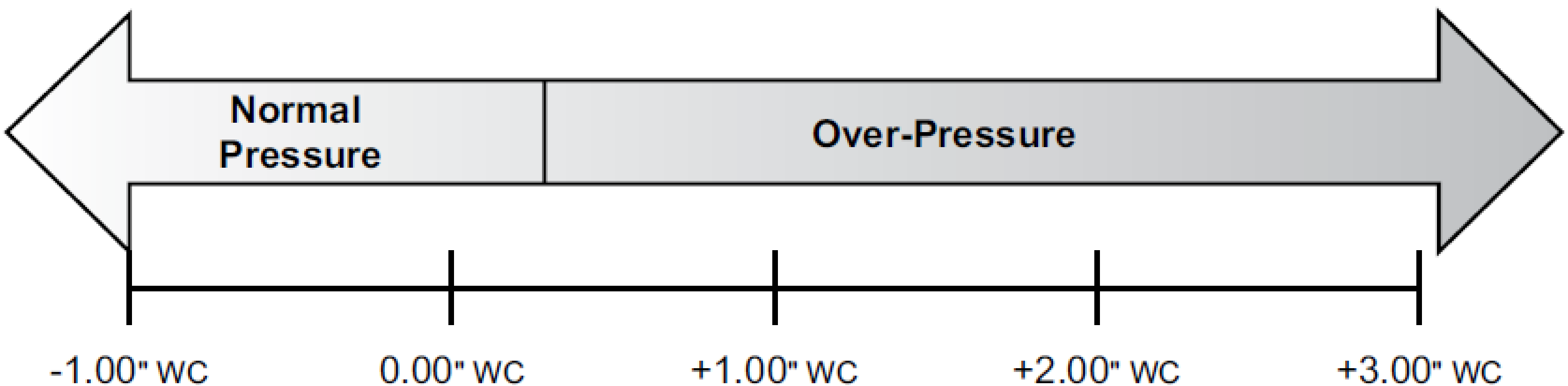
California Air Resources Board
Public Workshop
Enhanced Vapor Recovery
ISD Alarms and Emissions
Related to Overpressure



November 6, 2015 in Sacramento
November 10, 2015 in Diamond Bar

Housekeeping

- Emergency Exits, Building Evacuation, Restrooms
- Hold questions and comments till end of each segment
- For those participating via conference call and webinar, email your comments during the presentation to george.lew@arb.ca.gov
- Presentation, webinar information, and conference call information is posted at http://www.arb.ca.gov/vapor/vapor.htm

Purpose of Workshop

- Discuss findings from ARB studies
- Present ideas for possible solutions
- Request input from interested parties
- Identify and resolve issues prior to proposing a regulatory solution to our Board
- Answer questions

Discussion Topics

- Background
- Review of previous analysis and findings
- Presentation of new analysis and findings
- Summary of major conclusions
- Presentation of solutions being considered
- Next steps

Background

Enhanced Vapor Recovery (EVR) and In-Station Diagnostics (ISD)

- Statewide ~ 7,500 gasoline dispensing facilities (GDF) are equipped with Phase II EVR and ISD
- ISD continuously monitors the performance of the vapor recovery system (VRS) and alerts the operator of potential equipment failures
- One of the ISD parameters involves continuous monitoring of pressure in the headspace of the underground storage tanks (UST)

ISD Overpressure (OP) Alarm Criteria

Assessment Period	Current ISD OP Alarm Criteria
Weekly	5% of UST pressure data above 1.5"WCG (Section 9.2.4 of CP-201)
Monthly	25% of UST pressure data above 0.5"WCG (Section 9.2.4 of CP-201)
Daily	Daily assessment to identify vapor processor malfunction (Section 9.2.5 of CP-201)

Definitions

- ISD OP Alarm Problem: A situation in which the equipment inspection, testing, and troubleshooting conducted in response to an ISD OP alarm fails to identify an equipment malfunction
- OP Emission Problem: A situation in which the emissions resulting from positive pressure in the underground storage tank are of concern with regard to the regional ozone standard or near source risk due to benzene exposure

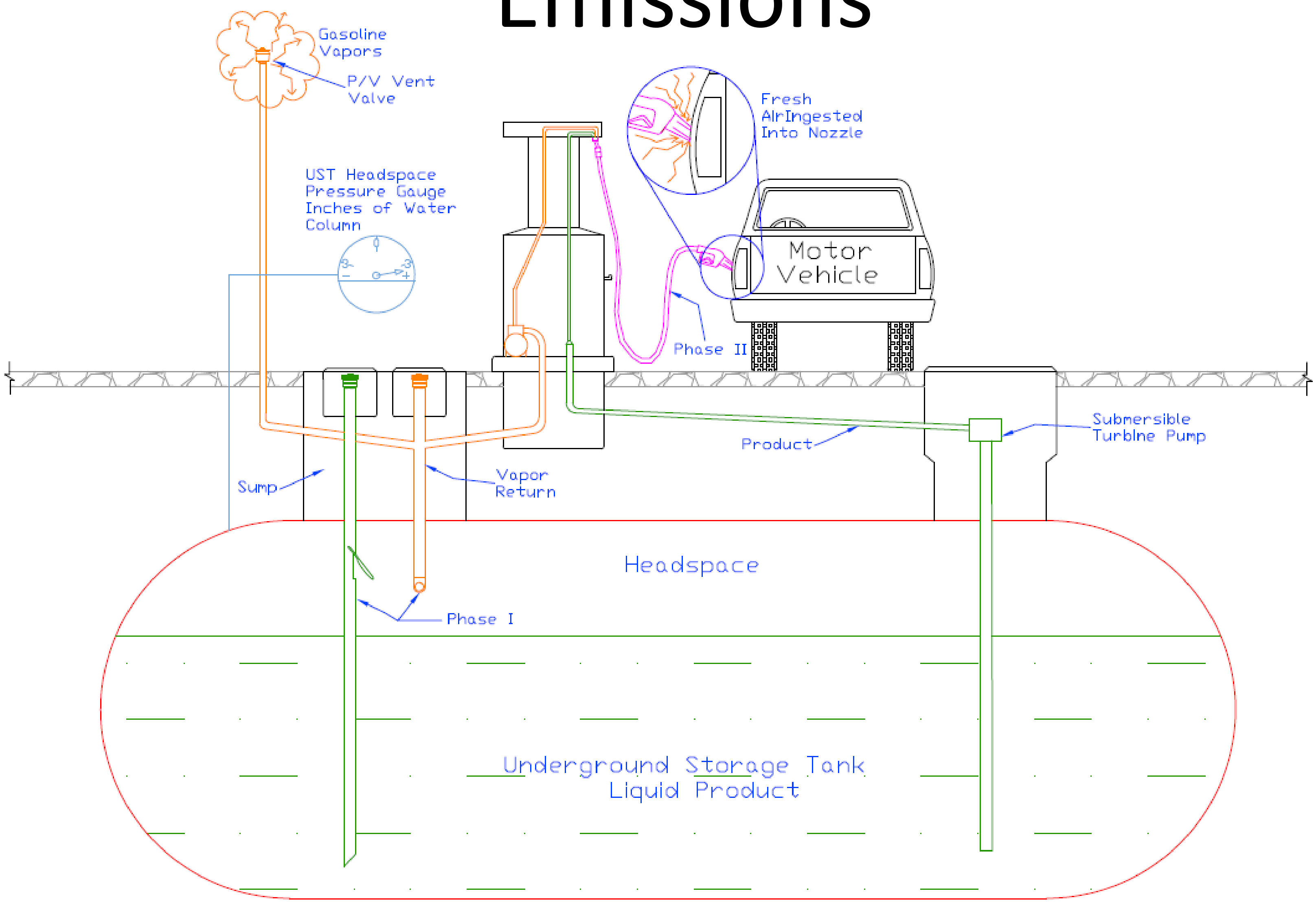
Why Are We Concerned?

