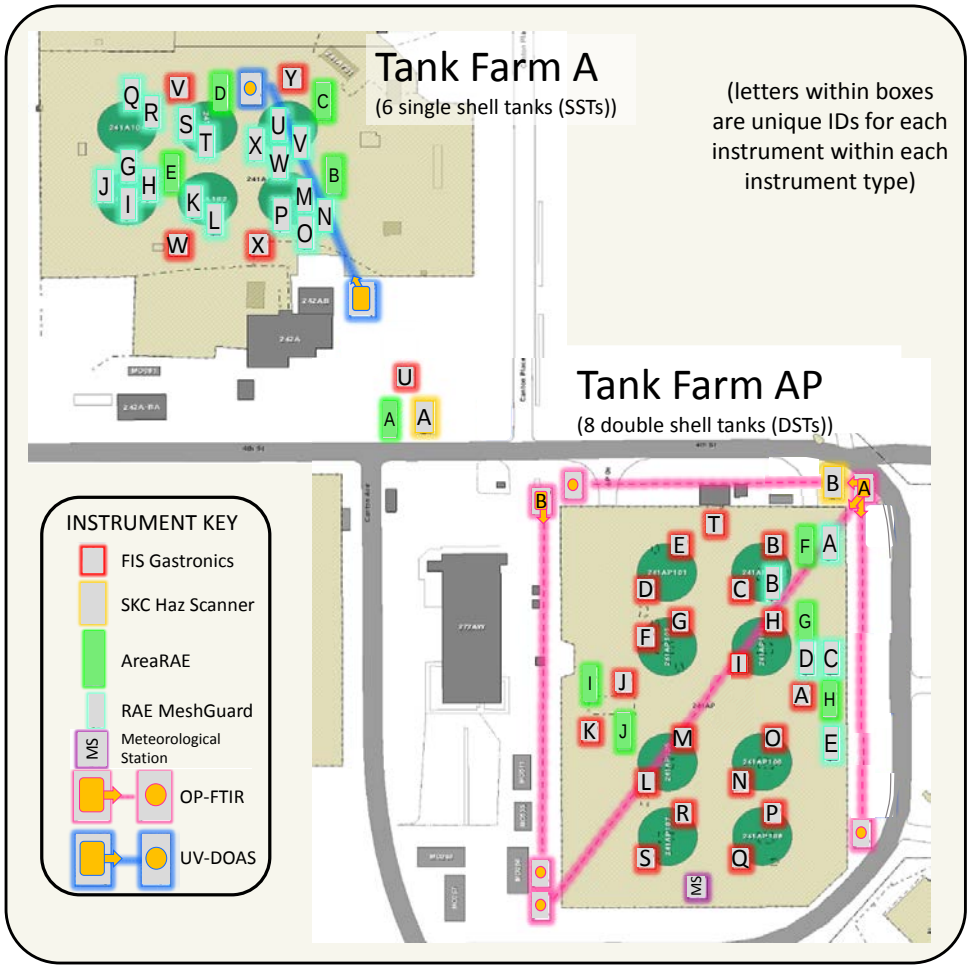
Direct Reading Instrumentation Weekly Summary

9/14/16 6:00 – 9/21/16 6:00

Sampling Location –A & AP-Tank Farms (map below)



This summary contains Vapor Monitoring and Detection System (VMDS) Phase 1 pilot-scale data collected over one week (September 14th at 6:00am through September 21st at 6:00am) using direct reading vapor detection instruments. Phase 1 testing is focused on evaluating component integration and functionality. Data shown may include results for calibration and bump (system check) tests performed to verify sensors are functioning; these tests are visible in the data as spikes. Any direct reading instrument alarms occurring during Phase 1 pilot-scale testing are taken to be actual events and are responded to accordingly.

Abbreviations:
NH_3 = ammonia
CO = carbon monoxide
CO_2 = carbon dioxide
LEL = lower explosive limit
NO = nitric oxide
N_2O = nitrous oxide
NO_2 = nitrogen dioxide
PM 2.5 / PM 10 = particle monitors for >2.5µm and >10µm particles respectively
H_2S = hydrogen sulfide
SO_2 = sulfur dioxide
VOC = volatile organic carbons, which include both volatile and semi-volatile compounds.

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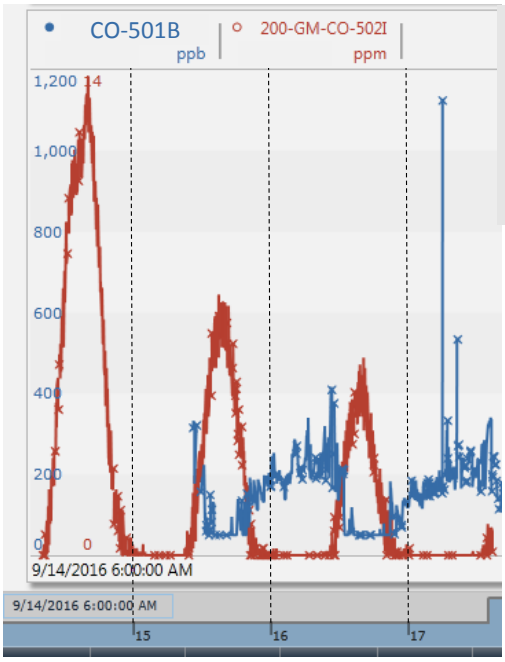
Week Summary:

HazScanner B was reporting, and although it is not calibrated it reported most of the compounds at levels typical of background for air: methane (if reported in ppb), CO_2, NH_3, O_3, and SO_2. It also detected hydrogen sulfide (H_2S) at levels (0.45 ppm maximum) well below OSHA's recommended ceiling concentration of 20ppm[1].

