List of Tables

Veeder-Root and INCON. Approximately 90 percent of ISD systems are Veeder-Root, while 10 percent are INCON. Based on this information, it was determined that data gathering activities during the Mega Blitz would attempt to emulate the distribution of EVR and ISD system type weighted by manufacturer sales. (Table 1, Appendix I)

Once the sites were selected, staff proposed data collection from each site to occur in a two to three week period before the RVP limit changes on November 1 and March 31 and a two to three week period after the RVP change. These collections dates would ensure the capture of pressure data before and after the wintertime switch to high RVP fuel and the pressure data before and after the summertime switch to control RVP fuel, in October, December, February, and April. The data downloads were performed primarily by CARB staff with site access provided by local air district staff. In some cases, especially in the South Coast AQMD, district staff performed the data download.

To conduct each site visit, both CARB and district staff were sent out with detailed ISD download instructions, a list of ISD download commands, an informational letter for the GDF operators, cables, laptop computers, and a data form for GDF details and operating parameters. The ISD download instructions (see Appendix II) detailed the explicit steps to take while connecting to the ISD console (Veeder-Root) via laptop and inputting the ISD text commands that indicate what report data to copy and save. The specific download commands include:

- Vapor Pressure Events (see Figure 1);
- ISD Monthly Status Report (see Figure 2);
- ISD Daily Report (see Figure 3);
- Delivery Report (see Figure 4);
- Flowmeter, AFM Busy Events Report (see Figure 5); and
- Assist Vapor Collection Test Results / Balance Flow Monitoring Test Results (see Figure 6 below)

The informational letter provided to GDF operators (see Appendix III) explained the purpose of the staff visit and download and provided staff contact information for those with questions or concerns. The GDF data collection form (see Appendix IV) prompted staff to document detailed information on the EVR and ISD systems, inventory reports, fuel deliveries, and site information. In order to properly examine the Mega Blitz information, all ISD overpressure and leak alarm data, as well as GDF site characteristics were consolidated into an Excel database.

Figure 1: Example of Raw ISD Data – Vapor Pressure Events

```
OCT  8, 2013 10:32 AM
VAPOR PRESSURE EVENTS
INDEX   DATE-TIME              PRESSURE  ULLAGE    FLAGS
0001    13-10-07 04:22:52        -0.013   25880.1   0000
0002    13-10-07 04:23:12        -0.014   25880.1   0000
0003    13-10-07 04:23:32        -0.016   25880.1   0000
0004    13-10-07 04:23:53        -0.017   25880.1   0000
0005    13-10-07 04:24:13        -0.018   25880.1   0000
0006    13-10-07 04:24:33        -0.019   25880.1   0000
0007    13-10-07 04:24:53        -0.019   25880.1   0000
0008    13-10-07 04:25:13        -0.020   25880.1   0000
0009    13-10-07 04:25:33        -0.020   25880.1   0000
0010    13-10-07 04:25:53        -0.020   25880.2   0000
```

