



API Field Measurement Study: Pneumatic Controllers

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Study Overview

➤ Goals

- Inventory pneumatic controllers at a range of site types
- Correctly classify pneumatic controllers and measure emissions
- Understand the frequency of malfunctioning pneumatic controllers and their emissions

➤ 72 sites operated by 8 companies selected for study in 4 AAPG basins

- Anadarko (# 360), San Juan (# 580), Gulf Coast (# 220) and Permian (# 430)

➤ Variety of site types in the production and gathering & boosting segments

➤ Variety of production/formation types; conventional gas, unconventional gas and oil

➤ Study conducted from June to December 2015

Site Details

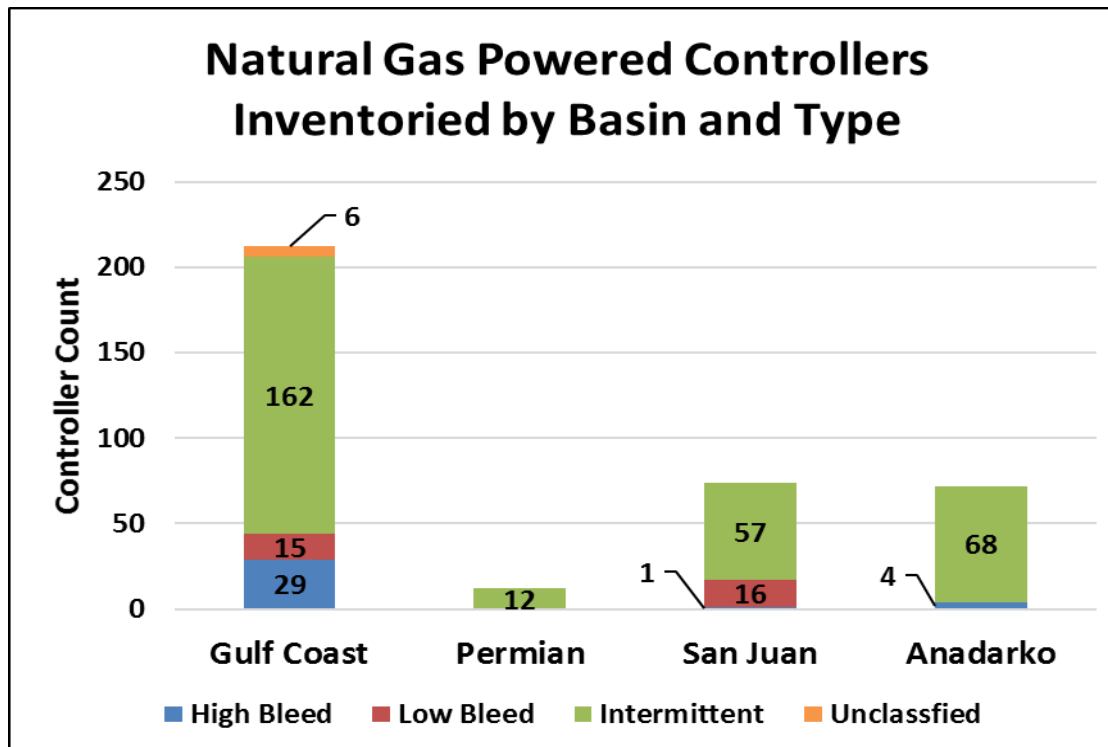
➤ A broad range of site types were represented in the study

Site Type and Category	San Juan	Anadarko	Permian*	Gulf Coast	Total
Natural Gas Sites	12	25	0	11	48
Well Site	6	8	0	3	17
Well Production	2	12	0	0	14
Central Production	3	1	0	6	10
Boosting and Gathering	1	4	0	2	7
Oil Sites	0	1	18	5	24
Well Site	0	0	9	2	11
Well Production	0	1	3	3	7
Central Production	0	0	4	0	4
Boosting and Gathering	0	0	2	0	2
Total	12	26	18	16	72

*3 Permian Basin natural gas sites, initially selected for study, were not included since they were EOR sites handling primarily CO₂