Recurring patterns were observed on several instruments. The HazScanner and AreaRAEs both showed recurring patterns for CO, see *Figure 1*. If a correlation is the CO sensors readings between the HazScanner and AreaRAEs

Figure 1) CO for HazScanner B (501B) and AreaRAE I (502I)



Note that the y-axis are different for each instrument. The HazScanner (501B) y-axis is 0 to 1,200 ppb (0 to 1.2 ppm) and the AreaRAE's y-axis is 1 to 14 ppm

The FIS-Gastronics are instrumentation for ammonia (NH_3), total volatile organic carbon (VOC) and nitrous oxide (N_2O). All nitrous oxide (N_2O) sensors continue to have calibration issues, the sensor on B was non-functional and four sensors were reporting. Both the RAE MeshGaurds' and Gastronics' did not report NH_3 during the week. Gastronics VOC detection was below 1ppm. Instrument 512Q reported VOCs in a recurring early morning pattern of up to about 1 ppm. A total VOC limit of 2 ppm currently is employed by the Industrial Hygiene Program Technical Basis[2].

MultiRAE instrument C reported VOC with a maximum value of 5.0 ppm (average 3.6 +/- 0.9 ppm). No cause for the reported values was determined.

Note regarding instrument tags as reported in OSI PI and often presented in weekly summary information captured directly from OSI PI: All gas monitoring instruments begin with 200-GM, followed by the target

[1] OSHA H_2S standard (https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9993)
[2] RPP-22491, Rev 1, "Industrial Hygiene Chemical Vapor Technical Basis": http://hanfordvapors.com/wp-content/uploads/2016/08/ESH_IHTechBasis_RPP-22491Rev1.pdf

analyte (such as NH_3), next is the instrument type (three digit number), and the instrument unit as sequential letters. For example, "200-GM-NH3-512C" is an ammonia sensor reporting from Gastronics' (denoted as "512") instrument "C".

September 14th – 21st 2016 Observations By Instrument:

HazScanner (501) – Data reported into OSI PI[3] for 501B, however it was logged as 501A. Configuration of the tags is also not complete, e.g., the methane sensor is reported as % when it should be most likely be ppb.

Table 1HazScanner comments

Compound (units)	Comment	OEL	Action Level	Detection Range
CH_4 (ppm)	Instrument reported values from 0 to 1,155%; it is assumed that the unit are incorrect and that the correct values are 0 to 1.16ppm (1,155ppb) (average of 0.37 +/- 0.24 ppm)			50 – 10,000
CO_2 (ppm)	0 to 415 ppm (average 350 +/- 21ppm).			50 – 5000
CO (ppm)	0.05 to 1.1ppm (average 0.16 +/- 0.07 ppm).	50	25	0.02 -10
H_2S (ppm)	0 to 0.45 ppm.		(d)	Unknown
NH_3 (ppm)	0 to 6.9 ppm (average of 0.5 +/- 0.9ppm).	50	25	<0.2 – 100
NO_2 (ppm)	0.00 to 1.41 ppm (average of 0.15 +/- 0.31 ppm).			0.005 – 5
O_3 (ppm)	0.00 to 0.05 ppm (average of 0.031 +/- 0.008 ppm).			0.001 – 0.15
PM10 (µg/m^3)	Average of 8.3 +/- 7.2 µg/m^3; one spike up to 266 µg/m^3.		(a)	10 – 5000
PM25 (µg/m^3)	Average of 5.1 +/- 6.6 µg/m^3; one spike up to 156 µg/m^3.		(b)	Unknown
SO_2 (ppm)	0.001 to 0.016 ppm (average of 0.001 +/- 0.0002 ppm (c))			0.005–5
VOC (ppm)	Instrument reported values from 0.00 to 0.08 ppm. Note that this sensors reporting time was much less than that of the others.		2	0.005 - 50

Notes:
a) 150 µg/m^3 over 24 hours, not to be exceeded more than once per year on average over 3 years[4]
b) 12.0 µg/m^3, annual mean, averaged over 3 years[5]
c) Note that the minimum reported and average reported values are less than the vendor's specified range for the instrument
d) OSHA Acceptable ceiling concentration is 20ppm[6]

[3] OSI PI is a data visualization software package from OSIsoft.
[4] EPA NAAQS Table (https://www.epa.gov/criteria-air-pollutants/naaqs-table)
[5] EPA NAAQS Table (https://www.epa.gov/criteria-air-pollutants/naaqs-table)
[6] OSHA H_2S standard (https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9993)