Figure 2: Example of Raw ISD Data – ISD Monthly Status Report

```
OCT  8, 2013 10:39 AM

ISD MONTHLY STATUS REPORT

EVR TYPE: BALANCE
ISD TYPE: 01.04
VAPOR PROCESSOR TYPE: VEEDER-ROOT POLISHER

OVERALL STATUS              :WARN            EVR VAPOR COLLECTION :WARN
EVR VAPOR CONTAINMENT       :WARN
ISD MONITOR UP-TIME         :100%
EVR/ISD PASS TIME           : 62%            VAPOR PROCESSOR      :PASS


ISD MONITORING TEST PASS/FAIL THRESHOLDS
                                                      PERIOD    BELOW  ABOVE

VAPOR COLLECTION BALANCE SYS FLOW PERFORMANCE          1DAYS     0.60  ----
VAPOR CONTAINMENT GROSS FAIL, 95th PERCENTILE          7DAYS     ----  1.30"wcg
VAPOR CONTAINMENT DEGRADATION, 75th PERCENTILE        30DAYS     ----  0.30"wcg
VAPOR CONTAINMENT LEAK DETECTION FAIL @2"WCG           7DAYS     ----  12.50cfh
STAGE I VAPOR TRANSFER FAIL, 50th PERCENTILE          20MINS     ----  2.50"wcg
VAPOR PROCESSOR SELF TEST FAIL                         1DAYS     ----  ----
VAPOR PROCESSOR MASS EMISSION FAIL (LB/KGAL)           1DAYS     ----  0.32

WARNING ALARMS
DATE     TIME     DESCRIPTION                    READING          VALUE
13-10-03 10:00:40 VAPOR CONTAINMENT LEAKAGE      CFH@2 INCHES WC   78.73
13-10-02 10:00:50 VAPOR CONTAINMENT LEAKAGE      GROSS FAIL
13-10-01 10:01:52 FLOW PERFORMANCE HOSE BLOCKAGE FP 8 BLEND3         0.59
FAILURE ALARMS
DATE     TIME     DESCRIPTION                    READING          VALUE

SHUTDOWN & MISCELLANEOUS EVENTS
DATE     TIME     DESCRIPTION                    ACTION/NAME
13-10-04 08:42:10 CONTAINMENT VAPOR LEAKAGE     TEST MANUALLY CLEARED
13-10-01 12:17:50 COLLECTION TEST HH08 GRADE    TEST MANUALLY CLEARED
```

Figure 3: Example of Raw Data - ISD Daily Report

```
ISD DAILY REPORT DETAILS

EVR TYPE: BALANCE
ISD TYPE: 01.02
VAPOR PROCESSOR TYPE: VEEDER-ROOT POLISHER

OVERALL STATUS              :WARN            EVR VAPOR COLLECTION :PASS
EVR VAPOR CONTAINMENT       :WARN
ISD MONITOR UP-TIME         :100%            STAGE I TRANSFERS:  1 of  1 PASS
EVR/ISD PASS TIME           : 90%            VAPOR PROCESSOR      :WARN

Status Codes: (W)Warn (F)Fail (D)Degradation Fail (G)Gross Fail
(ISD-W)ISD Self-Test Warning (ISD-F)ISD Self-Test Fail (N)No Test

       ISD    ISD  ---CONTAINMENT TESTS---      STAGE        ---COLLECTION TESTS
       EVR    %UP  GROSS   DGRD  MAX   MIN   LEAK   I   VAPOR  FP1   FP2   FP3
DATE  STATUS TIME   95%     75%  "WC   "WC   CFH   XFR  PRCSR  BLEND BLEND BLEND
03/01   PASS 100%  0.5   -0.0    0.0 -1.1     0        PASS   0.94  0.81  0.95
03/02   PASS 100%  0.4    0.0    0.2 -1.0     0        PASS   0.86  1.02  0.94
03/03   PASS 100%  0.5    0.0    0.8 -2.0     6        PASS   0.90  1.11  0.95
03/04   PASS 100%  0.4    0.0    2.0 -1.1     7        PASS   0.96  0.97  0.93
03/05   PASS 100%  0.4    0.0    0.0 -1.0     7        PASS   0.82  0.80  0.79
```

