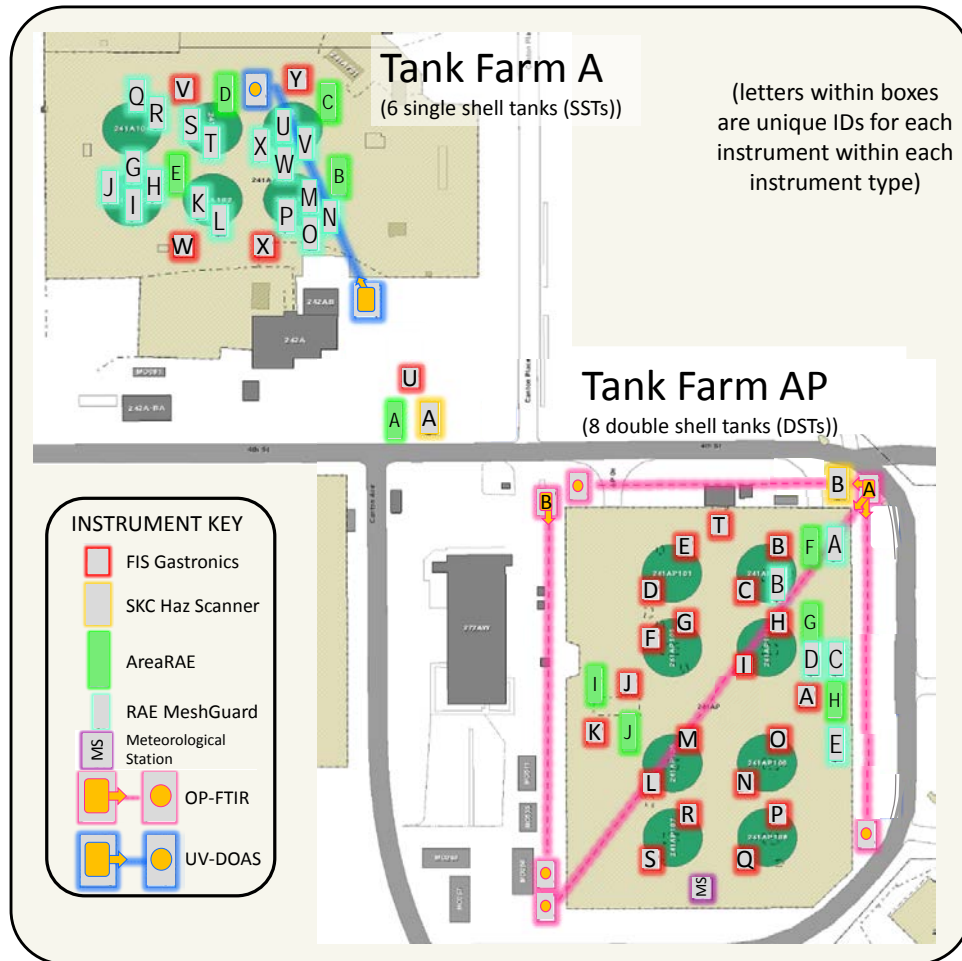


Direct Reading Instrumentation Weekly Summary

9/21/16 6:00 – 9/28/16 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 21st at 6:00am through September 28th 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:
- NH₃ = ammonia
 - CO = carbon monoxide
 - CO₂ = carbon dioxide
 - LEL = lower explosive limit
 - NO = nitric oxide
 - N₂O = nitrous oxide
 - NO₂ = nitrogen dioxide
 - PM 2.5 / PM 10 = particle monitors for >2.5µm and >10µm particles respectively
 - H₂S = hydrogen sulfide
 - SO₂ = sulfur dioxide
 - VOC = volatile organic carbons, which include both volatile and semi-volatile compounds.