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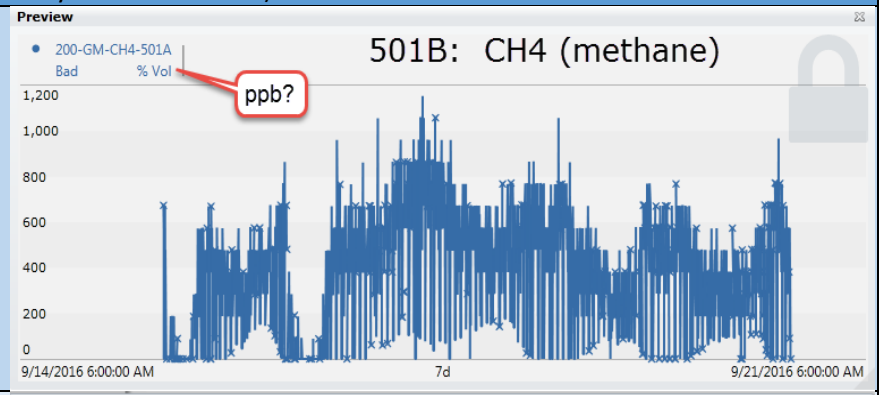
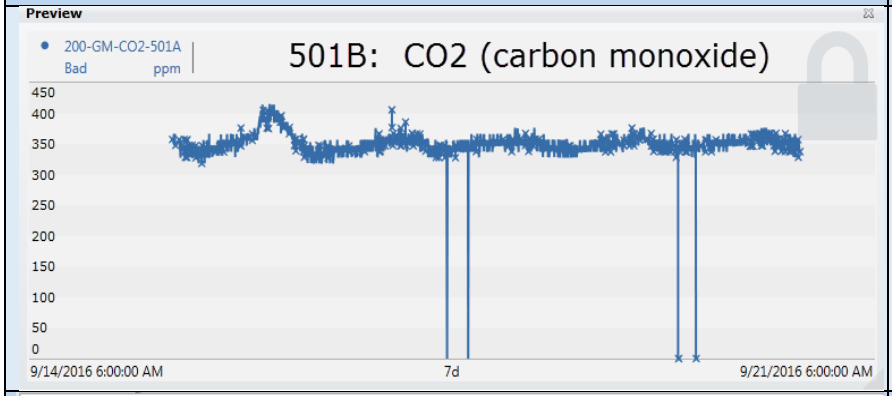
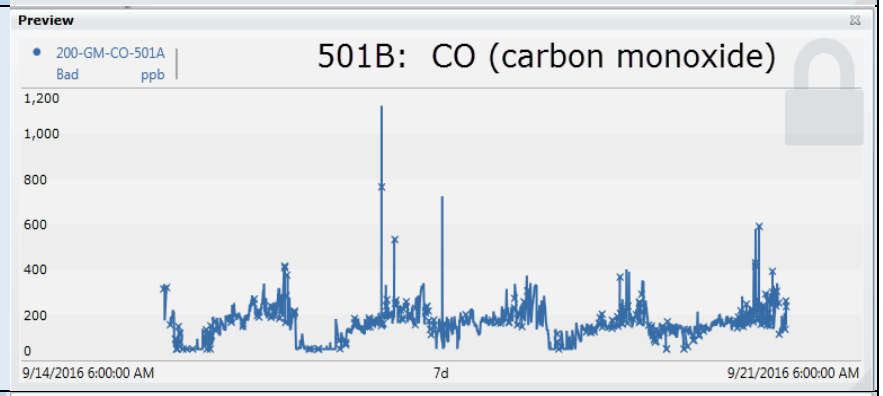
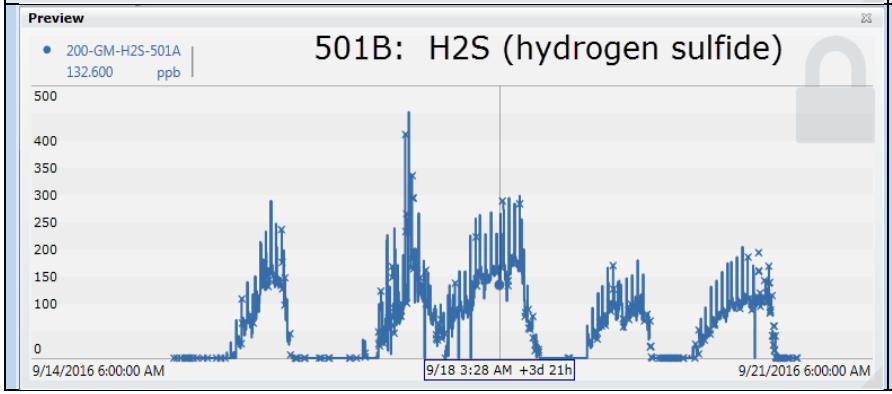
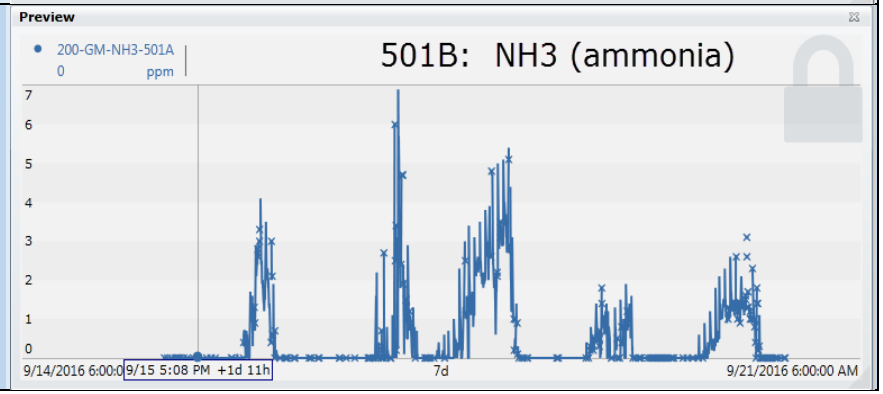
Table 2) HazScanner 501B Report.

HazScanner 501B (incorrectly labeled as 501A)	
The data presented here is as reported out of OSI PI. The instrument had not been calibrated and, in addition to the instrument being mislabeled, at least one sensor is incorrectly configured. Note: OSI PI reports the last data point in the time frame selected in the upper left hand box, left of the unit definition. When no data is present to report "Bad", "Configure", or "I/O Timeout" may be displayed depending on the error code from the instrument. This does not indicate readings that are out of instrument limits. Examples of what it may indicate are loss of data transmission signal or loss of instrument power.	
	