1. False ISD Alarms
   - Alarms require service provider response, yet no trouble is found in winter time
   - Costly and disruptive for GDF operator
2. Air Quality Impacts
   - Statewide ROG emissions from overpressure are estimated at 11 TPD winter and 1 TPD summer
   - Potential near source health risk issues at worst case sites due to increased benzene exposure

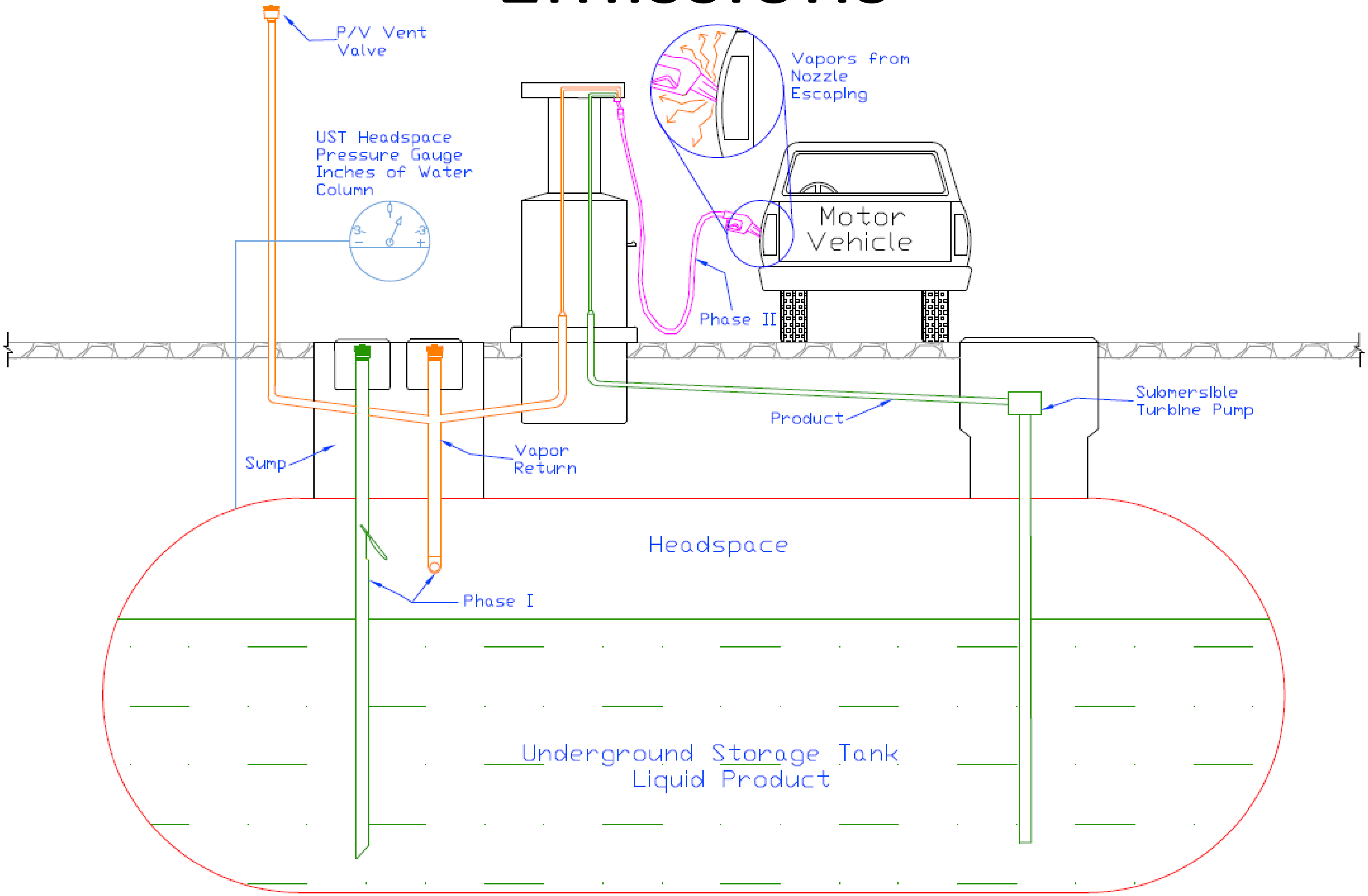
How Do Phase II Enhanced Vapor Recovery Systems Differ?

	Assist	Balance
% of GDF Population	60%	40%
Date Initially Certified	September, 2005	April, 2008
Principal of Operation	Active, requires vacuum pump in vapor return pathway	Passive, requires low resistance vapor return pathway
Nozzle Vapor Pathway	One way path, breathing losses from UST cannot occur	Two way path, allows breathing losses from UST to occur

Assist System: Pressure Driven Emissions



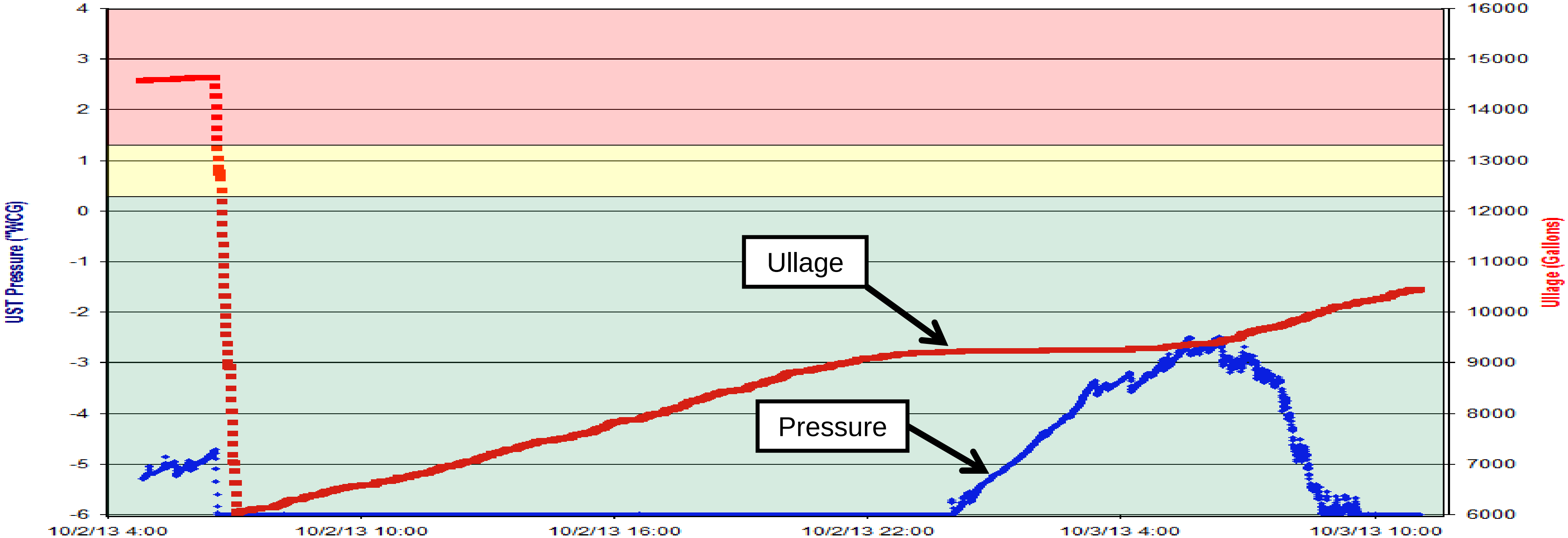
Balance System: Pressure Driven Emissions