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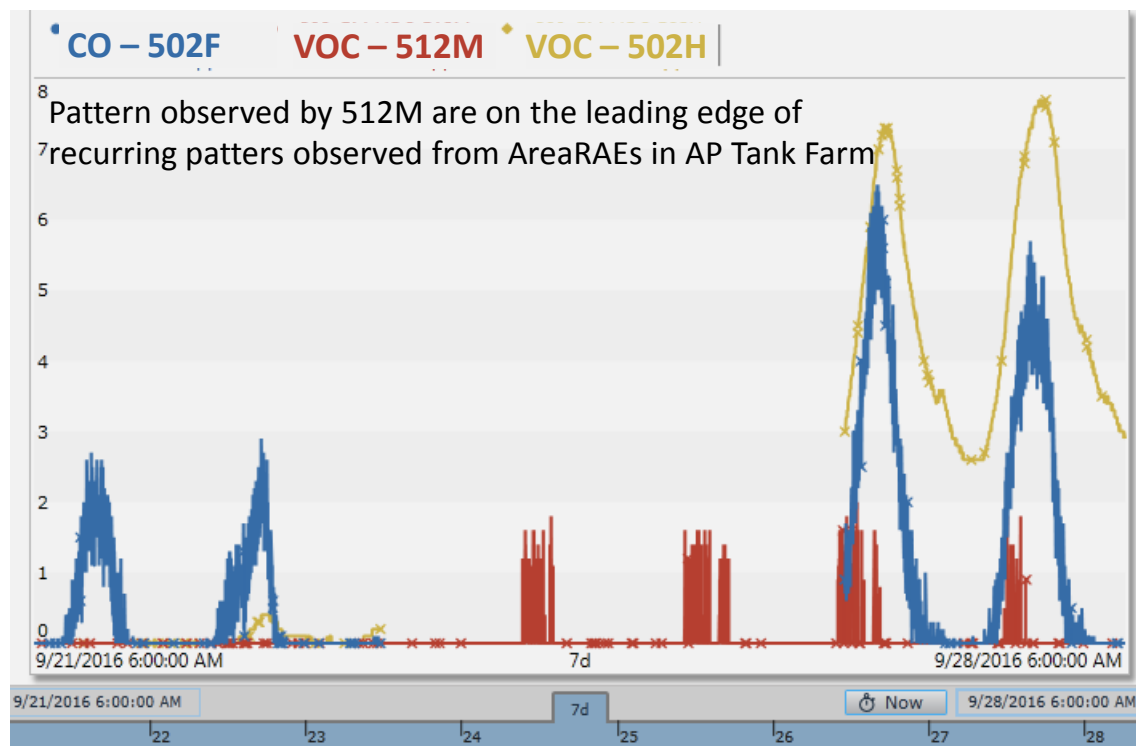
9/21/16 6:00 – 9/28/16 6:00

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: CH₄ (assume reported in ppb), CO₂, O₃, and SO₂. NH₃ was detected up to 4.7ppm on 9/22 at 20:30, this value is well below the action limit. It also detected hydrogen sulfide (H₂S) at levels (0.29 ppm maximum) well below OSHA's recommended ceiling concentration of 20ppm¹.

Recurring patterns were again observed the AreaRAE for several compounds. Except for VOCs on 502H, readings were well below action levels. All four instruments reporting in AP Tank Farm (F, G, H, and I) showed the same pattern for CO, with instrument H showing the same pattern for CO, NH₃, and VOCs. Instrument H's reported VOCs up to 7.7 ppm. No explanation has been identified for the pattern observed by the AreaRAEs in AP Farm. A total VOC limit of 2 ppm currently is employed by the Industrial Hygiene Program Technical Basis². Data from the AreaRAEs was plotted with data from the VOC sensor on instrument 512M (FIS-Gastronics) in Figure 1.

Figure 1)AreaRAE and Gastronics instrument M observation



No ammonia was detected on either the RAE MeshGauards or the FIS-Gastronics. VOC were detected up to the VOC limit of 2 ppm on 512M (see above).

¹ OSHA H₂S 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

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Gastronics N₂O sensors continue to show very sharp spikes, often to full scale. The expectation is that as a gas passes through monitoring equipment the concentration should change with some form of a bell shape curve (such as seen by CO and VOCs in *Figure 1*).

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 analyte (such as NH₃), 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 logging corrected between the instruments as reported by OSI PI³. The units for methane need to be updated, OSI PII reports units as %, when it should most likely be ppb. 501A was down most of the time and only briefly reported for two short periods. The log indicates that communications were being worked on 9/22.