Pneumatic Controllers – Inventory

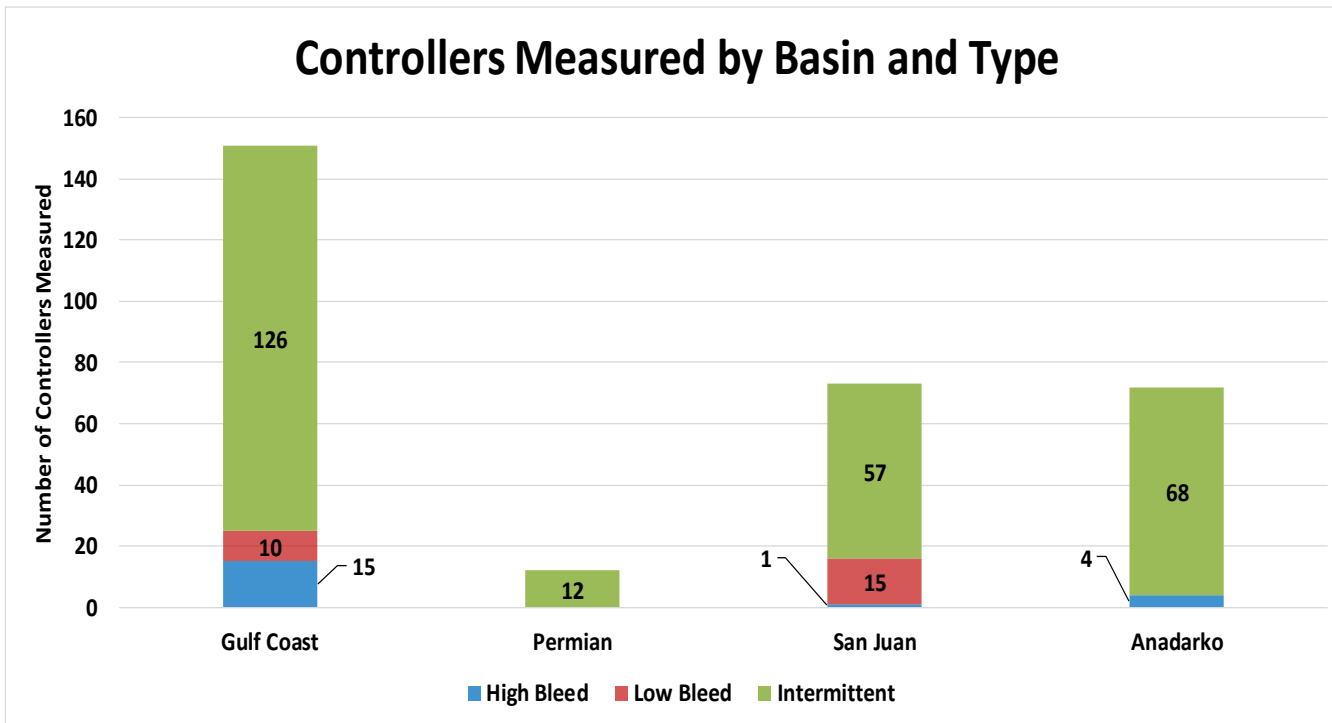
- Of 72 sites, controllers were inventoried at 67
 - 19 (26%) sites - no pneumatic controllers.
 - 40 (55%) sites – At least one natural gas powered pneumatic controller; with 32 sites exclusively natural gas
 - 8 (11%) sites - pneumatic controllers were exclusively air or primarily CO₂



- At 45 sites with detailed inventory
 - 420 non-mechanical controllers counted
 - 370 (88%) Operated by natural gas
 - 39 (9%) Operated by air or primarily CO₂
 - 7 (2%) Electric operated
 - 4 (1%) Out of service or energy type unknown