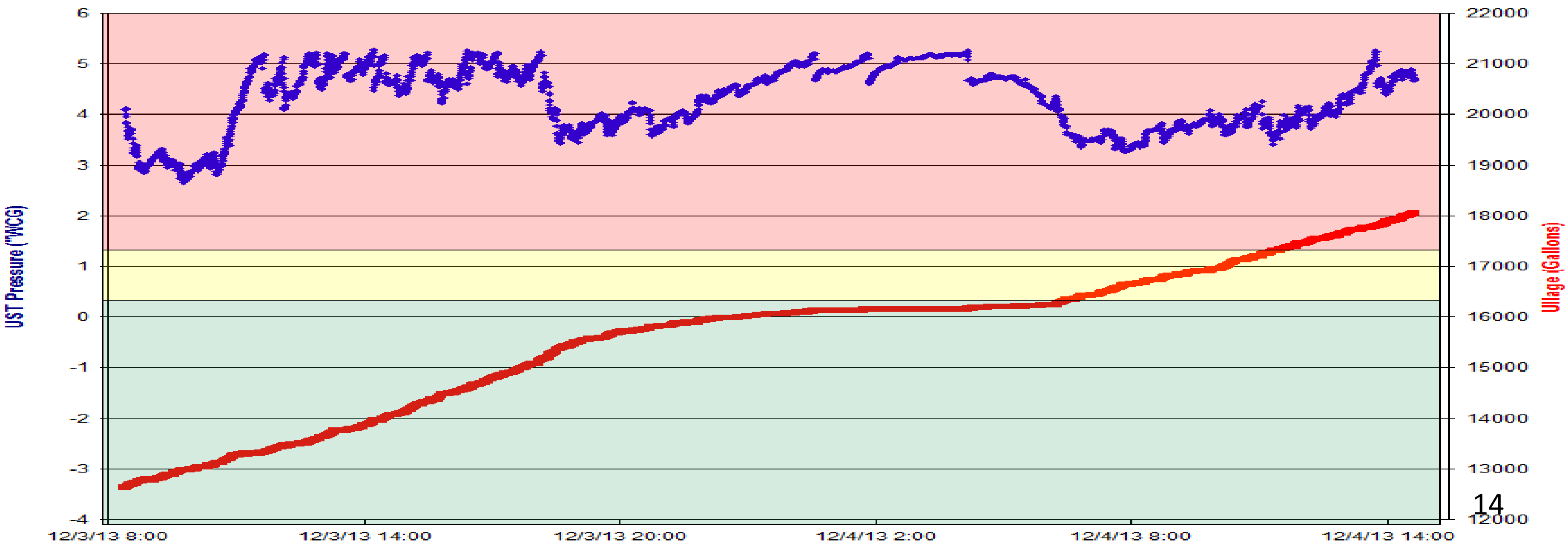


Scope of OP Problem: Assist Systems

Severity of Overpressure Condition	Estimated Population (~ 4500 sites, 60%)
Tier 1: No overpressure Alarms in December negligible pressure driven emissions. Little or no time at positive pressure.	Population: ~1035 (23% of assist sites)
Tier 2: Overpressure conditions which produced alarms in December, but an efficiency loss less than 5%. Positive pressure occurs during overnight idle period.	Population: ~1935 (43%, of assist sites)
Tier 3: Overpressure conditions which result in efficiency loss greater than 5% in winter months and/or potential concerns over elevated risk at the worst case sites. Positive pressure occurs for long periods of time during dispensing operations	Population: ~1530 (34% of assist sites)

South Coast Assist Site Pressure Comparison October and December

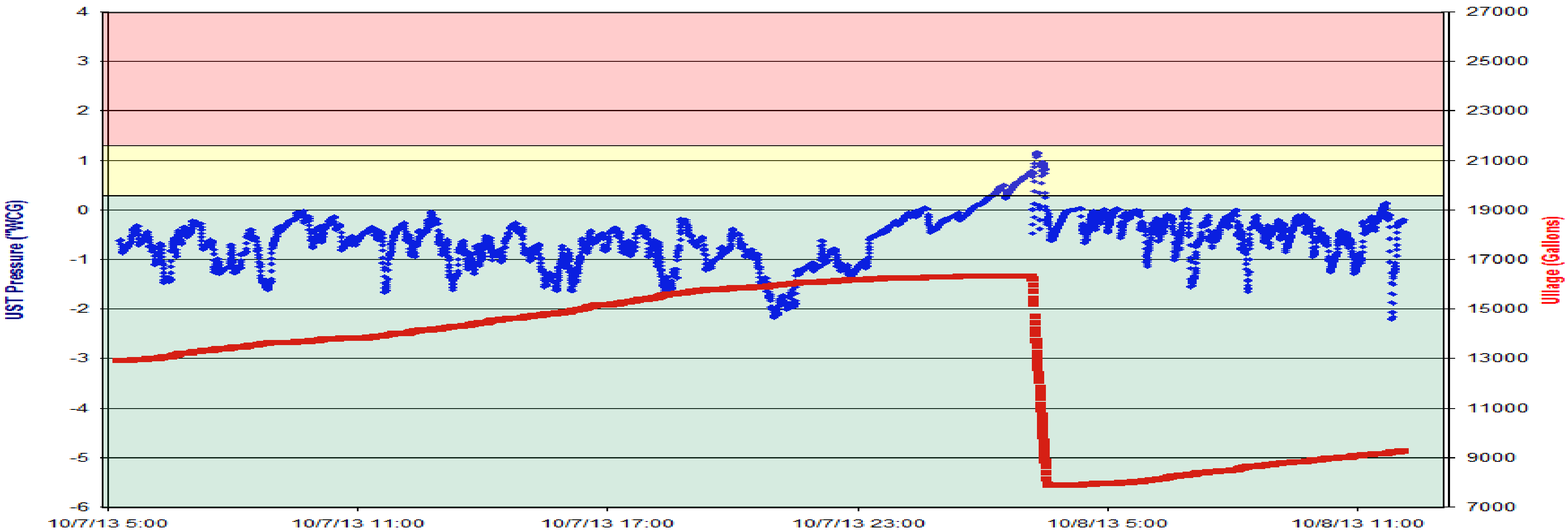


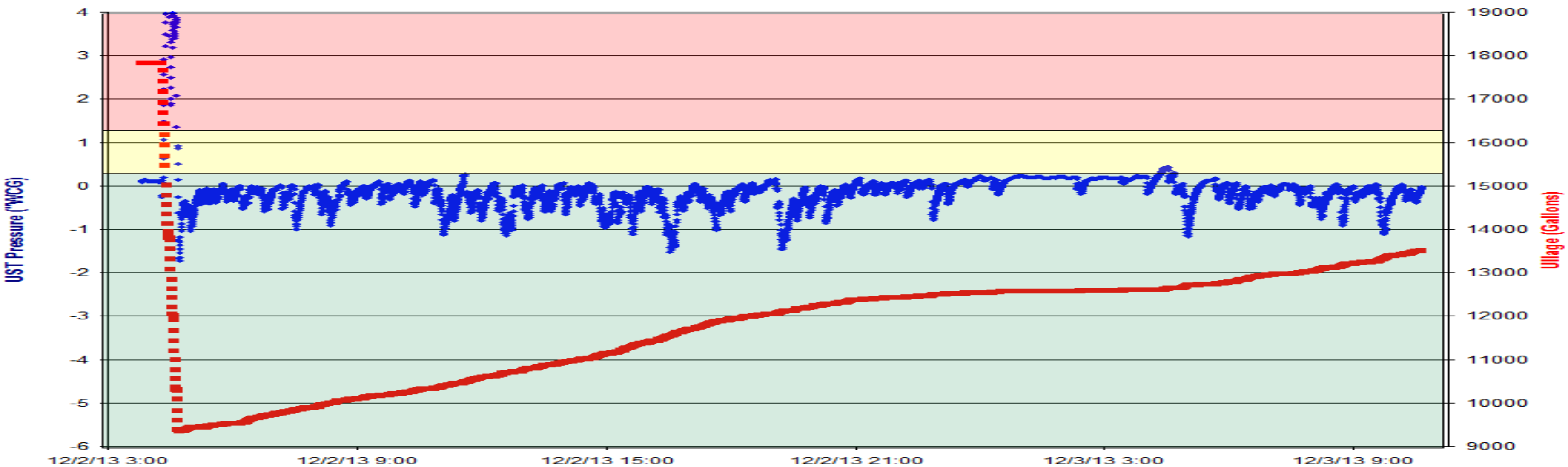


Scope of OP Problem: Balance Systems

Severity of Overpressure Condition	**Estimated Population** **(~ 3000 sites, 40%)**
Tier 1: No overpressure Alarms in December negligible pressure driven emissions. No positive pressure during dispensing operations.	Population: ~ 300 ~10% of sites have high throughput Not expected to exhibit positive pressure while dispensing
Tier 2: Overpressure conditions which result in overpressure alarms and efficiency loss less than 5%. Exhibit slight positive pressure during dispensing operations	We expect that most of the remaining 2700 sites will fall into tier 2, but further analysis is needed to estimate the number
Tier 3: Overpressure conditions which result in efficiency loss greater than 5% and/or potential concerns over elevated risk at worst case sites. Exhibit slight positive pressure during dispensing operations	We expect that only a small percentage of the remaining 2700 sites will fall into this tier, but further analysis is needed to estimate the number

South Coast Balance Site Pressure Comparison October and December





Causes of Overpressure

- Primary cause is uncontrolled Reid Vapor Pressure (RVP) of winter gasoline
- Secondary causes include:
  - Type of Phase II EVR system installed (Assist or Balance)
  - Excess air ingested when fueling vehicles equipped with on-board refueling vapor recovery (ORVR)
  - Gasoline throughput
  - GDF maintenance practices
  - GDF operating hours

