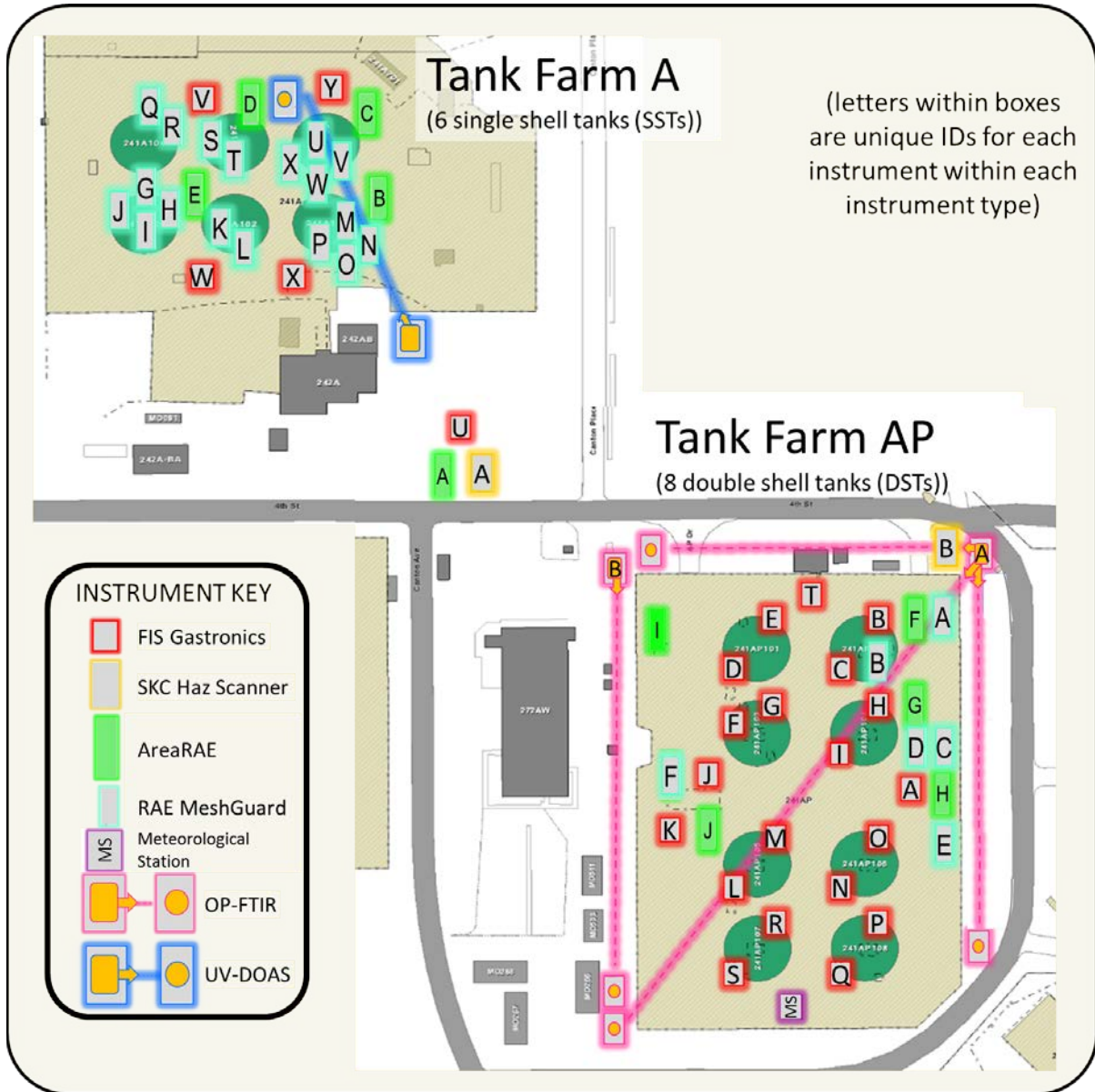


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Instrument/Sampling Locations –A & AP-Tank Farms (north is up)



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Abbreviations and Units

CH ₄	=	methane
CO	=	carbon monoxide
CO ₂	=	carbon dioxide
COPC	=	chemicals of potential concern
DRI	=	direct reading instrument
LEL	=	lower explosive limit
ND	=	not detected
NH ₃	=	ammonia
NO	=	nitric oxide
N ₂ O	=	nitrous oxide
NO ₂	=	nitrogen dioxide
O ₃	=	ozone
OEL	=	occupational exposure limit
OP-FTIR	=	open path Fourier transform infrared spectrometer ¹
OSHA	=	Occupational Safety and Health Administration
PEL	=	permissible exposure limit
ppb	=	parts per billion
ppm	=	parts per million
UV-DOAS	=	ultraviolet differential optical absorption spectrometer ²
VMDS	=	vapor monitoring detection system
VOC	=	volatile organic compounds, which include both volatile and semi-volatile compounds

VMDS Instruments

505	=	RAE MeshGuard (NH ₃ sensors)
506A	=	OP-FTIR Multipath (measures 24 analytes)
506B	=	OP-FTIR Single-path (measures 24 analytes)
508A	=	UV-DOAS (measures 26 analytes)
512	=	Gastronics (NH ₃ , VOC, and N ₂ O sensors)

¹ OP-FTIR Fact Sheet: <http://hanfordvapors.com/wp-content/uploads/2016/10/OP-FTIR-fact-sheet.pdf>

² UV-DOAS Quick Sheet: <http://hanfordvapors.com/wp-content/uploads/2016/10/UV-DOAS-Fact-Sheet.pdf>

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Introduction

This summary contains Vapor Monitoring and Detection System (VMDS) pilot-scale data collected over one week (2/1/2017 at 6:00 a.m. through 2/8/2017 at 6:00 a.m.) using direct reading vapor detection instruments, the open path Fourier transform infrared spectrometer (OP-FTIR), and the ultraviolet differential optical absorption spectrometer (UV-DOAS).