Pneumatic Controller Measurement Overview

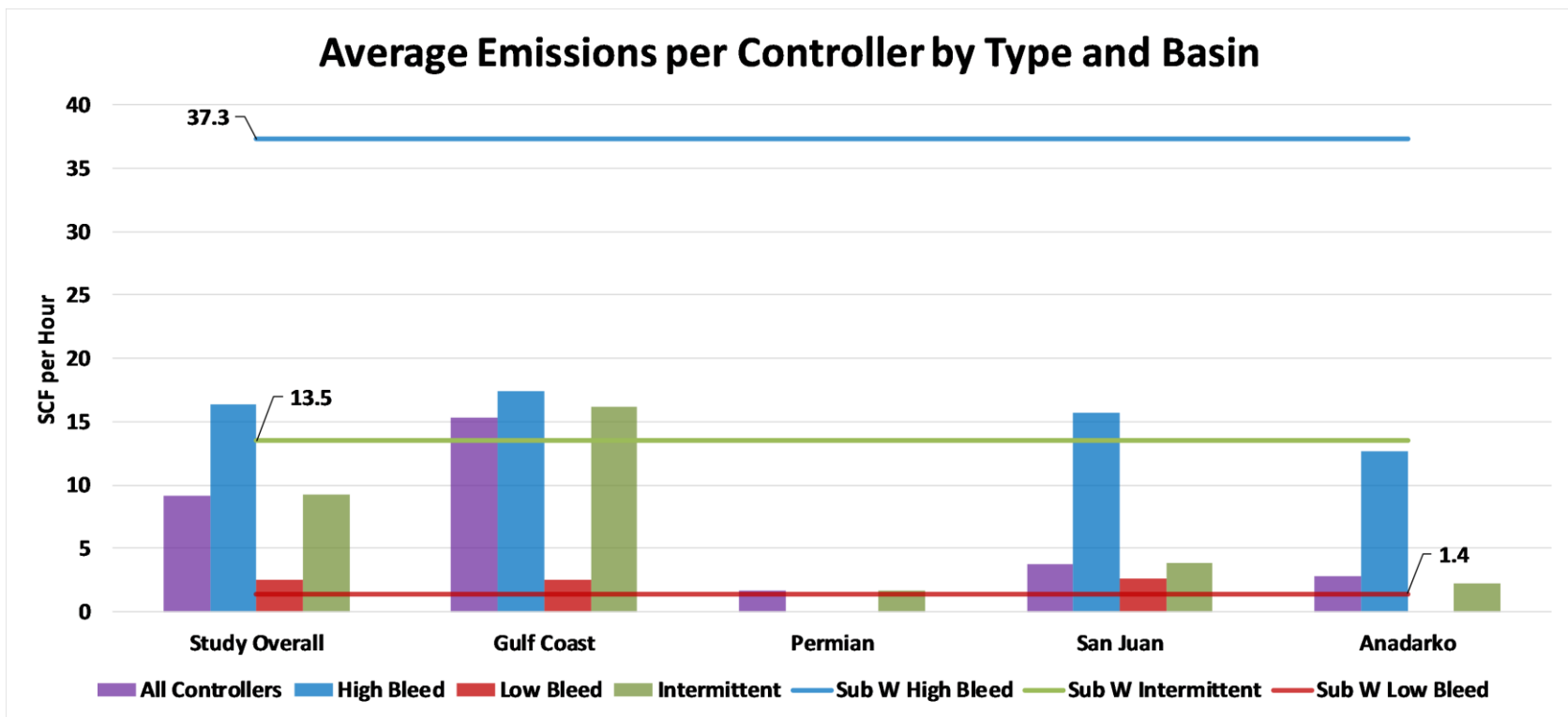
- Measured exhaust emissions from 308 controllers at 39 sites with nat. gas controllers
 - Most time series at 2 second sampling rate (0.5 Hz) for minimum of approx. 15 min
 - Daily calibration, and QA/QC used to ensure instrument performance.



Intermittent - 85.4%
High Bleed - 6.5%
Low Bleed - 8.1%

Pneumatic Controller Measurement Averages

- Study averages were dominated by Gulf Coast measurements
- Intermittent vent type controller average was dominated by malfunctioning controllers



Note: 0.13 scf/hr minimum emissions was used when instrument readings were below 0.13 scf/hr

Study Measurement Averages and Cumulative Emissions

Average Measured Emissions – SCFH Whole Gas					
	Study Overall	Gulf Coast	Permian	San Juan	Anadarko
Average Emissions – All	9.2	15.4	1.6	3.7	2.9
Average Emissions - High Bleed	16.4	17.4		15.7	12.6
Average Emissions - Low Bleed	2.6	2.7		2.6	
Average Emissions - Intermittent	9.2	16.2	1.6	3.8	2.3