Review of Previous Analysis and Findings

Major Elements of OP Study

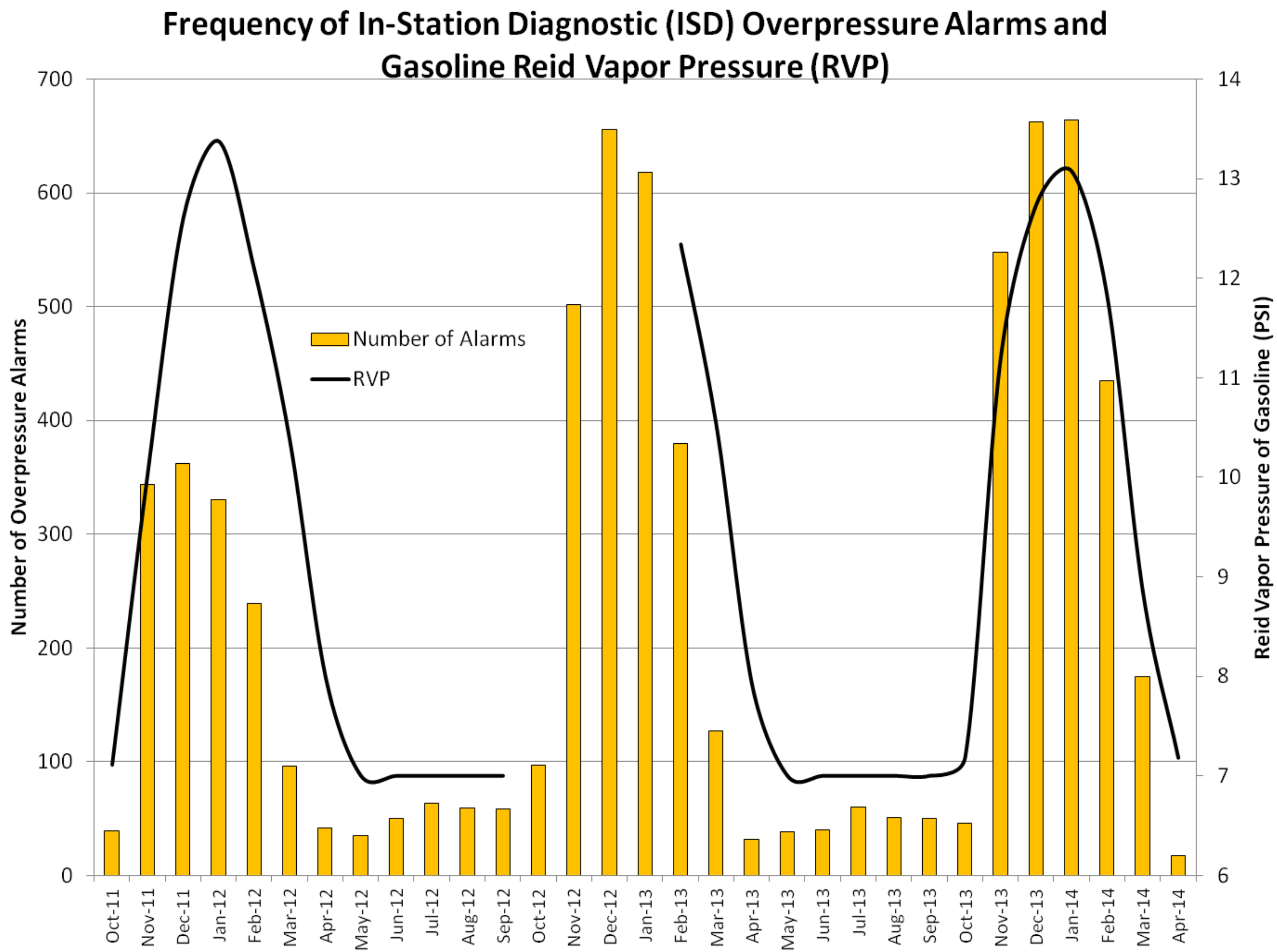
- Study Sites with Continuous Data Collection
- Vapor Recovery System (VRS) Performance Testing
- Reid Vapor Pressure (RVP) Sampling and Analysis
- Collection of ISD Alarm History, UST Pressure Data, and VRS Configuration from ~400 Sites

Study Sites with Continuous Data Collection

- Six sites in Northern California established Fall 2009
- Five sites in Southern California established Fall 2013
- Each equipped with "PV Zero" vent valve, barometric/UST pressure monitor, & ISD data acquisition system
- Data used to estimate pressure driven fugitive and vent line emissions

Vapor Recovery System Performance Testing

- Conducted at 15 Sites Exhibiting PWD
- ISD Operability
- Nozzle Bag Test
- CAS Integrity
- Vapor to Liquid (V/L) Ratio
- Dispenser Integrity
- System Pressure Integrity



Frequency of In-Station Diagnostic (ISD) Overpressure Alarms and Gasoline Reid Vapor Pressure (RVP)
Number of Overpressure Alarms
Reid Vapor Pressure of Gasoline (PSI)
Number of Alarms
RVP
0
100
200
300
400
500
600
700
6
7
8
9
10
11
12
13
14
Oct-11
Nov-11
Dec-11
Jan-12
Feb-12
Mar-12
Apr-12
May-12
Jun-12
Jul-12
Aug-12
Sep-12
Oct-12
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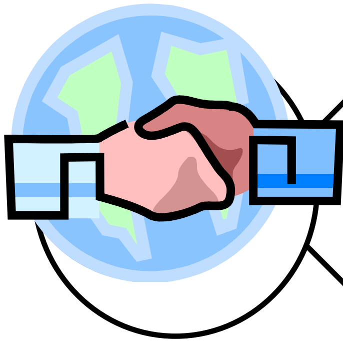
Mar-14
Apr-14

Data Collected From ~400 Sites in Six Geographic Regions



- Collaborative effort between ARB and Districts
- 14 ARB staff members
- 28 District staff members

<u>ISD Data</u>

- All alarm history data available (at least one year)
- Available pressure and ullage data
- Available records on last 10 deliveries to gather available data on fuel temperature
- V/L data on for recent vehicle fueling events