Figure 4: Example of Raw ISD Data - Delivery Report

```
OCT  8, 2013 10:47 AM

DELIVERY REPORT

T 1:UNLEADED 87
INCREASE    DATE / TIME              GALLONS TC GALLONS WATER  TEMP DEG F  HEIGHT

      END: OCT  7, 2013 11:42 AM       6873       6767  0.00       81.99   53.44
    START: OCT  7, 2013 11:20 AM       2332       2286  0.00       87.74   24.32
   AMOUNT:                             4541       4481

      END: OCT  3, 2013  1:28 PM       7579       7481  0.00       78.44   57.67
    START: OCT  3, 2013  1:04 PM       1645       1620  0.82       81.04   19.07
   AMOUNT:                             5934       5861

      END: SEP 30, 2013  9:10 AM       7002       6921  0.00       76.45   54.21
    START: SEP 30, 2013  8:46 AM       1104       1086  0.00       83.30   14.49
   AMOUNT:                             5898       5835

      END: SEP 25, 2013  6:00 PM       7160       7058  0.00       80.28   55.16
    START: SEP 25, 2013  5:34 PM       1213       1190  0.00       86.03   15.45
   AMOUNT:                             5947       5868

      END: SEP 23, 2013 12:41 PM       4726       4650  0.00       82.83   40.33
    START: SEP 23, 2013 12:23 PM        490        480  0.00       88.68    8.34
   AMOUNT:                             4236       4170

      END: SEP 18, 2013  5:51 PM       6721       6623  0.00       80.78   52.52
    START: SEP 18, 2013  5:24 PM        898        881  0.79       86.58   12.58
   AMOUNT:                             5823       5742

      END: SEP 15, 2013 10:16 AM       6071       5982  0.00       80.84   48.60
    START: SEP 15, 2013  9:57 AM       1521       1496  0.00       83.37   18.06
   AMOUNT:                             4550       4486

      END: SEP 11, 2013  6:35 PM       6331       6239  0.00       80.57   50.17
    START: SEP 11, 2013  6:09 PM        538        529  0.00       84.29    8.88
   AMOUNT:                             5793       5710

      END: SEP  7, 2013  6:33 AM       6152       6054  0.00       82.56   49.09
    START: SEP  7, 2013  6:08 AM       1626       1596  0.00       85.46   18.91
   AMOUNT:                             4526       4458

      END: SEP  3, 2013  5:55 PM       6861       6742  0.00       84.54   53.36
    START: SEP  3, 2013  5:24 PM        965        947  0.00       85.24   13.21
   AMOUNT:                             5896       5795
```

Figure 5: Example of Raw ISD Data – Vapor Flowmeter

```
OCT  8, 2013 10:47 AM
AFM BUSY EVENTS: FLOWMETER 1
INDEX START DATE-TIME    DUR     A/L     VAPOR    FUEL   #EV FLAGS  FPS    HOSES
 0001 13-09-08 13:10:50     76     0.23      3.2   14.0    1   003E  02     01
 0002 13-09-08 13:44:17     59     0.33      1.7    5.2    1   003E  02     01
 0003 13-09-08 15:17:59     39    -0.03     -0.3    9.3    1   003E  02     01
 0004 13-09-08 15:38:20    164    -0.20     -2.9   14.9    1   003E  01     00
 0005 13-09-08 16:11:38    108     0.20      3.2   15.9    1   003E  02     01
 0006 13-09-08 16:50:12    233     1.94     25.1   12.9    1   003E  02     01
 0007 13-09-08 17:37:59    170     0.62      9.7   15.6    1   002E  01     00
 0008 13-09-08 19:14:56     65     1.35     12.2    9.0    1   002E  02     01
 0009 13-09-08 20:25:43     87     0.69      6.9   10.0    1   002E  02     01
 0010 13-09-08 21:02:16    117     0.26      2.8   10.6    1   003E  02     01
 0011 13-09-08 21:30:51     81     0.08      0.4    5.0    1   003E  02     01
 0012 13-09-08 21:42:27     59     0.82      3.9    4.7    1   002E  02     01
 0013 13-09-08 22:01:58     66     0.08      0.4    5.3    1   003E  02     01
 0014 13-09-09 06:57:05     31     0.67      1.4    2.1    1   0037  02     01
 0015 13-09-09 07:01:23    135     0.32      2.1    6.3    1   003E  01     00
 0016 13-09-09 08:09:11     26     1.72      1.7    1.0    1   0037  02     01
```