Note that average values may change slightly as analysis is completed

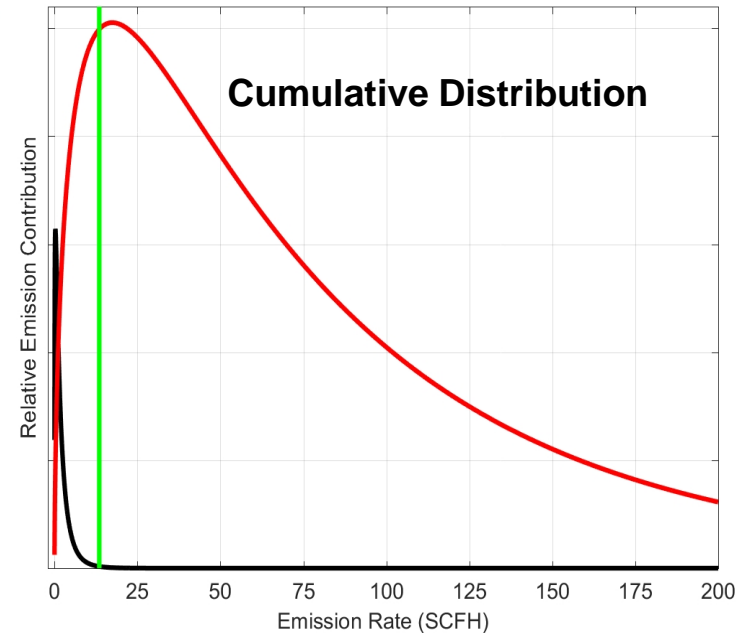
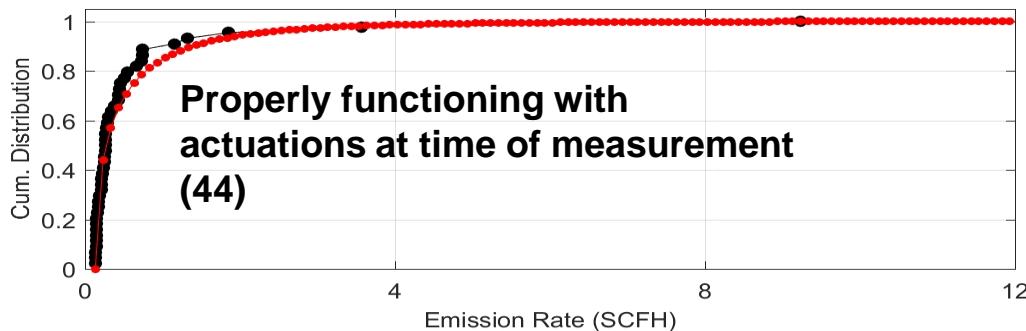
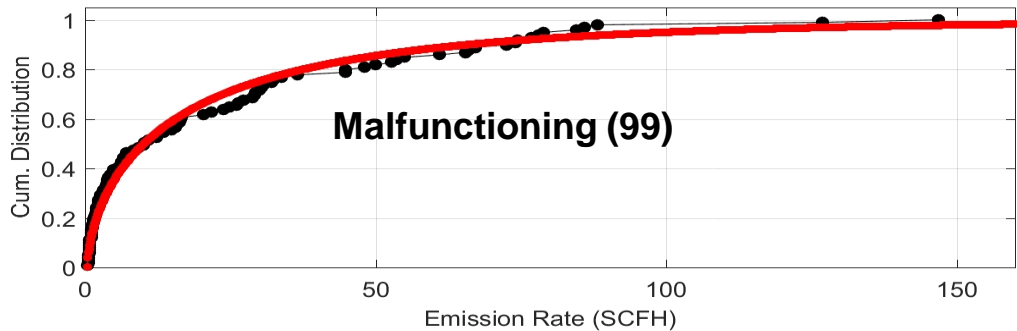
Cumulative Measured Emissions – SCF Whole Gas			
	Count	Study Cumulative Measured SCF	% of Study Measured Controller Emissions
High Bleed	20	327	11.6%
Low Bleed	25	65.8	2.3%
Properly Functioning Intermittent	164	42.3	1.5%
Malfunctioning Intermittent	99	2,387	84.6%

Note that category counts and cumulative measurements may change slightly as analysis is completed

Intermittent PC Data Fitting

➤ Cumulative distribution fitting with Weibull distribution function

- Dominated by number of Gulf Coast measurements
- Minimally emitting controllers excluded from Weibull distribution but included in cumulative distribution



	Weibull scale parameter	Weibull shape parameter
Properly functioning	0.2735	0.5463
Malfunctioning	17.4266	0.6294

Red Line – Malfunctioning
 Black Line – Properly Functioning
 Green Line – Subpart W EF

Instruments and Measurement Approach

- Controller exhaust was measured with high volume samplers
- Most measurements were made with the GHD recording high volume sampler with about 0.5 Hz recording
- 8 measurements were made with the Indaco high volume sampler and 1 with the Bacharach high volume sampler. All 9 were either zero measured emissions or had constant emissions
- The effective resolution of the GHD sampler was empirically determined to be 0.26 scf/hr
- To conservatively account for minimal emissions (see page) 0.13 scf/hr (1/2 the effective resolution) was used as the minimum rate for intermittent vent controller measurements below this value
- Instrument response factors were developed for each instrument using the gas composition at each site with measurements

Conclusions

➤ Comparison to Subpart W Emissions Factors

- Subpart W High bleed is higher than study (37.3 vs. 16.4)
- Subpart W Low bleed is lower than study (1.39 vs. 2.6)
- Consider new tiered approach for Subpart W Intermittent
 - Properly Functioning Intermittent Controller >> 0.3 scfh
 - Malfunctioning Intermittent Controller >> 24.1 scfh
- Tiered approach supported by skewed emission distribution in this and other studies
- Tiered approach would enable collection of more accurate GHGRP emission data

Questions?