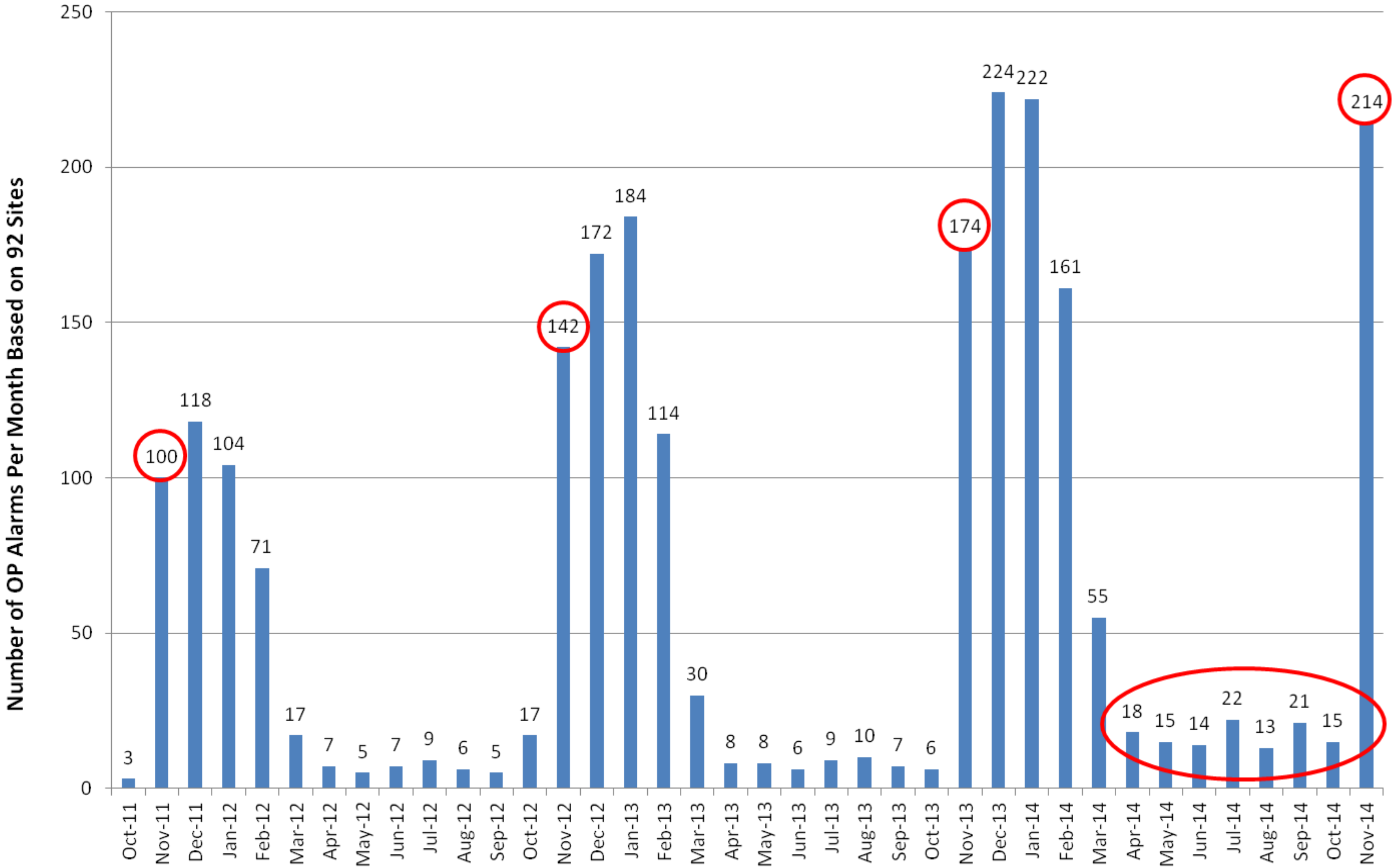
<u>GDF Characteristics</u>

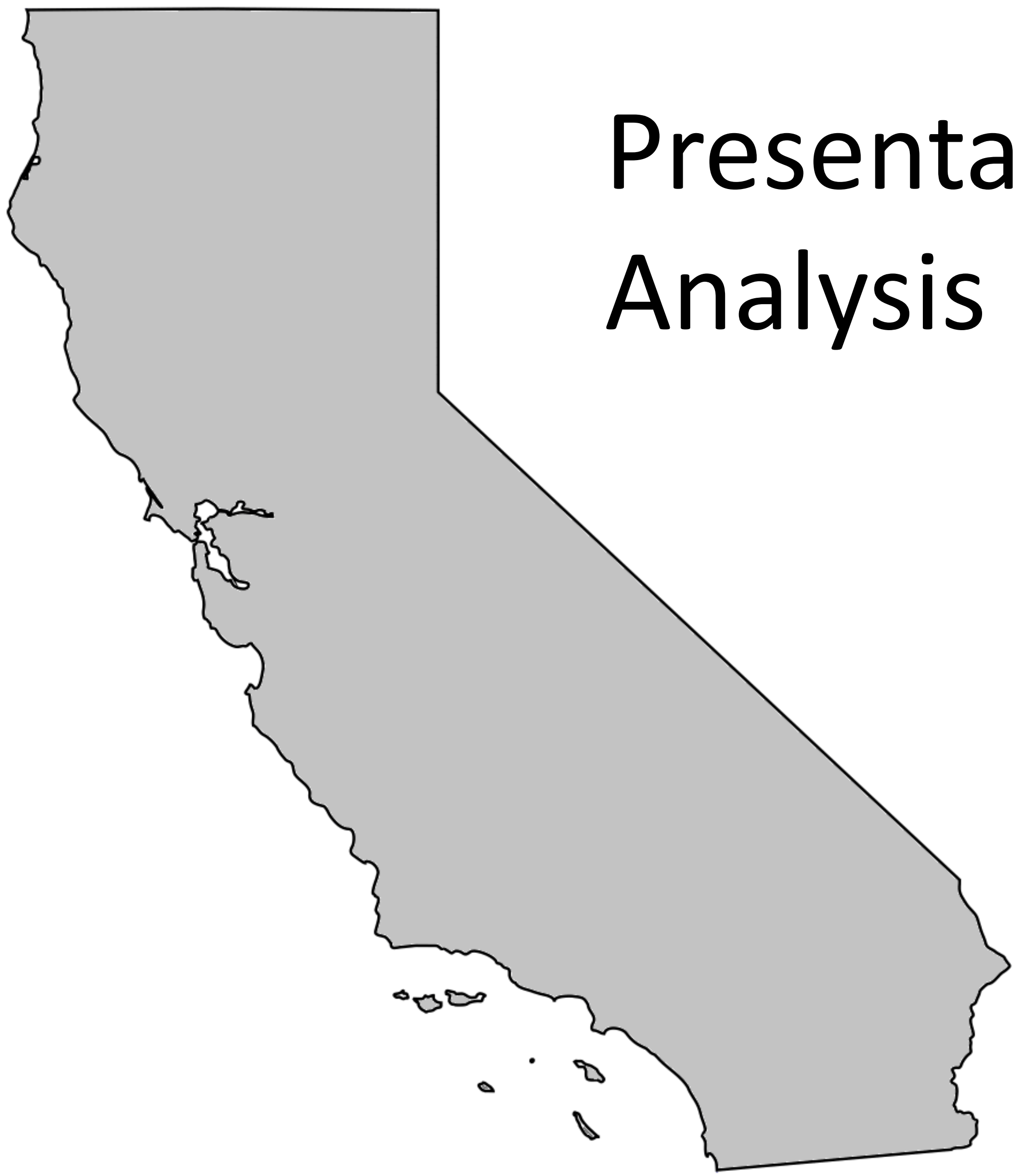
- Operating hours
- Throughput
- Gasoline brand and source
- Inventory report with tank capacities

Prevalence of OP Alarms:

Data Set	OP Alarms	October 2013	November 2013
Assist Sites (274)	Average Number of Alarms Per Site	0.16	1.84
	% of Sites With at Least One Alarm	8.8%	69.7%
Balance Sites (121)	Average Number of Alarms Per Site	0.02	0.36
	% of Sites With at Least One Alarm	1.7%	19.8%

Trend in Overpressure Alarm Frequency

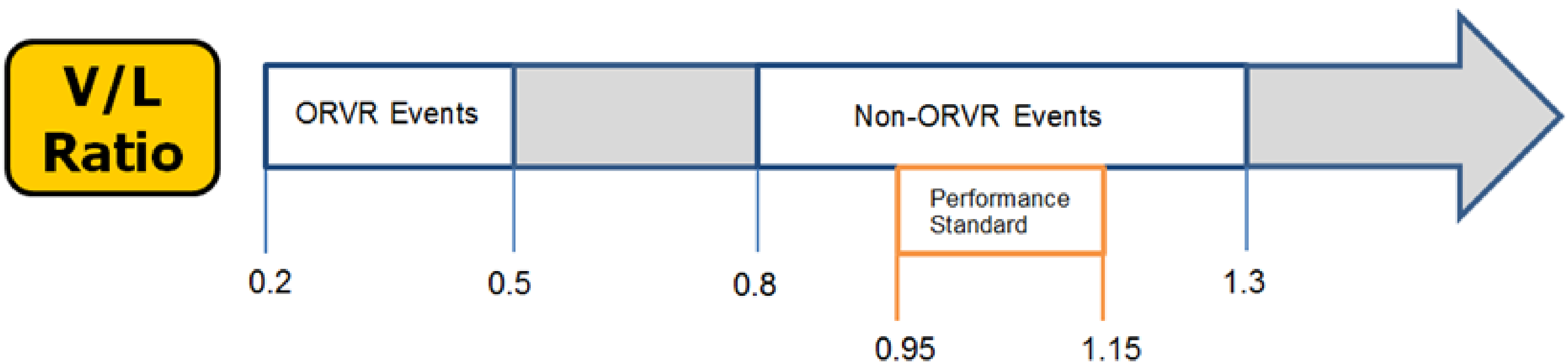




Presentation of New Analysis and Findings

Expected V/L Ratio During Refueling of ORVR Vehicles

- The assist nozzle is designed to reduce the V/L to < 0.5 when refueling ORVR vehicles
- Air ingestion and vapor growth occurs inside UST when V/L > 0.5 on ORVR vehicles