Table 1 HazScanner comments

Compound (units)	Comment	OEL	Action Level	Detection Range
CH ₄ (ppm)	Both 501A and 501B report methane in terms of %, this is under investigation, at present it is assumed the units should be ppb. 501A: ND to 1.06ppm (1,056ppb) (average of 0.32 +/- 0.26 ppm) 501B: ND to 0.96 ppm (average of 0.29 +/-0.25 ppm)			50 – 10,000 (d)
CO ₂ (ppm)	501A: ND to 367 ppm (average 345 +/- 11 ppm). 501B: ND to 443 ppm (average 361 +/-34 ppm)			50 – 5000
CO (ppm)	501A: 0.05 to 0.39 ppm (average 0.11 +/- 0.06 ppm). 501B: ND to 1.93 ppm (average 0.16 +/-0.08)	50	25	0.02 -10
H ₂ S (ppm)	501A: ND to 0.08 ppm. 501B: ND to 0.29 ppm		(C)	Unknown
NH ₃ (ppm)	501A: ND 501B: ND to 4.7 ppm (average 0.3 +/-0.6)	50	25	<0.2 – 100
NO ₂ (ppm)	501A: 0.00 to 1.05 ppm (average 0.28 +/- 0.39 ppm). 501B: ND to 0.0243 ppm (average 0.035 +/-0.059ppm)			0.005 – 5
O ₃ (ppm)	501A: ND to 0.042 ppm (average 0.033 +/- 0.003 ppm) 501B: ND to 0.039 ppm (average 0.021 +/-10 ppm)			0.001 – 0.15
PM10 (µg/m ³)	501A: Average of 8 +/-8 µg/m ³ ; max 42 µg/m ³ . 501B: Average of 9 +/-9 µg/m ³ ; max 105 µg/m ³ .		(a)	10 – 5000
PM25 (µg/m ³)	501A: Average of 7 +/- 8 µg/m ³ ; max 52 µg/m ³ . 501B: Average 5 +/-7 µg/m ³ ; max 53 µg/m ³ .		(b)	Unknown
SO ₂ (ppm)	501A: ND 501B: ND to 0.069 ppm (average is less than detection limit)			0.005–5

³ OSI PI is a data visualization software package from [OSIsoft](http://OSIsoft.com).

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VOC (ppm)	501A: ND to 0.08 ppm (average 0.03 +/-0.02 ppm) 501B: ND to 0.09 ppm (average 0.03 +/-0.02 ppm)		2	0.005 - 50
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- Notes:
- a) 150 µg/m³ over 24 hours, not to be exceeded more than once per year on average over 3 years⁴
 - b) 12.0 µg/m³, annual mean, averaged over 3 years⁵
 - c) OSHA Acceptable ceiling concentration is 20ppm⁶
 - d) The methane detection range is from PNNL-25892 and looks suspect, it is being verified.

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 2) AreaRAE Comments

Compound (units)	Comment	OEL	Action Level	Detection Range
CO (ppm)	Four instruments reporting, F, G, H, and I. Same daily peaks seen as previous week. Starting late morning and subsiding in the evening <i>Figure 2</i> . <ul style="list-style-type: none"> • F – max 6.5 ppm, average 0.9 +/-1.5 ppm • G – max 4 ppm, average 0.3 +/-0.8 ppm • H – max 15.7 ppm, average 1.9 +/-3.5 ppm • I – max 2.8 ppm, average 0.2 +/-0.5 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. <ul style="list-style-type: none"> • F – max 1.6 ppm, average 1.1 +/-0.2 ppm • G – max 1.8 ppm, average 1.2 +/-0.2 ppm • H – max 4.7 ppm, average 1.9 +/-0.9 ppm • I – max 2.4 ppm, average 1.9 +/-0.2 ppm 	25	12.5	1 – 50
Oxygen (%)	<ul style="list-style-type: none"> • F – average 21.0 +/-0.1 % • G – average 20.9 +/-0.1 % • H – average 20.8 +/-0.3 % • I – average 21.0 +/-0.1 % 		<19.5	1 - 30
VOC (ppm)	Below detection limit for reporting sensors F, G, and I. <ul style="list-style-type: none"> • H – max 7.7 ppm, average 2.1 +/-2.6 ppm 		2	1 - 200

⁴ EPA NAAQS Table (<https://www.epa.gov/criteria-air-pollutants/naaqs-table>)