Figure 6: Example of Raw ISD Data - Vapor Flow Monitoring Report

```
OCT  8, 2013 10:58 AM
BALANCE FLOW MONITORING TEST RESULTS


Rec# Test_Timestamp     EstPrOrvr OrvrLimit SiteChi^2 CritVal SiteChi^2Result
0330 13-09-02 09:59:09  78.52%    94.00%    143.16     20.48  valid_orvr_tests
Dispenser---- -----Flow Monitoring--- ---------------Orvr---------------
Labl Hose AFM Status  A/L   Days Evnt Status  V  #0 #AL %Blck %Thrs %Zero
  01   00  00  PASS    0.87 11.8    68 PASS    0  30  68 44.12 92.50 64.54
  02   00  00  PASS    0.92  3.9    91 PASS    0  31  91 34.07 90.60 66.44
  03   00  01  PASS    0.98  4.9    69 PASS    0  57  69 82.61 92.40 64.64
  04   00  01  PASS    0.98 10.9    69 PASS    0  60  69 86.96 92.40 64.64
  05   00  02  PASS    0.84  0.8    70 PASS    0  52  70 74.29 92.30 64.74
  06   00  02  PASS    0.70  3.9    72 PASS    0  48  72 66.67 92.11 64.93
  07   00  03  PASS    0.83  3.9    77 PASS    0  64  77 83.12 91.66 65.38
  08   00  03  NOTEST     N  0.6     2 PASS    0   2   2100.00  0.00  1.00
  09   00  04  PASS    0.88  8.9    73 PASS    0  68  73 93.15 92.01 65.03
  10   00  04  PASS    0.85  8.9    72 PASS    0  59  72 81.94 92.11 64.93
  11   00  05  PASS    0.90  3.9    82 PASS    0  67  82 81.71 91.25 65.79
  12   00  05  PASS    0.92  3.9    72 PASS    0  62  72 86.11 92.11 64.93
```

2. Methodology

Once CARB and district staff conducted their site visits and collected the target data, CARB staff returned to the office and created two large Excel databases, one for overpressure alarms and the other for leak alarms, in which to assemble and analyze the information. The goal was to determine whether a correlation existed between GDF operating parameters and overpressure occurrence severity. Additionally, an Excel macro program was created that pulls a segment of the ISD download (the ullage pressure and volume) to flag and identify sites that exhibit PWD, called "VR Vapor Pressure Events P/U Plot." A second Excel macro was created that pulls a different segment of the ISD download, the most recent 1,000 refueling transaction data available for each dispenser to determine site vapor-to-liquid (V/L) ratio and overall distribution of V/L, called "Histogram Assistance Tool" (HAT).

A. Mega Blitz Database – Overpressure Alarms

For the two Excel databases created, each was initially populated with 46 fields for each GDF site. The data for each GDF site includes information on location, hours of operation, types of vapor recovery and ISD systems, recent fuel deliveries, gasoline throughput, gasoline capacity, average UST and delivered fuel temperatures at each site visit, and changes to the sites between visits. Once specific site details were recorded, staff then populated another 32 fields with overpressure warning alarm information. For the Overpressure Alarm specific database (see Appendix V), staff analyzed the ISD downloads going as far back as October 2011. From the ISD monthly reports, staff tabulated the overpressure warning alarm occurrences in each month, up until the last Mega Blitz download site visit in April 2014.

B. Mega Blitz Database – Leak Alarms

The Mega Blitz Leak Alarm database (see Appendix VI) consisted of the same 46 GDF site specific fields as the Mega Blitz Overpressure Alarm database. However, instead of quantifying the overpressure warning alarms taking place each month and across the entire Mega Blitz study period, it quantifies the warning leak alarms occurring monthly. With data gleaned from the ISD alarm reports, staff populated 32 fields with monthly leak alarm totals from October 2011 to April 2014, and tabulated the alarm totals and frequency for each site.

C. Vapor Pressure Events Pressure / Ullage Plot – PWD Identification

Along with quantifying frequency of overpressure and leak alarms pulled from the ISD data downloads, staff also examined the UST pressure data contained in ISD Vapor Pressure Events command for evidence of PWD. The Vapor Pressure Events command provides the most recent 30 hours of pressure and ullage data and consists of 5,400 records. To identify PWD, staff created an Excel macro, VR Vapor Pressure Events P/U Plot, that identified which sites demonstrated specific data traits (flags). The

versus summertime overpressure alarm occurrences. The data presented was gathered from the first two rounds of ISD data downloads in October and December 2013 and pulled from stored alarm information dating back to April 2012. There were a total of 395 GDF sites initially studied in the Mega Blitz, with 272 being assist EVR system sites and 123 being balance EVR system sites. 313 of those sites were open 24 hours a day and 82 shut down service at night. Overpressure alarm occurrences were high in the wintertime fuel months, with 2,329 alarms taking place between December 2012 and March 2013, and in November 2013. Overpressure alarms in the summertime fuel months between April 2012 and October 2013, were relatively low, totaling 317.