	

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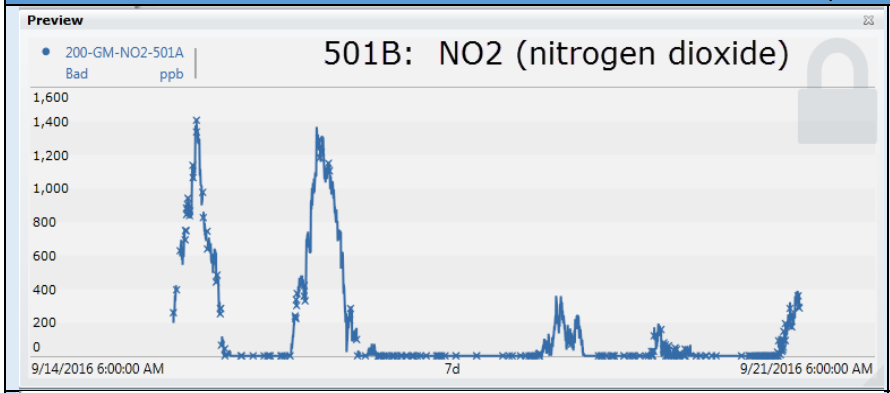
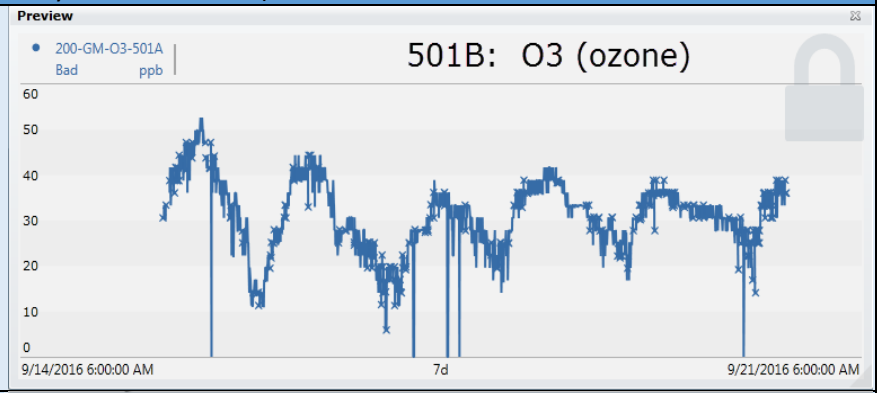
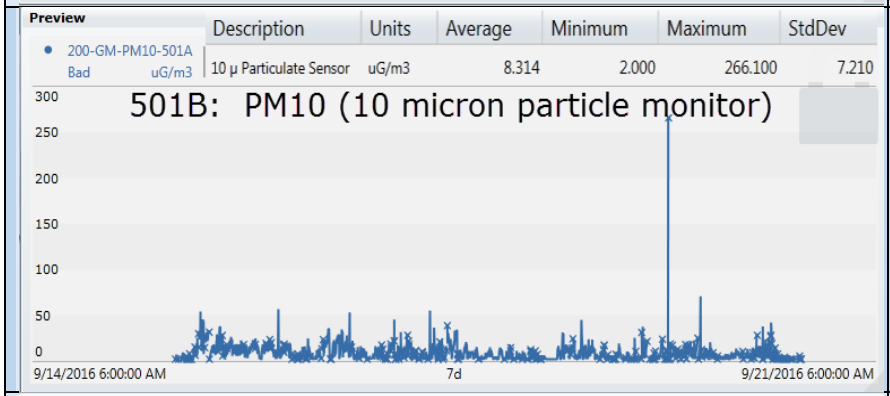
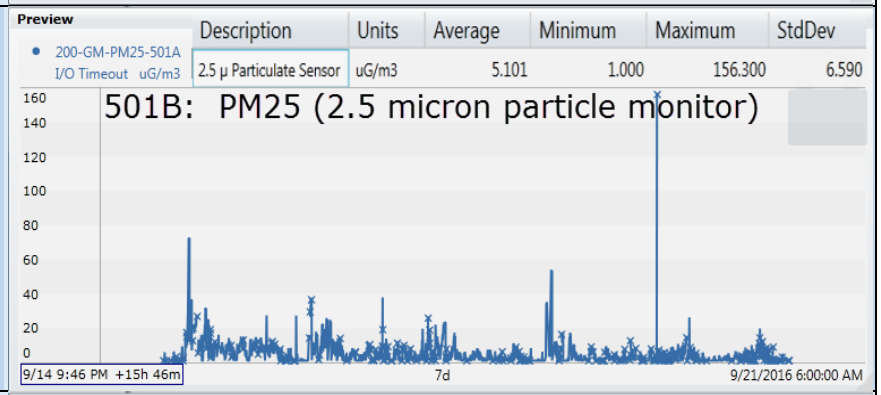
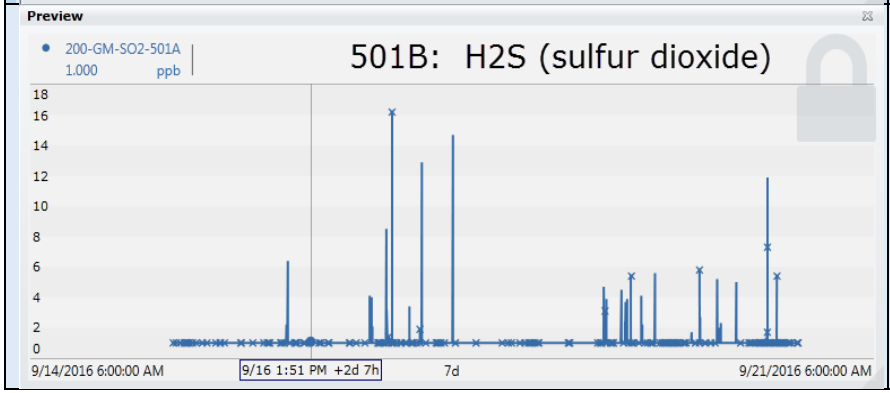
HazScanner 501B (incorrectly labeled as 501A)