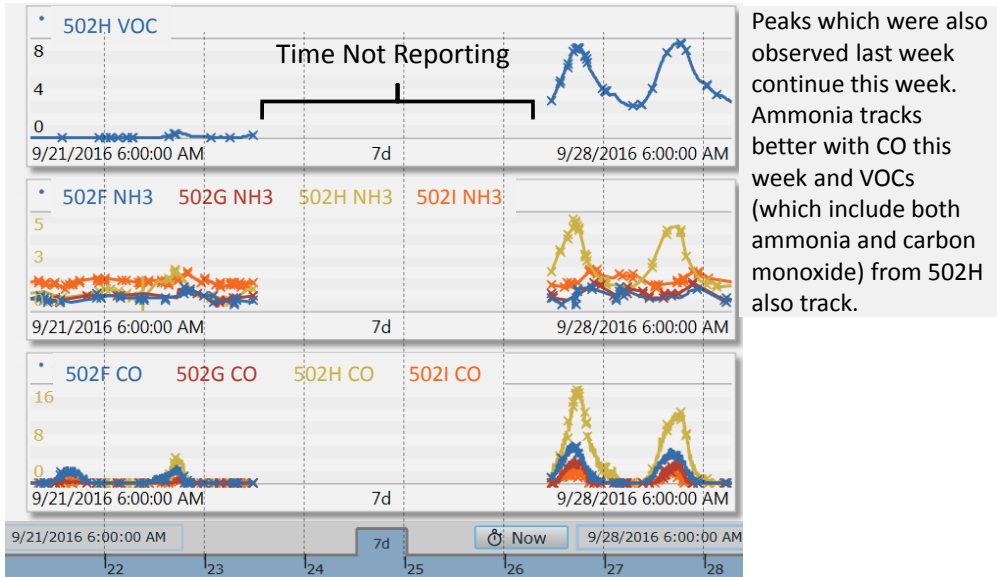
⁵ EPA NAAQS Table (<https://www.epa.gov/criteria-air-pollutants/naaqs-table>)

⁶ OSHA H₂S standard (https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9993)

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Figure 2: AreaRAE Carbon Monoxide, Ammonia, and VOC Monitor Data.



ToxiRAE (503) – Instruments are personnel monitors and are not continuously utilized during daytime; they were not deployed for the time period under evaluation.

Table 3)ToxiRAE Comments

Compound (units)	Comment	OEL	Action Level	Detection Range
VOC (ppm)	Not in use.	N/A	2	0.1 - 2000

MultiRAE (504) – Instruments are personnel monitors and are not continuously utilized during daytime; they were not deployed during the time period under evaluation.

Table 4) MultiRAE Comments

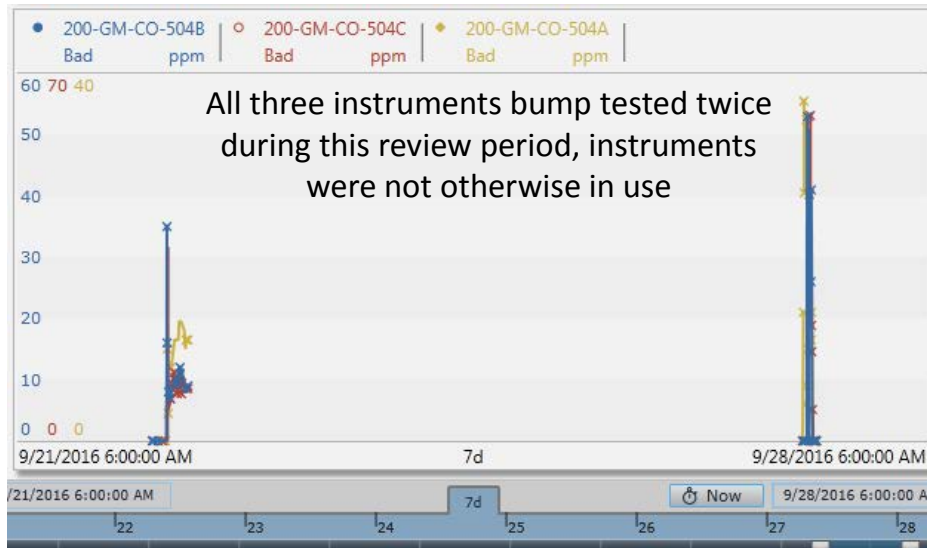
Compound (units)	Comment	OEL	Action Level	Detection Range
CO (ppm)	A – Bump tested twice, not in use remainder of time. B – Bump tested twice, not in use remainder of time. C – Bump tested twice, not in use remainder of time.	50	25	0 – 500
LEL (%)	A – Bump tested twice, not in use remainder of time. B – Bump tested twice, not in use remainder of time. C – not reporting	N/A		0 – 100
NH ₃ (ppm)	A – not reporting B – not reporting C – Bump tested twice, not in use remainder of time.	25	12.5	1 – 500
Oxygen (%)	A – Bump tested twice, not in use remainder of time. B – Bump tested twice, not in use remainder of time.		<19.5	1 – 30

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Compound (units)	Comment	OEL	Action Level	Detection Range
	C – Bump tested twice, not in use remainder of time.			
VOC (ppm)	A – not reporting B – not reporting C – Bump tested twice, not in use remainder of time.	N/A	2	0.1 – 5000

Figure 3) MultiRAE bump tested.