Table 3: General Site Information – Statewide

All Sites	Number	Percent
Sites in Mega Blitz	395	N/A
Assist Sites in Mega Blitz	272	68.9%
Balance Sites in Mega Blitz	123	31.1%
Sites open 24 Hours	313	79.2%
Sites that shutdown at night	82	20.8%
OP Alarms: Dec 2012 – March 2013 & Nov 2013 (Winter)	2329	N/A
OP Alarms: April 2012 – October 2013 (Summer)	317	N/A
Ratio of Winter vs Summer OP Alarms	7.3	N/A
Sites with Veeder-Root ISD	377	95%
Sites with INCON ISD	18	5%

Tables 4 and 5 lists the factors associated with overpressure alarm occurrences for all sites in October and November 2013, respectively. Staff looked at the number and percentage of overpressure alarms in comparison to hours of operation (24 hour sites versus those that shut down at night). There was a ten-fold increase in the total number of overpressure alarms from October to November (the switch to winter fuel) and more sites experienced at least one overpressure alarm in November as compared to October. In October 2013, there was on average 0.12 overpressure alarms per GDF, with an average of 0.11 overpressure alarms at 24 hour sites and 0.13 overpressure alarms at sites that shut down at night. In November 2013, there was on average 1.39 overpressure alarms per GDF, with an average of 1.38 overpressure alarms at 24 hour sites and 1.43 overpressure alarms at sites that shut down at night.

Table 4: General Site Information for October 2013

October 2013 - All Sites	Number	Percent
Sites with at least 1 OP Alarm in Oct 2013	26	6.6%
Total number of OP Alarms in October 2013	46	N/A
OP Alarms/GDF	0.12	N/A
OP Alarms at 24 Hour sites in Oct 2013	35	76.1%
OP Alarms/GDF at 24 Hour sites in Oct 2013	0.11	N/A
OP Alarms at sites that shut down at night in Oct 2013	11	23.9%
OP Alarms/GDF that shut down at night in Oct 2013	0.13	N/A

Table 5: General Site Information for November 2013

November 2013 - All Sites	Number	Percent
Sites with at least 1 OP Alarm in Nov 2013	215	54.4%
Total number of OP Alarms in Nov 2013	548	N/A
OP Alarms/GDF	1.39	N/A
OP Alarms at 24 Hour sites in Nov 2013	431	78.6%
OP Alarms/GDF at 24 Hour sites in Nov 2013	1.38	N/A
OP Alarms at sites that shut down at night in Nov 2013	117	21.4%
OP Alarms/GDF that shut down at night in Nov 2013	1.43	N/A

B. Overpressure and Leak Alarms

Initial findings from the Mega Blitz study and data analysis focused on the site visits from October and November 2013. Table 6 below shows the prevalence of overpressure alarms from that time period, as all GDF sites combined and then the split between assist and balance EVR system sites. There was an average of 0.12 overpressure alarms per site in October 2013 with summertime fuel, which increased to an average of 1.39 overpressure alarms per site in November 2013 with wintertime fuel. From October to November, the percentage of sites with at least one alarm increased from 6.6 percent to 54.4 percent. Alarms per site during that time increased for both assist and balance sites. In November 2013, nearly 70 percent of assist EVR system sites had at least one overpressure alarm while nearly 20 percent of balance EVR system sites experienced at least one alarm.

Table 6: Prevalence of Overpressure Alarms

Data Set	Overpressure Alarms	October 2013	November 2013
All Sites Combined (395)	Average Number of Alarms Per Site	0.12	1.39
	% of Sites With at Least One Alarm	6.6%	54.4%
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%

Table 7 compares the prevalence of leak alarms for the same time periods. There was an average of 0.33 leak alarms per site in October 2013 with summertime fuel, which decreased to an average of 0.29 leak alarms per site in November 2013 with wintertime fuel. From October to November the percentage of sites with at least one alarm stayed the same at 16.2 percent. Alarms per site during that time decreased slightly for assist sites and increased slightly for balance sites. In November 2013, 8.8 percent of assist EVR system sites had at least one leak alarm while 33.1 percent of balance EVR system sites experienced at least one alarm.