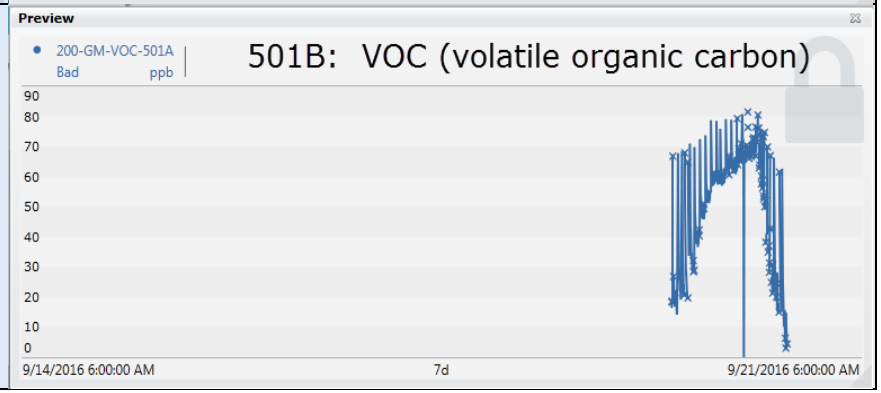












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AreaRAE (502) – Fixed instruments located in and around both A and AP Tank Farms. See tables and figures below for weekly status and reporting information.

Table 3) AreaRAE Comments

Compound (units)	**Comment**	**OEL**	**Action Level**	**Detection Range**
CO (ppm)	Four instruments reporting, F, G, H, and I. Same daily peeks seen as previous week. Starting late morning and subsiding in the evening *Figure 2*. • F – max 13.4 ppm, average 1.9 +/-3.1 ppm • G – max 13.6 ppm, average 1.4 +/-3.0 ppm • H – max 10.4 ppm, average 0.9 +/-2.1 ppm • I – max 13.8 ppm, average 1.3 +/-2.8 ppm	50	25	1 – 500
LEL (%)	Constant at 0% for all sensors reporting, F, G, H, and I.			0 – 100
NH_3 (ppm)	Four instruments reporting, F, G, H, and I. • A – max 2.0 ppm, average 1.7 +/-0.3 ppm • F – max 1.8 ppm, average 1.2 +/-0.2 ppm • G – max 2.0 ppm, average 1.3 +/-0.2 ppm • H – max 2.3 ppm, average 1.4 +/-0.3 ppm • I – max 2.5 ppm, average 1.9 +/-0.2 ppm	25	12.5	1 – 50
Oxygen (%)	• A – average 20.9 +/-0.1 % • F – average 21.0 +/-0.1 % • G – average 20.9 +/-0.1 % • H – average 20.9 +/-0.1 % • I – average 21.0 +/-0.1 %		<19.5	1 - 30
VOC (ppm)	Below detection limit for reporting sensors A, F, G, H, and I.		2	1 - 200

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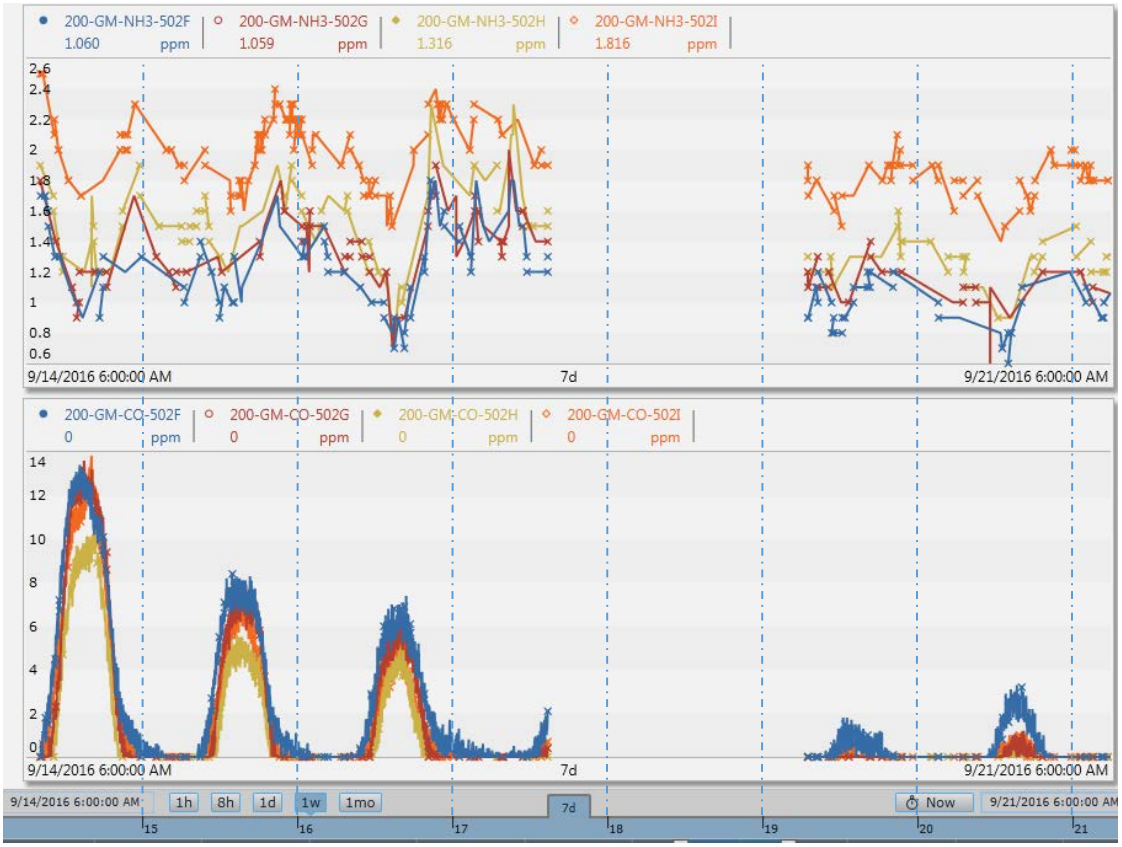
Figure 2: AreaRAE Carbon Monoxide and Ammonia Monitor Data.