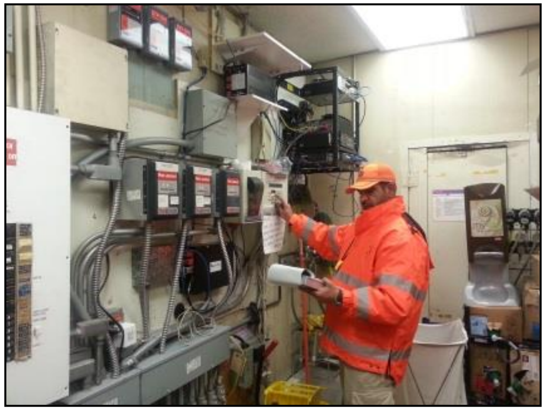


Assist System ORVR Recognition

- Tier 3 sites (PWD) exhibit higher V/L when compared to Tier 2 and Tier 1 sites
- The ability of the assist nozzle to identify ORVR vehicles has declined over the last several years
- ORVR vehicle identification can vary within the same make, model, and model year

Assist Nozzle ORVR Recognition Study

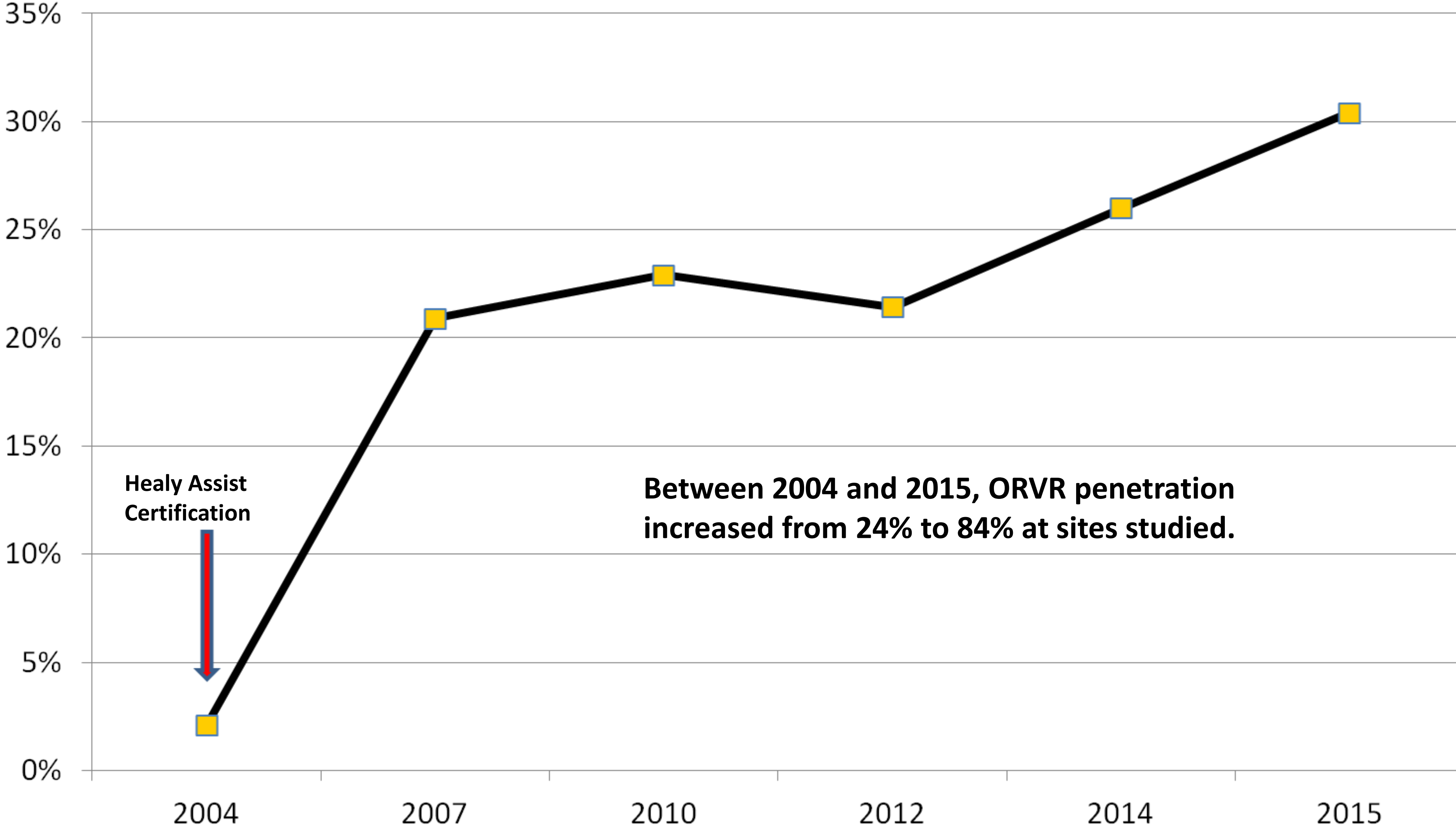
- Conducted in January 2015, at six retail GDF located in San Diego region
- Total of ~ 1600 valid vehicle refueling observations, 85% ORVR, 15% Non-ORVR
- Observed and recorded each vehicle refueling event followed by retrieval of V/L data from ISD



ORVR Recognition Study Findings

- Percentage of ORVR vehicles with V/L ≥0.5 (mis-identification rate) was 30%
- Percentage of ORVR vehicles with V/L ≥ 1.0 was 18%
- Capless fill pipes represented 4% of data set, 75% had a V/L ≥ 1.0

Trends in Assist Nozzle ORVR Mis-Identification Rate



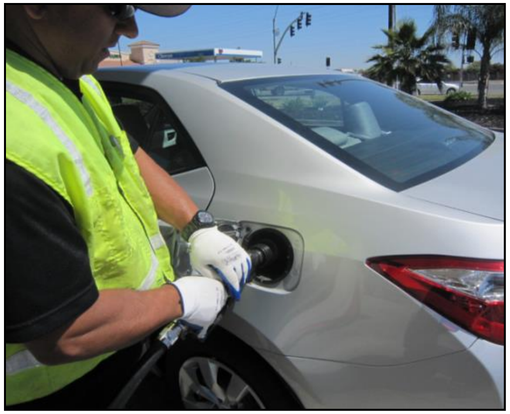
Differences in ORVR V/L by Model Year

Model Year Duration	Number of ORVR Events	ORVR V/L	Number of ORVR Events with V/L Greater Than 0.5	Percent of ORVR Events with V/L Greater Than 0.5
2000-2011	838	0.49	222	27%
2012-2015	496	0.61	189	38%

ORVR Vehicle Refueling Experiment

(Summer 2015)

Step 1: Remove existing fuel from ORVR vehicle of interest



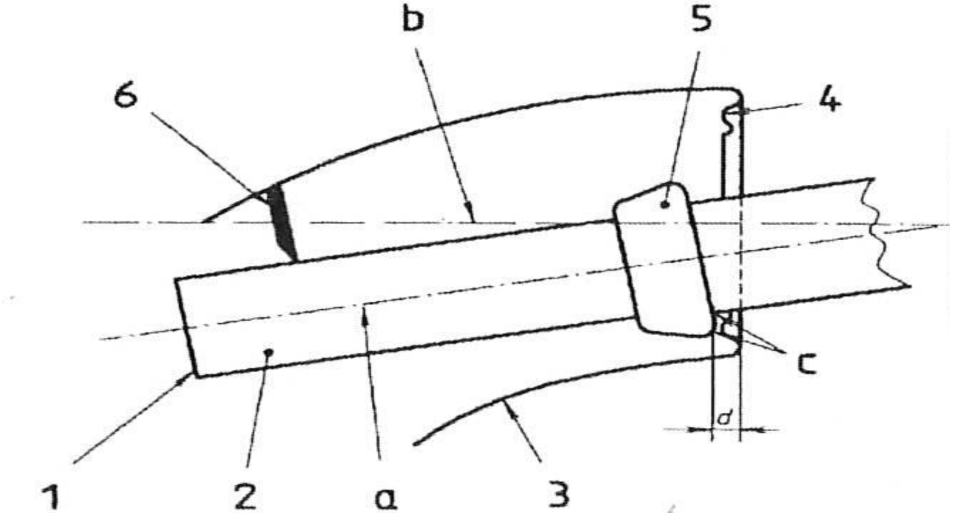
Step 2: Dispense fuel under controlled conditions

Step 3: Record volume dispensed, vacuum generated, time, and vehicle information

Step 4: Retrieve ISD data, determine V/L ratio

Breakthrough/Key Finding

V/L can vary depending on whether nozzle is securely latched or loosely latched in the vehicle fill pipe



