00064	0.0025
F	108	3	0.89	7,810	0.64	0.01302	0.0570
F	108	6	0.04	367	0.03	0.00061	0.0027
F	108	1	0.04	346	0.03	0.00058	0.0025
F	108	2	0.04	346	0.03	0.00058	0.0025
F	108	7	0.03	304	0.03	0.00051	0.0022
F	108	4	0.03	300	0.02	0.00050	0.0022
F	108	5	0.03	300	0.02	0.00050	0.0022
F	108	8	0.03	300	0.02	0.00050	0.0022
F	108	9	0.03	300	0.02	0.00050	0.0022
F	109	4	0.77	3,219	0.55	0.01354	0.0282
F	109	5	0.12	493	0.08	0.00207	0.0043
F	109	3	0.04	146	0.02	0.00062	0.0013
F	109	1	0.03	143	0.02	0.00060	0.0012
F	109	2	0.03	143	0.02	0.00060	0.0012
F	110	1	1.61	14,124	1.31	0.02115	0.0926
F	110	1	1.61	14,124	1.31	0.02115	0.0926
F	110	2	0.10	848	0.08	0.00127	0.0056
F	110	3	0.10	848	0.08	0.00127	0.0056
G	111	WH pres 1	0.04	335	0.03	0.00047	0.0019
G	111	WH Flow	0.04	335	0.03	0.00047	0.0019
G	112	Sales pres	0.12	951	0.09	0.00243	0.0097
G	112	sep pres 1	0.12	951	0.09	0.00243	0.0097

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
G	113	Sales press	0.25	1,937	0.19	0.00354	0.0140
G	113	sep pres 1	0.09	720	0.07	0.00130	0.0052
G	113	HT tmp 1	0.05	367	0.04	0.00067	0.0026
G	114	Sales pres 1	0.22	1,770	0.17	0.00387	0.0155
G	114	HT pres	0.08	662	0.06	0.00145	0.0058
G	114	HT pres 1	0.03	208	0.02	0.00046	0.0018
G	115	HT pres	0.09	720	0.06	0.00185	0.0074
G	115	sep pres 1	0.03	212	0.02	0.00054	0.0022
G	116	HT pres	0.09	720	0.07	0.00139	0.0056
G	116	Sep pres 1	0.09	720	0.07	0.00139	0.0056
G	116	Sep pres 2	0.09	720	0.07	0.00139	0.0056
G	116	HT tmp 1	0.06	466	0.05	0.00091	0.0036
G	116	Sep pres 3	0.03	210	0.02	0.00041	0.0016
G	116	Sep pres 4	0.03	209	0.02	0.00041	0.0016
G	117	HT pres	0.09	720	0.08	0.00134	0.0054
G	117	sep pres 1	0.09	720	0.08	0.00134	0.0054
G	118	Sales pres	0.25	1,967	0.18	0.00436	0.0175
G	118	HT pres 1	0.09	720	0.07	0.00159	0.0064
G	118	HT pres 2	0.03	212	0.02	0.00047	0.0019
G	119	GPU pres	0.09	720	0.07	0.00127	0.0051
G	119	GPU pres 1	0.09	720	0.07	0.00127	0.0051
G	119	sep pres 1	0.03	212	0.02	0.00037	0.0015
G	119	GPU pres 1	0.03	212	0.02	0.00037	0.0015
G	120	WH pres	0.06	467	0.04	0.00083	0.0033
G	120	WH Flow	0.06	467	0.04	0.00082	0.0033
G	121	WH Flow	0.03	259	0.03	0.00034	0.0013
G	121	WH pres	0.03	259	0.03	0.00034	0.0013
G	121	Sep pres 1	0.03	203	0.02	0.00027	0.0011
G	121	Sep pres 2	0.03	203	0.02	0.00027	0.0011
G	122	GPU lvl 1	26	209,297	20.34	0.40096	1.6070
G	122	HW pres 1	0.06	467	0.05	0.00089	0.0036
G	122	WH Flow	0.06	466	0.05	0.00089	0.0036
G	123	WH pres	0.03	270	0.03	0.00042	0.0017
G	124	WH pres 1	0.06	468	0.05	0.00081	0.0032
G	124	WH Flow	0.06	467	0.05	0.00081	0.0032
G	125	WH pres	0.09	720	0.07	0.00127	0.0051
G	126	WH pres 1	0.06	468	0.05	0.00074	0.0030
G	126	WH Flow	0.06	467	0.05	0.00074	0.0030
G	127	sep Lvl 1	20	161,322	17.83	0.13273	0.5320
G	127	Well Head	0.07	598	0.07	0.00049	0.0020
G	128	compr pres 1	2.36	18,637	1.94	0.02704	0.1067
G	128	compr lvl 1	1	4,008	0.42	0.00581	0.0230