ToxiRAE (503) – Instruments are personnel monitors and are not continuously utilized during daytime; they were not deployed for most of the time period under evaluation. Data recorded for only a short period of time for VOC on a couple of instruments.

Table 4)ToxiRAE Comments

Compound (units)	Comment	OEL	Action Level	Detection Range
VOC (ppm)	Below detection limit when reporting for evaluation period; instruments reporting were G, J, and K.	N/A	2	0.1 - 2000

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MultiRAE (504) – Instruments are personnel monitors and are not continuously utilized during daytime; they were not deployed for most of the time period under evaluation. Issues with LEL sensors: 1) 504B reported consistent 45% values and, 2) 504C indicated 20.9% when reporting – most likely a labeling issue, this is under investigation.

Table 5) MultiRAE Comments

Compound (units)	**Comment**	**OEL**	**Action Level**	**Detection Range**
CO (ppm)	• A – below detection limit when reporting for evaluation period • B – below detection limit when reporting for evaluation period • C – max 15.0 ppm, average 2.9 +/-4.2 ppm	50	25	0 – 500
LEL (%)	• A – 0% reported for the entire evaluation period • B – Reported a constant 45% when reporting throughout the evaluation period • C (a) – Reported 20.9 for a brief period, most likely reporting O_2 level.	N/A		0 – 100
NH_3 (ppm)	Only instrument C reported: read 1.0 ppm from 6:30 to 9:15 then 0.0 for the remainder of reporting period (average 0.04 +/- 0.20 ppm	25	12.5	1 – 500
Oxygen (%)	Instruments A and B reported constant 20.9 % when reporting. Instrument C reported 0 from 7:00 to 10:30, then 20.9% for the remainder of the reporting period (average of 19.8 +/- 4.7 %)		<19.5	1 – 30
VOC (ppm)	Only instrument C reported: max 5.0 ppm (average 3.6 +/- 0.9 ppm	N/A	2	0.1 – 5000

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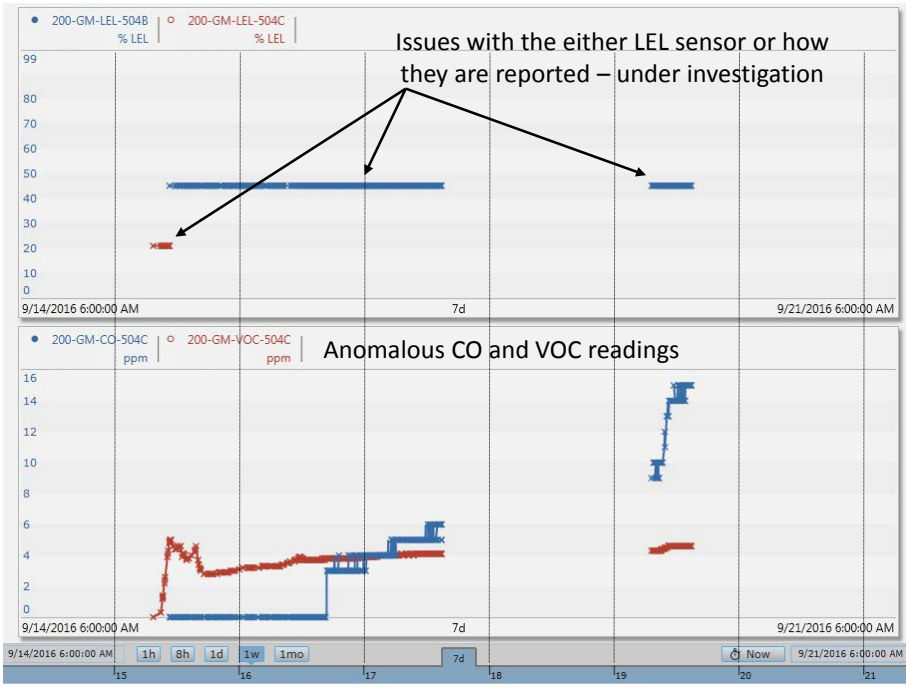
Figure 3) MultiRAE report on anomalous data



RAE MeshGuard (505) – Ammonia detection instruments deployed primarily in A Tank Farm with a couple located AP Tank Farms.

Table 6) RAE MeshGuard Comments.

Compound (units)	Comment	OEL	Action Level	Detection Range
NH_3 (ppm)	Below detection limit for the period of time in under review. Instruments A, C, D, F, J, N, O, P, Q, R, S, T, V, and X were bump tested at 11:00 to 16:00 on the 20th.	25	12.5	1 – 50

Notes: a) The tag for oxygen is assumed to be crossed with the tag for LEL.

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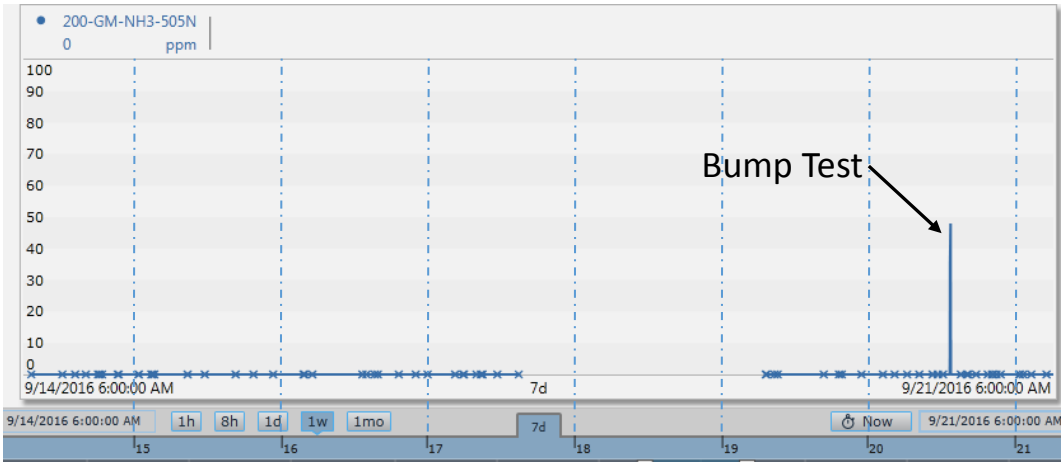
Figure 4) Example of RAE MeshGuard report; ammonia below detection limit on all reporting instruments during normal operations