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

Table 5) 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 for all instruments reporting: A, C, D, F, J, M, N, O, P, Q, R, T, V, X, and Y.	25	12.5	1 – 50

Notes:

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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 6) Gastronics comments.

Compound (units)	Comment	OEL	Action Level	Detection Range
NH ₃ (ppm)	<p>No ammonia reported on any instrument (other than bump tests)</p> <ul style="list-style-type: none"> • Bump tests performed on D, E, F, G, H, I, K, T, and U. • Instruments not reporting were C, J, R, V and W (19 instruments reported at least for some period during the week in review) 	25	12.5	1 – 500
VOC (ppm)	<ul style="list-style-type: none"> • Instruments reporting no detection of VOCs: B, E, F, H, L, O, and U (some instruments were bump tested) • Instruments that reported a maximum value of < 1ppm are A, D, G, I, K, Q, S, T, and Y (Q continued it daily pattern) <ul style="list-style-type: none"> ○ Note A, D, S, and Y report values 10x actual measurement due to programming; trouble shooting in progress. • Instruments reporting > 1ppm: maximum values were 2ppm for M, 1.2 ppm for N, and 1.6 ppm for X. • 512P started reporting High VOC after power was cycled to restart communications, 37ppm was reported. Cycling power appears to affect calibration (from test log). The instrument was up only a short time. 	N/A	2	0 – 1000
N ₂ O (ppm)	<p>N₂O sensors only installed on A, C, D, and U; sensor on B was not functional and reported max scale (1100 ppm) most of the time.</p> <ul style="list-style-type: none"> • 512A reported spikes from 0 to ~180ppm with increasing frequency starting at 16:00 on 9/23 • 512C reported ND (zero) except for one spike on 9/27 to 175ppm • 512 reported ND (zero) except for one spike due to a bump test on 9/27 • 512U spiked to full scale 5 times after 9/25 (one on 9/27 was during a bump test) 			0 – 1000

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Figure 4) Nitrous oxide reporting for Gastronics