Table 7: Prevalence of Leak Alarms

Data Set	Leak Alarms	October 2013	November 2013
All Sites Combined (395)	Average Number of Alarms Per Site	0.33	0.29
	% of Sites With at Least One Alarm	16.2%	16.2%
Assist Sites (274)	Average Number of Alarms Per Site	0.19	0.13
	% of Sites With at Least One Alarm	11.7%	8.8%
Balance Sites (121)	Average Number of Alarms Per Site	0.65	0.65
	% of Sites With at Least One Alarm	26.4%	33.1%

Figures 10 and 11 provide temporal trends of the prevalence of overpressure and leak alarms from month to month. Figure 10 displays the number of overpressure alarms occurring monthly, from October 2011 to March 2014, showing the increase in alarms during winter months. Figure 11 displays the number of leak alarms occurring monthly, from October 2011, to March 2014, showing an increase in the summer months.

Figure 10: Prevalence of Overpressure Alarms, October 2011 to March 2014

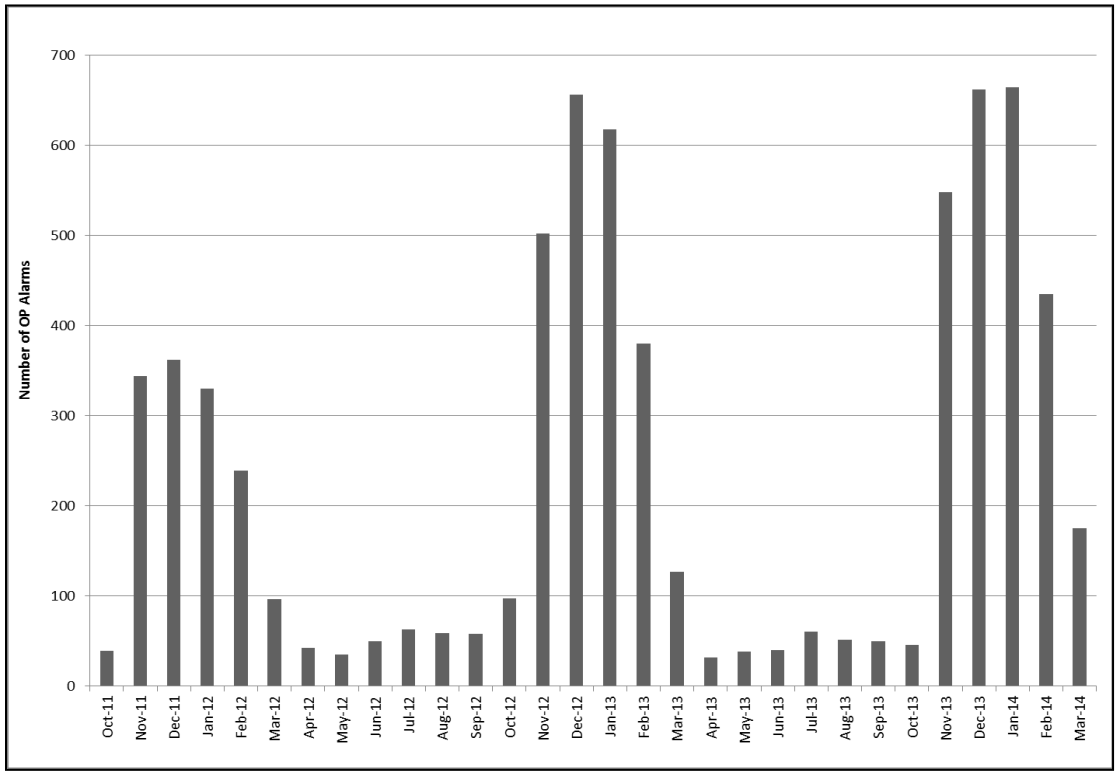
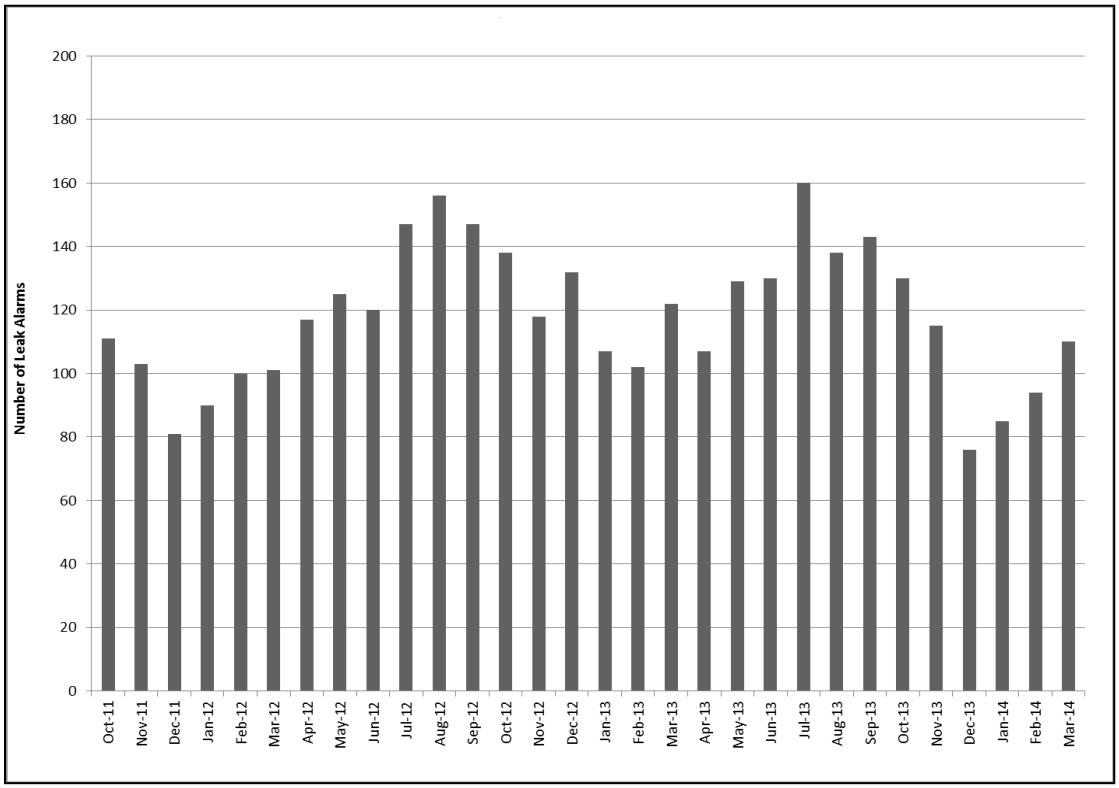