FIS-Gastronics (512) – Monitor for ammonia, volatile organic carbon, and nitrous oxide. Earlier all Nitrous oxide sensors were removed for temperature compensation, at the time of reporting only five were installed.

Table 7) Gastronics comments.

Compound (units)	**Comment**	**OEL**	**Action Level**	**Detection Range**
NH_3 (ppm)	No ammonia reported on any instrument (other than bump tests) until ~14:40 on 9/19 where: • G, J, K, and O reported ammonia of ~20 to ~35ppm until calibration. • L has an ammonia spike that looks like a bump test at 14:40	25	12.5	1 – 500
VOC (ppm)	• Sensors on instruments A, C, D, M, O, P, Q, S, X, and Y reported non-zero concentrations <1 ppm. o Note A, D, and Y report values 10x actual measurement due to programming; trouble shooting in progress. • Q had a recurring pattern, see figure below (<1 ppm).	N/A	2	0 – 1000
N2O (ppm)	N_2O sensors only installed on A, B, C, D, and U; sensor on B was not functional and reported max scale (1100 ppm) most of the time; work is ongoing to determine if Gastronics N2O sensors can be kept in calibration.			0 – 1000

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Figure 5) Nitrous oxide reporting for Gastronics

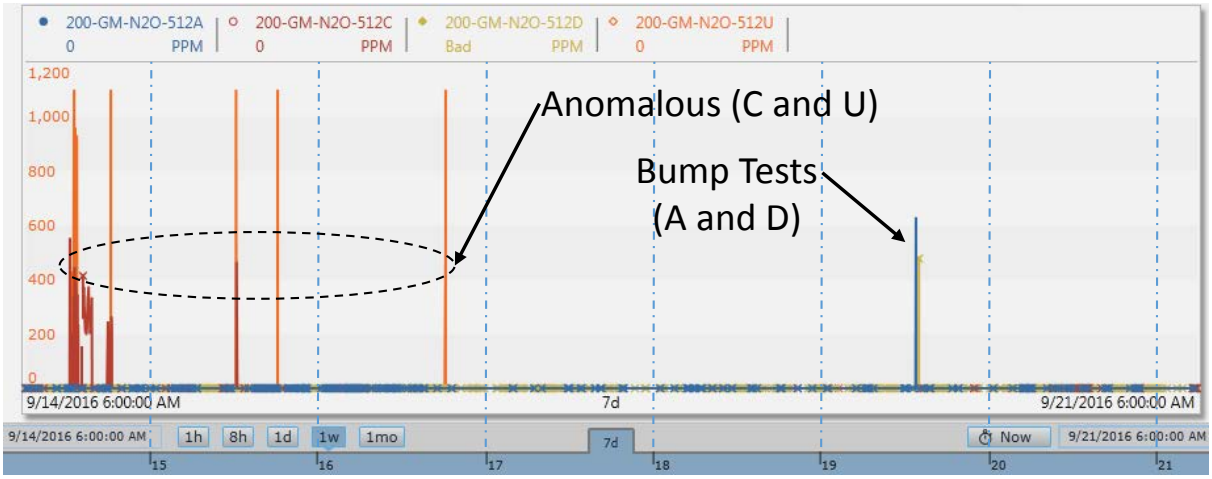

Figure 6) Gastronics VOC recurring pattern on instrument Q

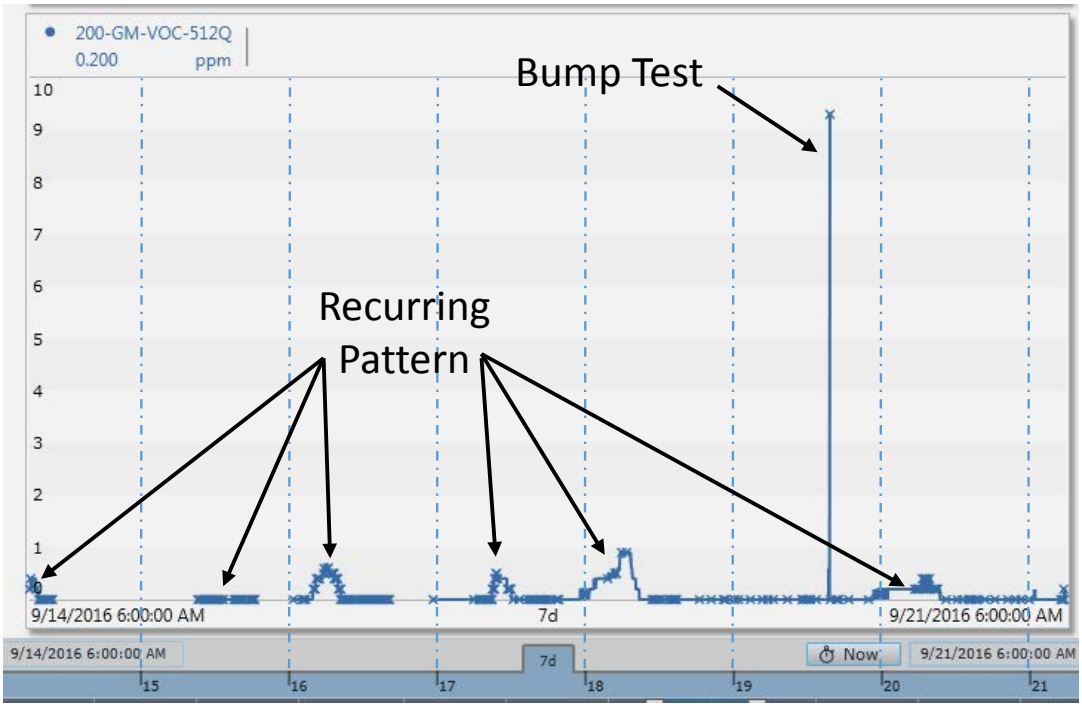

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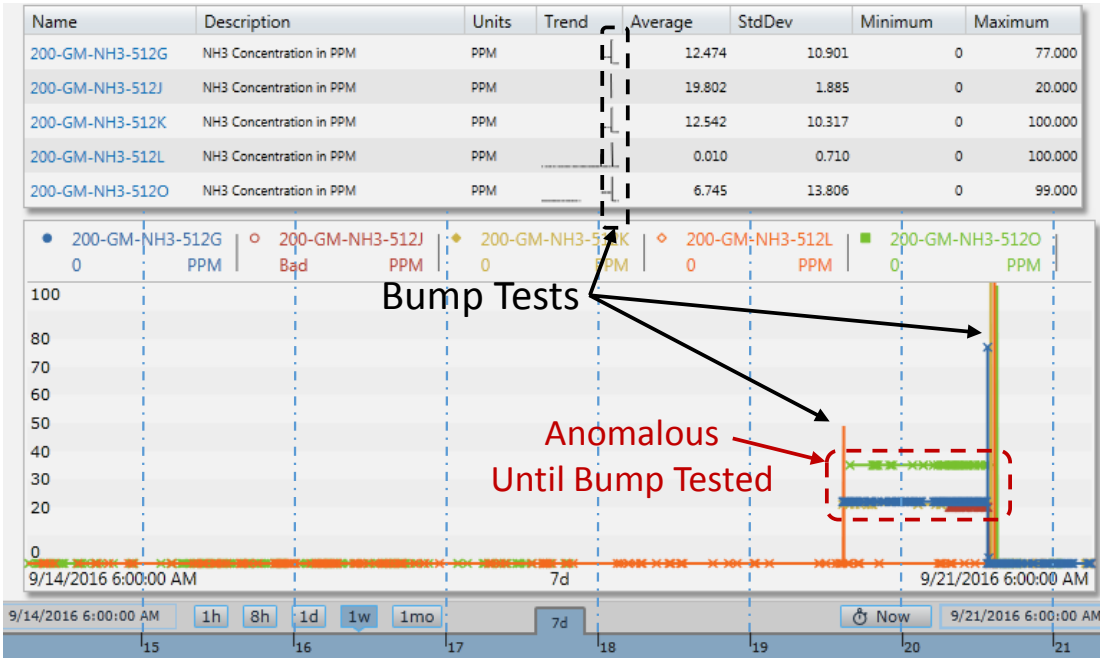
Figure 7) Ammonia reporting for Gastronics



September 14th – 21st 2016 Instrument Operational Status:

Time reporting is calculated using the average time sensors are reporting to OSI PI[7] for each instrument:

Table 8) HazScanner (501) % time reporting by instrument

Instrument	% Time Reporting	Instrument	% Time Reporting
501A (b)	71	501B (b)	71

Notes:
a) % time reporting is based on hourly interval data as exported from OSI PI.
b) The instrument tags were incorrect during this time period; data reported for 501B was reported as being from 501A