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
G	128	compr lvl 2	1	4,008	0.42	0.00581	0.0230
G	128	compr lvl 3	0.48	3,801	0.40	0.00551	0.0218
G	129	SEP lvl 2	20	158,944	15.04	0.35419	1.3983
G	129	SEP lvl 1	20	160,365	15.04	0.35413	1.4108
G	129	Well Head	0.07	556	0.05	0.00122	0.0049
G	130	GPU lvl 1	20	160,999	15.57	0.30252	1.2125
G	130	GPU lvl 2	20	160,998	15.57	0.30252	1.2125
G	130	GPU pres	0.07	567	0.05	0.00107	0.0043
G	130	GPU tmp 1	0.03	218	0.02	0.00041	0.0016
G	130	GPU tmp 2	0.03	210	0.02	0.00040	0.0016
G	131	GPU lvl 2	20	162,735	15.74	0.30578	1.2256
G	131	GPU lvl 1	20	162,735	15.74	0.30578	1.2256
G	131	GPU tmp 1	0.04	339	0.03	0.00064	0.0026
G	131	GPU tmp 2	0.04	339	0.03	0.00064	0.0026
G	132	Sep pres	0.25	1,967	0.14	0.00907	0.0363
G	133	Sep pres 2	0.81	6,476	0.47	0.02147	0.0861
G	133	sep pres 1	0.25	1,967	0.14	0.00652	0.0261
G	133	compr lvl 1	0.23	1,879	0.14	0.00623	0.0250
G	133	compr lvl 2	0.06	491	0.04	0.00163	0.0065
G	134	compr pres 1	0.81	6,476	0.47	0.00747	0.0299
G	134	SEP Press 2	0.25	1,967	0.14	0.00227	0.0091
G	134	sep pres 1	0.25	1,967	0.14	0.00227	0.0091
G	134	compr lvl 1	0.24	1,897	0.14	0.00219	0.0088
G	134	compr lvl 2	0.06	491	0.04	0.00057	0.0023
G	135	sep pres 1	0.25	197	0.14	0.00652	0.0026
G	136	Sep pres 1	0.03	223	0.01	0.00105	0.0042
G	137	compr pres 1	0.72	5,745	0.42	0.02033	0.0815
G	137	compr lvl 1	0.21	1,672	0.12	0.00592	0.0237
G	137	sep pres 1	0.08	662	0.05	0.00234	0.0094
G	137	compr lvl 2	0.05	383	0.03	0.00136	0.0054
G	138	compr pres 1	0.81	6,476	0.47	0.02281	0.0914
G	138	sep pres 1	0.22	1,770	0.13	0.00623	0.0250
G	139	Sep pres 1	0.81	6,476	0.42	0.03174	0.1272
G	139	sep pres 1	0.25	1,967	0.13	0.00964	0.0386
G	140	GPU pres	0.63	5,073	0.35	0.02189	0.0877
G	140	compr pres 1	0.20	1,572	0.11	0.00679	0.0272
G	140	sep pres 1	0.03	212	0.01	0.00092	0.0037
G	141	Sep pres 2	0.81	6,476	0.44	0.03155	0.1265
G	141	sep pres 1	0.25	1,967	0.13	0.00958	0.0384
G	142	Sep pres	0.81	6,476	0.46	0.02844	0.1140
G	142	compr pres 1	0.25	1,967	0.14	0.00864	0.0346
G	142	sep pres 1	0.12	951	0.07	0.00417	0.0167

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
G	143	Sep pres 1	0.81	6,476	0.47	0.02906	0.1165
G	143	GPU pres	0.26	2,046	0.15	0.00918	0.0368
G	143	GPU pres 1	0.25	1,967	0.14	0.00882	0.0354
G	143	compr lvl 1	0.23	1,879	0.14	0.00843	0.0338
G	143	compr lvl 2	0.22	1,774	0.13	0.00796	0.0319
G	144	compr pres 1	0.80	6,347	0.54	0.02058	0.0813
G	144	compr pres 2	0.80	6,347	0.54	0.02058	0.0813
G	144	GPU pres	0.09	720	0.06	0.00230	0.0092
G	144	GPU pres 1	0.09	720	0.06	0.00230	0.0092
G	144	GPU pres	0.09	696	0.06	0.00230	0.0089
G	144	HT tmp 1	0.07	531	0.05	0.00172	0.0068
G	144	sep pres 1	0.05	360	0.03	0.00119	0.0046
G	145	Sep pres 3	0.81	6,525	0.54	0.02069	0.0829
G	145	sep pres 1	0.09	720	0.06	0.00228	0.0092
G	145	HT tmp 1	0.07	573	0.05	0.00182	0.0073
G	145	Sep pres 2	0.03	223	0.02	0.00071	0.0028
H	146	1	0.07	656	0.05	0.00134	0.0059
H	146	2	0.06	532	0.04	0.00109	0.0048
H	147	1	0.12	1,030	0.09	0.00211	0.0092
H	147	2	0.12	1,030	0.09	0.00211	0.0092
H	148	3	0.13	1,105	0.09	0.00226	0.0099
H	148	4	0.13	1,105	0.09	0.00226	0.0099
H	148	6	0.12	1,030	0.09	0.00211	0.0092
H	148	5	0.11	968	0.08	0.00198	0.0087
H	148	7	0.11	968	0.08	0.00198	0.0087
H	148	2	0.10	906	0.07	0.00185	0.0081
H	149	1	0.13	1,105	0.09	0.00226	0.0099
H	149	2	0.13	1,105	0.09	0.00226	0.0099
H	149	3	0.13	1,105	0.09	0.00226	0.0099
H	150	3 - plunger	0.20	1,739	0.17	0.00191	0.0084
H	150	1	0.12	1,030	0.10	0.00113	0.0050
H	150	2 - plunger	0.07	655	0.06	0.00072	0.0032
H	151	2	0.06	532	0.05	0.00034	0.0015
H	152	1	0.13	1,105	0.11	0.00076	0.0033
H	152	2	0.13	1,105	0.11	0.00076	0.0033
H	152	3	0.13	1,105	0.11	0.00076	0.0033
H	153	1	0.13	1,105	0.11	0.00070	0.0031
H	153	2	0.13	1,105	0.11	0.00070	0.0031
H	153	3	0.12	1,030	0.11	0.00066	0.0029
H	153	4	0.12	1,030	0.11	0.00066	0.0029
H	154	3 - plunger	0.57	4,992	0.51	0.00323	0.0141
H	154	4 - plunger	0.56	4,938	0.51	0.00319	0.0140