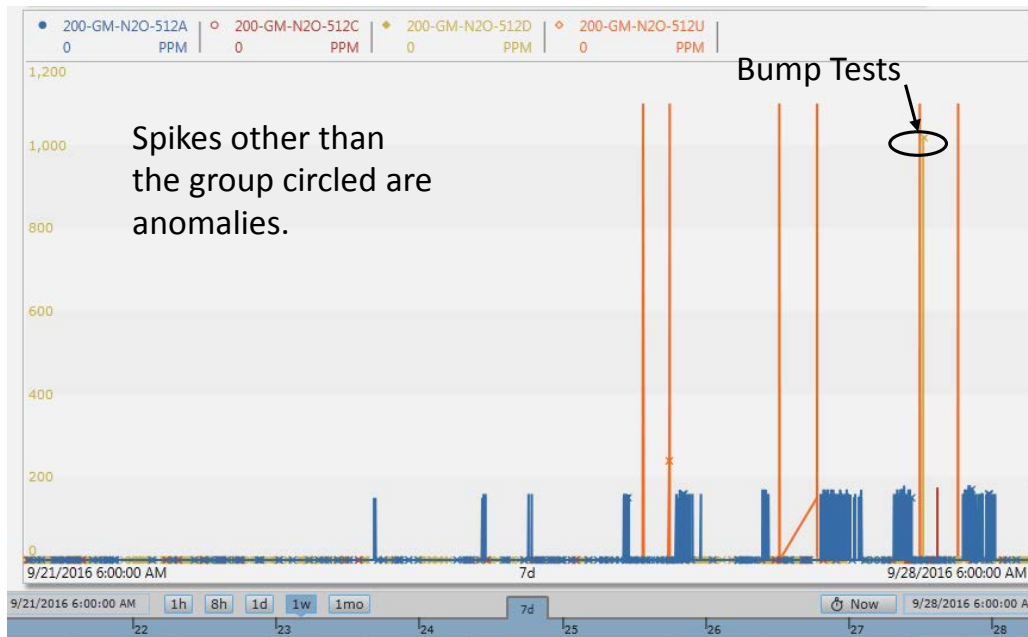
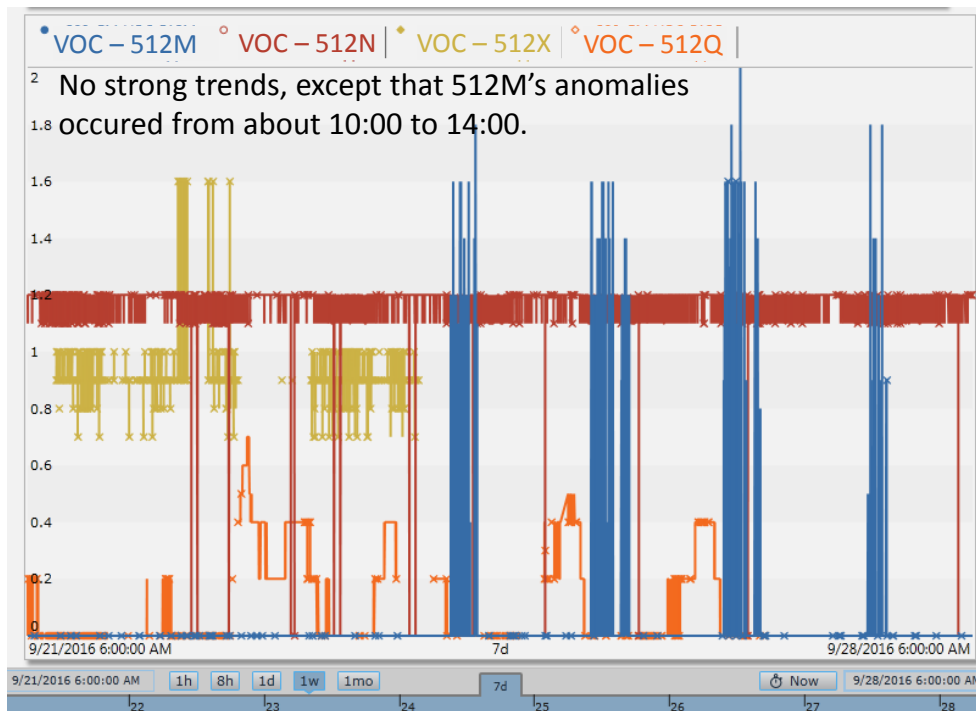


Figure 5) Gastronics VOC figure for instruments reporting >1ppm, plus instrument Q



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September 14th – 21st 2016 Instrument Operational Status:

Time reporting is calculated using the average time sensors are reporting to OSI PI⁷ for each instrument:

Table 7) HazScanner (501) % time reporting by instrument

Instrument	% Time Reporting	Instrument	% Time Reporting
501A (b)	10	501B (b)	30

- 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 8) AreaRAE (502) % time reporting by instrument

Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting
502A	0	502D	0	502G	56	502J	0
502B	0	502E	0	502H	56		
502C	0	502F	57	502I	57		

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

Table 9) 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	0
503C	0	503G	0	503K	0
503D	0	503H	0		

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

Table 10) 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	4	504B	5	504C	5

- Notes:
- a) % time reporting is based on average hourly interval data as exported from OSI PI.
 - b) NH₃ and VOC for sensors A and B were down 100% of the time.

⁷ OSI PI is a data visualization software package from OSIs0oft.57

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Table 11) MeshGuard (505) RAE % time reporting.

Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting
505A	57	505G	0	505M	11	505S	0
505B	0	505I	0	505P	57	505W	0
505C	57	505J	58	505Q	57	505X	57
505D	56	505K	0	505R	31	505Y	12
505E	0	505L	0	505T	57		
505F	57	505N	57	505U	0		
505H	0	505O	56	505V	56		

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

Table 12) Gastronics (512) % time reporting by instrument

Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting
512A	96	512H	99	512N	96	512T	99
512B	76	512I	97	512O	13	512U	100
512C	0	512J	0	512P	11	512V	0
512D	86	512K	95	512Q	64	512W	0
512E	99	512L	1	512R	0	512X	10
512F	97	512M	99	512S	14	512Y	12
512G	92						

Notes: a) % time reporting is based on average sensor hourly interval data as exported from OSI PI for NH₃ sensors.