Table 9) AreaRAE (502) % time reporting by instrument

Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting
502A	2.4	502D	0	502G	72	502J	0
502B	0	502E	0	502H	73		
502C	0	502F	73	502I	73		

Notes:
a) % time reporting is based on hourly interval data as exported from OSI PI.

[7] OSI PI is a data visualization software package from OSIsoft.

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Table 10) ToxiRAE (503) % time reporting by instrument (personal monitors only used when operators are in the field)

Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting
503A	0	503E	0	503I	0
503B	0	503F	0	503J	2
503C	0	503G	4	503K	4
503D	0	503H	0		

Notes: a) % time reporting is based on average hourly interval data as exported from OSI PI.

Table 11) MultiRAE (504) time reporting by instrument (personal monitors only used when operators are in the field)

Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting
504A	23	504B	21	504C	25

Notes: a) % time reporting is based on average hourly interval data as exported from OSI PI.
b) NH_3 and VOC for sensors A and B were down 100% of the time.

Table 12) MeshGuard (505) RAE % time reporting.

Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting
505A	75	505G	0	505M	0	505S	61
505B	0	505H	0	505N	72	505T	65
505C	73	505I	0	505O	69	505U	0
505D	72	505J	72	505P	65	505V	72
505E	0	505K	0	505Q	72	505W	0
505F	73	505L	0	505R	60	505X	71

Notes: a) % time reporting is based on hourly interval data as exported from OSI PI.

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Table 13) Gastronics (512) % time reporting by instrument

Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting
512A	94	512H		512N		512T	
512B	97	512I	98	512O	66	512U	100
512C	28	512J	1	512P	29	512V	0
512D	91	512K	24	512Q	67	512W	0
512E	98	512L	96	512R	0	512X	5
512F	10	512M	90	512S	8	512Y	82
512G	20						

Notes:

a) % time reporting is based on average sensor hourly interval data as exported from OSI PI for NH_3 sensors.