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
H	155	2	0.13	1,105	0.11	0.00031	0.0014
H	155	4	0.13	1,105	0.11	0.00031	0.0014
H	155	1	0.09	781	0.08	0.00022	0.0010
H	155	3	0.09	781	0.08	0.00022	0.0010
H	156	5 - plunger	0.23	2,017	0.21	0.00057	0.0025
H	156	1	0.13	1,105	0.11	0.00031	0.0014
H	156	2	0.13	1,105	0.11	0.00031	0.0014
H	156	3	0.09	781	0.08	0.00022	0.0010
H	157	1	0.12	1,093	0.11	0.00071	0.0031
H	157	2	0.12	1,093	0.11	0.00071	0.0031
H	157	3	0.07	656	0.07	0.00042	0.0019
H	158	1	0.09	781	0.08	0.00050	0.0022
H	158	2	0.09	781	0.08	0.00050	0.0022
H	158	3	0.09	781	0.08	0.00050	0.0022
H	158	4	0.09	781	0.08	0.00050	0.0022
H	159	2	0.91	7,983	0.77	0.00352	0.0154
H	159	1	0.10	842	0.08	0.00037	0.0016
H	160	2	0.90	7,892	0.76	0.00390	0.0171
H	160	1	0.10	904	0.09	0.00045	0.0020
H	161	4	0.25	2,150	0.18	0.00319	0.0140
H	161	5	0.25	2,150	0.18	0.00319	0.0140
H	161	6	0.25	2,150	0.18	0.00319	0.0140
H	161	7	0.25	2,150	0.18	0.00319	0.0140
H	161	2	0.18	1,536	0.13	0.00228	0.0100
H	161	3	0.18	1,536	0.13	0.00228	0.0100
H	161	1	0.10	905	0.08	0.00134	0.0059
H	162	7 - plunger	0.34	3,008	0.32	0.000005	0.00002
H	162	3	0.24	2,146	0.23	0.000003	0.00001
H	162	4	0.24	2,146	0.23	0.000003	0.00001
H	162	5	0.24	2,146	0.23	0.000003	0.00001
H	162	6	0.24	2,146	0.23	0.000003	0.00001
H	162	8 - plunger	0.05	443	0.05	0.000001	0.000003
H	162	1	0.03	223	0.02	0.0000003	0.000002
H	162	2	0.03	223	0.02	0.0000003	0.000002
H	163	1	0.13	1,104	0.10	0.00115	0.0050
H	163	2	0.13	1,104	0.10	0.00115	0.0050
H	164	1	0.13	1,104	0.10	0.00067	0.0030
H	165	1	0.09	781	0.07	0.00106	0.0047
H	166	1	0.37	3,258	0.28	0.00412	0.0180
H	166	2	0.18	1,600	0.14	0.00202	0.0089
H	166	3	0.18	1,600	0.14	0.00202	0.0089
H	167	1	0.11	966	0.10	0.00020	0.0009

Company ID	Site ID	Controller ID	scf gas/hour	scf gas/year	scf methane/hour	lb VOC/hour	ton VOC/year
H	167	2	0.11	966	0.10	0.00020	0.0009
H	168	1	0.11	966	0.10	0.00012	0.0005
H	169	1	0.08	718	0.06	0.00080	0.0035
H	170	1	0.08	718	0.06	0.00087	0.0038
H	171	1	0.09	780	0.07	0.00094	0.0041
H	172	2 - plunger	0.41	3,554	0.34	0.00165	0.0072
H	172	4	0.40	3,513	0.34	0.00163	0.0072
H	172	1 - plunger	0.27	2,384	0.23	0.00111	0.0049