Item	Description
5	Nozzle Latch Ring
C	Fill Pipe Locking Lip

Secure Latch vs Loose Latch

Nozzle Secure Latch

Nozzle Loose Latch

ORVR Vehicle Refueling Experiment August 2015 (Certified Nozzle)

Vehicle Make/Model	Secure/Loose Latch	Nozzle Boot (InH_20)	Avg V/L
Nissan Altima	Secure	-1.35	0.43
Nissan Altima	Loose	0.00	1.10
Toyota Corolla	Secure	-1.74	0.24
Toyota Corolla	Loose	0.00	1.09
Toyota Prius C	Secure	-1.48	0.25
Toyota Prius C	Loose	0.00	1.14
Honda Civic	Secure	-1.37	0.46
Honda Civic	Loose	N/A *	0.49
*Vacuum needle came loose during fueling			

ORVR Vehicle Refueling Experiment September 2015 (Prototype Nozzle)

Vehicle Make/Model	Secure/Loose Latch*	Nozzle Boot (InH_20)	Avg V/L
Nissan Altima	Secure	-0.96	0.21
Nissan Altima	Loose	-	-
Toyota Corolla	Secure	-1.57	0.18
Toyota Corolla	Loose	-	-
Toyota Prius C	Secure	-1.48	0.19
Toyota Prius C	Loose	-	-
Honda Civic	Secure	-0.85	0.27
Honda Civic	Loose	-	-

*Loose latch not possible

ORVR Vehicle Refueling Experiment Conclusions

- ORVR vehicle mis-identification can vary **within** the same vehicle **make, model, and model year**
- ORVR vehicle mis-identification issue appears to be related to two potential causes:
  - Engagement of nozzle “latch ring” with fill pipe “locking lip” (loose latch vs secure latch)
  - Vehicle fill pipe design (open path to atmosphere)
- Prototype nozzle performed well, FFS pleased with results and will establish R&D test site

Questions Regarding Balance System

- Although balance systems don't experience a high frequency of overpressure alarms, they operate at slightly positive pressure for ~ 25% of time with winter fuel and ~ 13% of the time with summer fuel
- Is outward flow (reverse flow) at the nozzle preventing the overpressure alarm from occurring?
- If so, should we be concerned about these emissions?

City	Hours of Operation	Thoughput kgal/mo	% of Data Points Greater than Zero in Oct.	% of Data Points Greater than Zero in Dec.	Avg of Data Points Greater than Zero Oct.	Avg of Data Points Greater than Zero in Dec.
Diamond Bar	24 Hr	100	19.5%	34.4%	0.27	0.16
Ontario	24 Hr	110	15.9%	17.6%	0.27	0.20
Chino	24 Hr	110	7.4%	31.8%	0.35	0.24
Stanton	24 Hr	115	21.6%	36.5%	0.17	0.17
Yorba Linda	Closed Nightly	116	24.7%	28.2%	0.10	0.25
Brea	24 Hr	119	16.2%	32.2%	0.08	0.22
Chino	24 Hr	125	17.7%	19.4%	0.27	0.14
La Habra	24 Hr	128	23.8%	27.2%	0.34	0.21
Bellflower	24 Hr	132	10.6%	18.5%	0.20	0.07
Sun City	Closed Nightly	133	12.4%	23.4%	0.05	0.18
Costa Mesa	24 Hr	143	15.9%	32.0%	0.14	0.82
Ontario	24 Hr	150	8.2%	25.7%	0.08	0.23
Long Beach	24 Hr	151	14.5%	29.3%	0.20	0.11
Stanton	Closed Nightly	154	13.8%	25.9%	0.41	0.07
Stanton	24 Hr	155	1.4%	15.9%	0.17	0.36
Murrieta	24 Hr	160	2.9%	19.1%	0.12	0.13
City of Industry	24 Hr	160	19.8%	28.2%	0.02	0.27
Los Angeles	24 Hr	161	4.3%	30.8%	0.03	0.14
Hollywood	24 Hr	165	14.9%	32.2%	0.26	0.23
Burbank	24 Hr	170	22.6%	20.2%	0.21	0.45
Bellflower	24 Hr	170	15.5%	27.3%	0.27	0.22
Garden Grove	24 Hr	180	8.0%	25.7%	0.22	0.16
Santa Monica	24 Hr	200	5.2%	13.0%	0.05	0.17
Yorba Linda	24 Hr	203	17.5%	28.2%	0.34	1.08
Santa Ana	24 Hr	205	12.0%	19.1%	0.13	0.23
Diamond Bar	24 Hr	250	4.0%	17.0%	0.08	0.24
Ontario	24 Hr	280	9.8%	21.0%	0.12	0.13
	Average		**13.3%**	**25.2%**	**0.18**	**0.26**
	Std Dev.		**6.62%**	**6.34%**	**0.11**	**0.22**
	Minimum		1.4%	13.0%	0.02	0.07
	Maximum		24.7%	36.5%	0.41	1.08

Primary Objectives of Balance System Testing

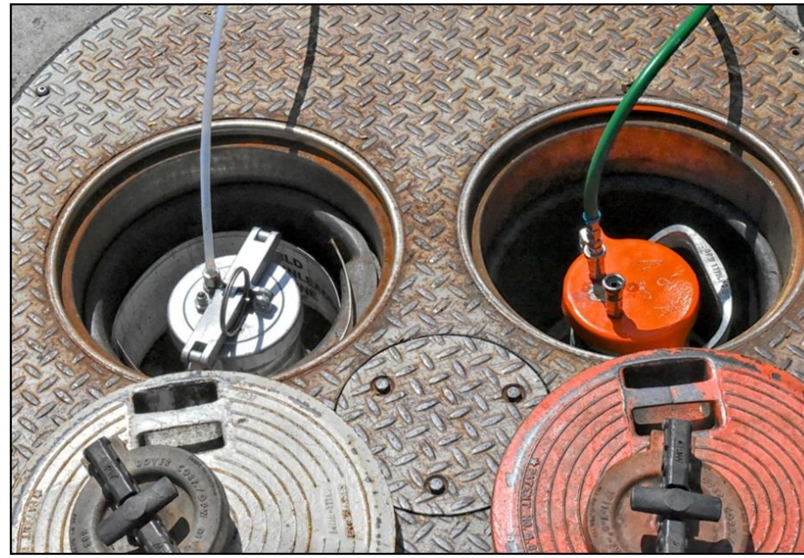
- Determining if the release of vapors through the balance nozzle explains the difference in frequency of overpressure that is observed at GDF with balance systems vs GDF with assist systems
- Determine the mass of vapor that can be emitted when UST is held at a slight positive gauge pressure (0.1 to 0.3 “WCG)

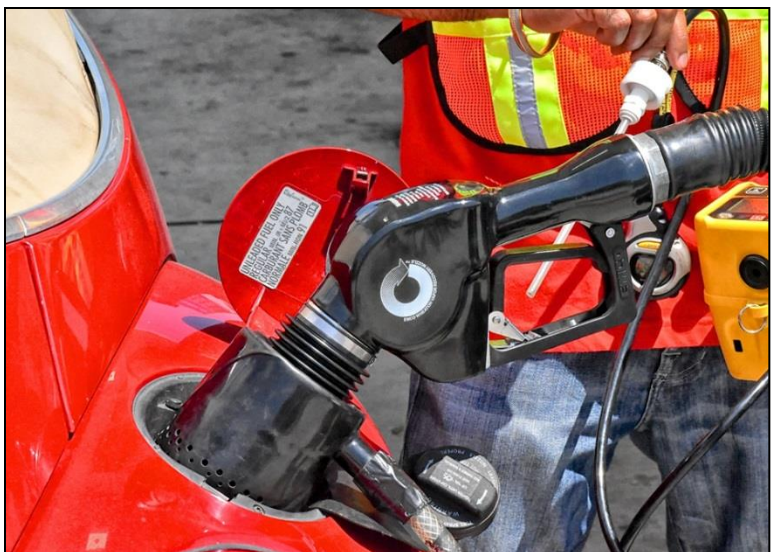
Balance System Testing

(July 2015)

- Phase II efficiency testing conducted on 60 cars under normal operating conditions to establish baseline, then on 200 cars at slightly positive UST pressure
- Both VST and EMCO nozzles tested
- Pump used to bubble air through liquid gasoline at bottom of underground storage tank
- Pressure switch used to turn pump on at pressure below 0.1 “WCG and turn pump off at pressure above 0.3 “WCG