Figure 11: Prevalence of Leak Alarms, October 2011 to March 2014



C. PWD Related Findings

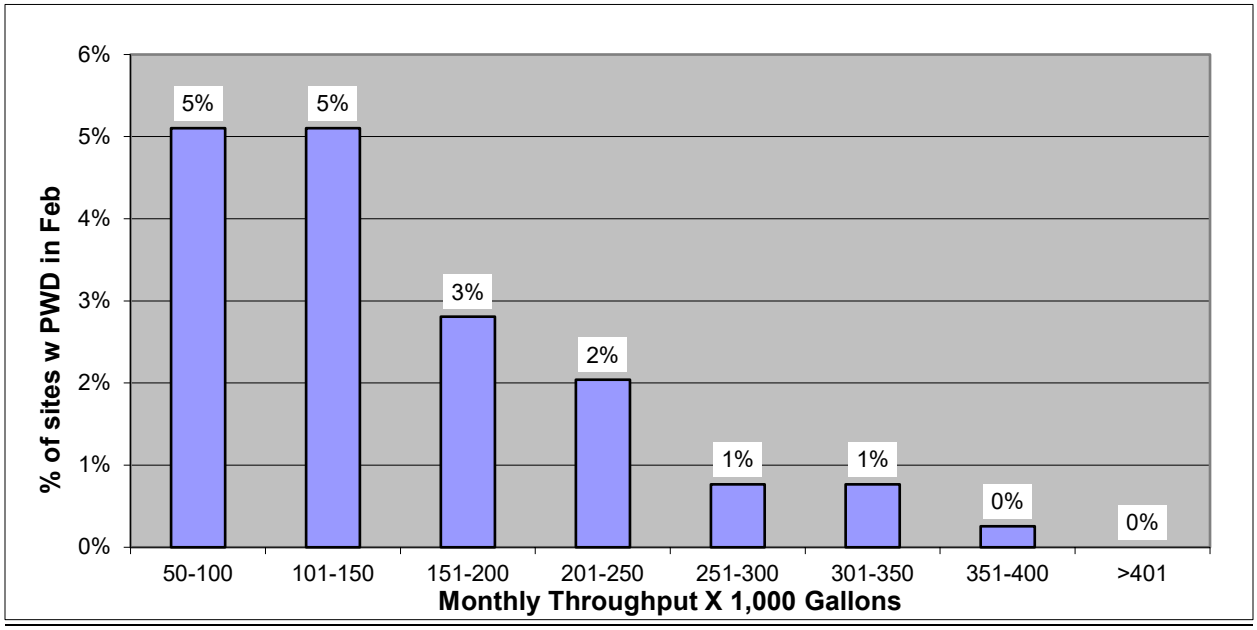
The following tables provide information pertaining to the characteristics of GDF sites (assist versus balance, throughput, and hours of operation) in comparison to occurrences of overpressure alarms and PWD within the Mega Blitz study. Table 8 displays the percentage of PWD occurrences statewide and regionally from December 2013 to February 2014. Across all regions, instances of PWD at assist EVR system sites decreased from December 2013 to February 2014, falling from 34.2 percent to 24.4 percent. This trend followed in four of the five regions, except for South Coast where PWD occurrence increased from 33.3 percent of assist EVR system sites to 40.2 percent in the same time period. The drops in PWD can likely be attributed to cooler ambient temperatures and lower RVP.

Table 8: Statewide PWD Percentage

Location	Assist* PWD – December 2013	Assist* PWD – February 2014
All Counties/Districts	34.2%	24.4%
SJVAPCD	68%	20%
BAAQMD	50%	18%
Sacramento	11.1%	2.8%
San Diego	22.7%	22.7%
South Coast	33.3%	40.2%

*PWD was not observed at balance EVR system sites.

Figure 17: PWD and Monthly Gasoline Throughput in February 2014



4) PWD and Ullage Volume

Staff examined thirty assist sites located in SCAQMD; ten exhibiting PWD in December 2013 and February 2014; ten exhibiting PWD in December but not February; and ten not exhibiting PWD in December, but exhibiting it in February. The average throughput, UST capacity in gallons, and average ullage volume in gallons was also noted. Table 18 below shows that despite the varied stages of PWD, UST ullage was consistent at nearly 60 percent.

Table 18: Ullage Volume and Prevalence of PWD

Number of Sites	Average Throughput	PWD in Dec	PWD in Feb	Average UST Capacity (gallons)	Average Ullage Volume (gallons)	% Ullage
10	153,900	No	No	32,800	19,230	58.6%
10	134,900	Yes	Yes	32,700	18,790	57.5%
10	149,900	Yes	No	31,800	18,600	58.5%

5) V/L Ratios at PWD versus non-PWD Sites

To assess the effect of PWD on vapor to liquid (V/L) ratios of assist sites, staff used the HAT tool to compare the V/L ratios of PWD to non-PWD assist sites from October 2013, to December 2013 in four regions. Data was collected from 42 sites in South Coast, 22 sites in the Bay Area, 20 sites in San Diego, and 16 sites in the San Joaquin Valley. Each region studied contained an equal number of PWD and non-PWD sites as well as a similar monthly gasoline throughput at the GDFs. Table 19 below shows that the V/L