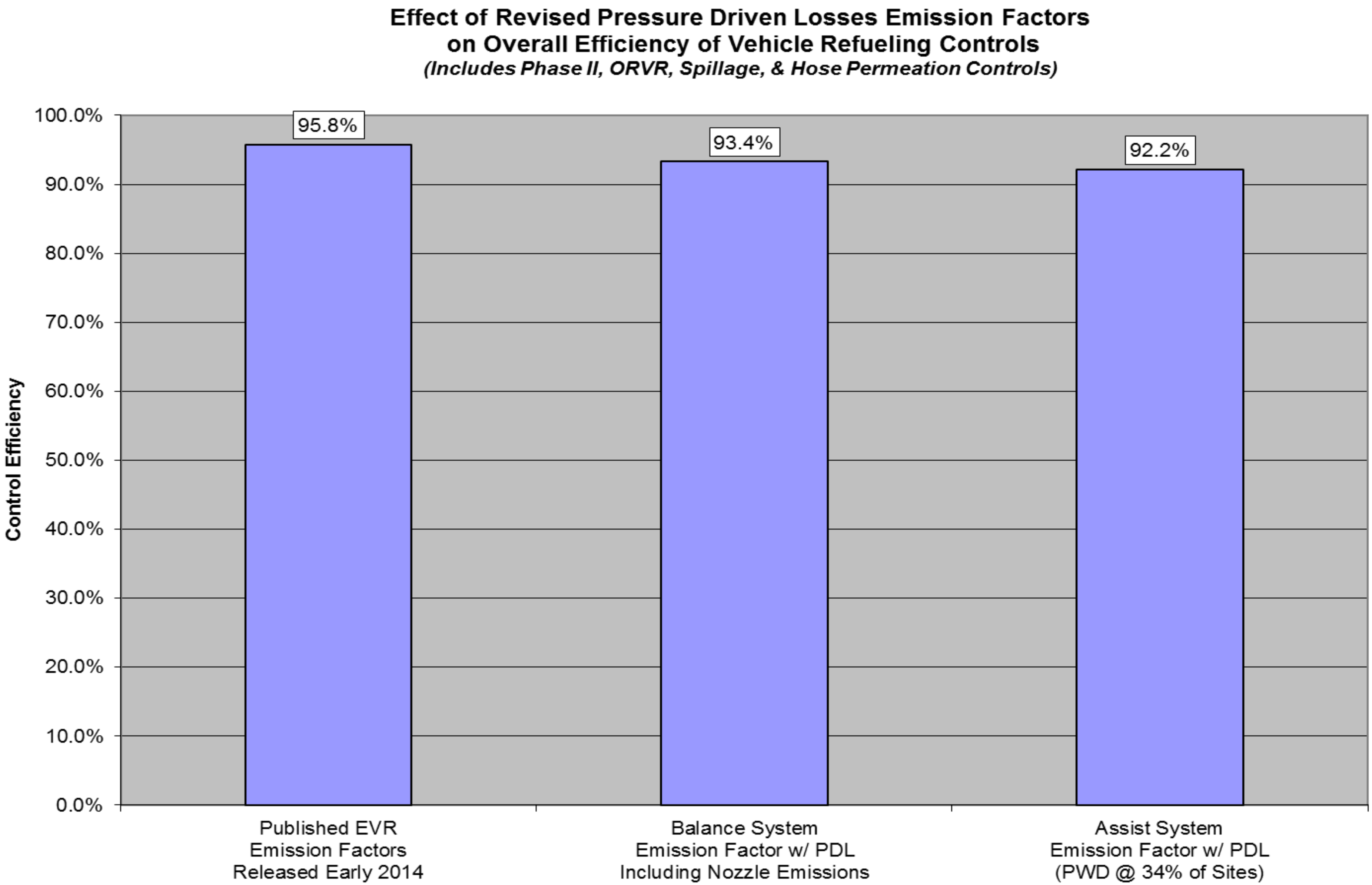
Balance System Testing





Slight UST Pressure Results in Reduced Nozzle Collection Efficiency and Higher Emissions During Fueling Events

	# of Events	Dispensed Gasoline Volume (gallons)	Efficiency Loss Based on UEF = 7.65 lb/kgal	Dispenser VR Line Pressure ("WCG)		
				Ave.	Max.	Min.
Baseline ORVR Events	30	386	0.5%	-0.64	-0.16	-1.14
Baseline Non- ORVR Events	30	409	1.9%	-0.44	0.00	-1.00
Pressurized ORVR Events	99	1246	10.5%	0.15	0.22	0.09
Pressurized Non- ORVR Events	96	1471	25.4%	0.19	0.29	0.09


Effect of Revised Pressure Driven Losses Emission Factors
on Overall Efficiency of Vehicle Refueling Controls
(Includes Phase II, ORVR, Spillage, & Hose Permeation Controls)
Control Efficiency
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
95.8%
93.4%
92.2%
Published EVR Emission Factors Released Early 2014
Balance System Emission Factor w/ PDL Including Nozzle Emissions
Assist System Emission Factor w/ PDL (PWD @ 34% of Sites)

Balance System Testing Conclusions

- Pressure driven emissions from balance systems are on the same order of magnitude as pressure driven emissions from assist systems
- The outward flow through the balance nozzle is sufficient to release the vapors produced by evaporation in the UST
- This is the reason that the balance systems exhibit lower UST pressures and fewer overpressure alarms than the assist systems

Summary of Major Conclusions

Major Conclusions

- OP is driven by RVP and is primarily a winter problem
- Current pressure based ISD alarm standards can be more stringent than needed to ensure acceptable system performance
- Poor seal at ORVR fill pipe a major contributor
- Both balance and assist systems are affected
- Emission estimates characterize extent of problem:
  - Regional Basis (Ozone AAQS) : Minor impact 1 ton per day statewide in summer months
  - Site Specific Basis (Benzene Risk): Potentially significant at worst case sites. Statewide 11 tons per day in winter months

Presentation of Solutions Being Considered

Potential Solutions

1. Address loose latch problem on assist nozzles to lower air ingestion and on balance nozzles to reduce emissions at positive pressure
2. Revise ISD alarm thresholds to be emission-based rather than pressure-based
3. Certify high capacity processors capable of handling worst case vapor production caused by evaporation
4. Adopt new vehicle fill pipe performance standards to ensure new model ORVR vehicles and EVR nozzles control V/L to less than 0.5

Address Loose Latch Problem

- Ensure that fuel cannot be dispensed unless a good seal is made between nozzle and vehicle
- Relatively low cost for nozzle spout kit
- Assuming natural turnover, 4 years for 100% implementation
- Lower ORVR V/L will reduce UST pressures and pressure driven emissions

Emission-Based ISD Alarm Criteria

Current ISD Threshold	Proposed ISD Threshold
Percentage of time at pressure: • 5% of time greater than 1.5 ”WCG over seven days • 25% of time greater than 0.5 ”WCG over 30 days	Summer: Efficiency loss due to pressure driven losses Year Round: Emission rate to limit health risks due to benzene

Estimated cost of implementing revised alarm criteria $5,500 per site

High Capacity Processors

- Costs $12K to $50K per site depending on the processor system chosen
- Could completely eliminate pressure driven emissions regardless of all other factors (GDF parameters, vehicle fleet, fuel RVP etc.)
- Only needed at sites which continue to have overpressure emission alarms with new criteria

New Vehicle Fill Pipe Performance Standards

- Required to ensure nozzle vehicle compatibility into the future
- Necessary since vehicle designs change on a frequent basis
- Long implementation time frame since vehicle lives are greater than 10 years
- Does not address incompatibility associated with earlier model year vehicles

Next Steps

Further Analysis Planned

- Study loose latch prevalence in balance nozzles
- Download ISD data from ~400 sites to check current alarm and PWD trends
- Evaluate performance of improved nozzles & high capacity processors
- Assess health risk issues
- Develop amendment for ORVR vehicle fill pipe standards
- Estimate effectiveness and cost of each proposed solution

Next Steps

- Field testing of potential solutions (new nozzles and high capacity processors)
- Review and refine emission estimates
- February 2016 - Informational update to the Board
- Spring 2016 - Workshop on effectiveness of proposed solutions
- Summer 2016- Workshop on proposed regulatory language
- Late in 2016- Propose regulatory amendments to the Board

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