Pilot-scale testing is focused on evaluating component integration and functionality. Data shown may include results for calibration and calibration check (bump test) tests performed to verify sensors are functioning; these tests are typically visible in the data as spikes. Any alarms occurring during pilot-scale testing are taken to be actual events and the appropriate actions/notifications are undertaken.

The spectrometer instruments—OP-FTIR and UV-DOAS—provide real-time multi-gas measurement (qualitative and quantitative) of gases. Even though the instrument is very accurate regarding the quantification of chemical compounds, reported results cannot be directly calculated into a concentration for a specific location, this is due to its sample size – an open path between two points. The sample path is defined by the location of the emitter and the reflector which may be tens to hundreds of meters apart. Therefore data from these instrument types will not be directly compared to the Occupational Exposure Limits (OELs) and Action Levels, but used to determine concentrations of compounds along the path of the instrument's beam.

For the spectrographic instruments (OP-FTIR and UV-DOAS), each analyte has a specific reference spectrum, which represents the absorption characteristics for that chemical in the IR or UV spectral regions. Reference spectra for each analyte are stored in a library that specifies which absorption features are analyzed, how that analysis is performed, and reporting threshold values. Revisions to the library are periodically performed to improve accuracy of analysis for analytes; spectrographic instruments reporting for the VMDS project are still in the iterative optimization process and periodic changes to the library are being performed. Revisions to the library may result in the identification of a compound not previously thought to be present, or conversely determine that a previously reported analyte was not actually present. Identification of an analyte depends on the analytical method (UV or IR), the library used, analyte concentration, other chemical compounds present, and other factors. The compounds present can interfere/overlap with the analyte spectral signature, especially for compounds having the same functional groups (e.g., methane or ketone groups). Work is ongoing to optimize the library and minimize these interferences.

The direct read instruments located within AP and A Tank Farms include the RAE MeshGuard (505) sensors for detecting NH₃ and the Gastronics (512) units with sensors for detecting NH₃ and VOCs.

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Summary for 2/1/2017 through 2/8/2017

The following sections summarize data reporting for vapor monitoring and detection instruments at AP and A Tank Farms for the 2/1/2017 through 2/8/2017 period. Instruments at AP Tank Farm include open path FTIR instruments (multi-path and single path) and the RAE MeshGuard and Gastronics direct reading instruments. A Tank Farm includes the UV-DOAS spectrographic instrument and the RAE MeshGuard and Gastronics direct reading instruments. No waste retrieval activities occurred during this reporting period.

AP TANK FARM

OP-FTIR

During the week in review, instrument 506A detected nitrous oxide (N₂O) and methane (CH₄). Nitrous oxide and CH₄ are typically found in the atmosphere at background levels of approximately 0.330 ppm for N₂O and 1.80 ppm for CH₄³. The recurring pattern of simultaneous N₂O and CH₄ spikes on this instrument was noted again this week (Figure 1). Instrument 506A operated normally until 2:17 pm, 2/1/2017 when the unit did not properly re-boot following generator maintenance. The instrument was restored to service at 7:50 am, 2/2/2017. Between 1:50 am on 2/3/2017 and 11:30 am on 2/3/2017, the instrument reported constant, invalid readings. Instrument 506A went off-line at 11:30 am on 2/3/2017 due to a power interruption, but power was restored at 10:20 am, 2/6/2017 and data were reported during the remainder of the week.

Instrument 506B reported N₂O, CH₄, ammonia (NH₃), 1-butanol (BuOH), and methyl nitrite (MeNO₂) during this week. Detection of methane and nitrous oxide was affected by fog and precipitation, which interferes with the OP-FTIR signal and causes the reported concentration of these chemicals to decrease (Figure 2). Methyl nitrite and 1-butanol detections during these fog and precipitation events are considered suspect. The OP-FTIR instrument was offline between 10:45 am on 2/6/2017 and 6:30 am on 2/7/2017, as shown by zero readings for methane and nitrous oxide (Figure 2). During the instrument re-start at 6:30 pm on 2/7/2017, 1-butanol was reported and is considered suspect as an artifact of the instrument start up process. Ammonia is typically not detected by the OP-FTIRs in AP Tank Farm, but during this week, multiple peaks ranging up to 0.024 ppm were detected. This concentration is well below the OEL of 25 ppm for ammonia⁴.

Most compounds detected by both OP-FTIR instruments are typically present in air at detectable levels. Consistency in measured values for these compounds indicates that the OP-FTIR units are effectively measuring composition of the gas components within its path. Specific instrument information is reported in Table 1 and Figures 1 and 2 below.

³ Climate Change Indicators: Atmospheric Concentration of Greenhouse Gases: <https://www.epa.gov/climate-indicators/climate-change-indicators-atmospheric-concentrations-greenhouse-gases>

⁴ OSHA: https://www.osha.gov/dts/chemicalsampling/data/CH_218300.html

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Table 1. Chemical Species Detected^a on Open Path FTIRs at AP Tank Farm.

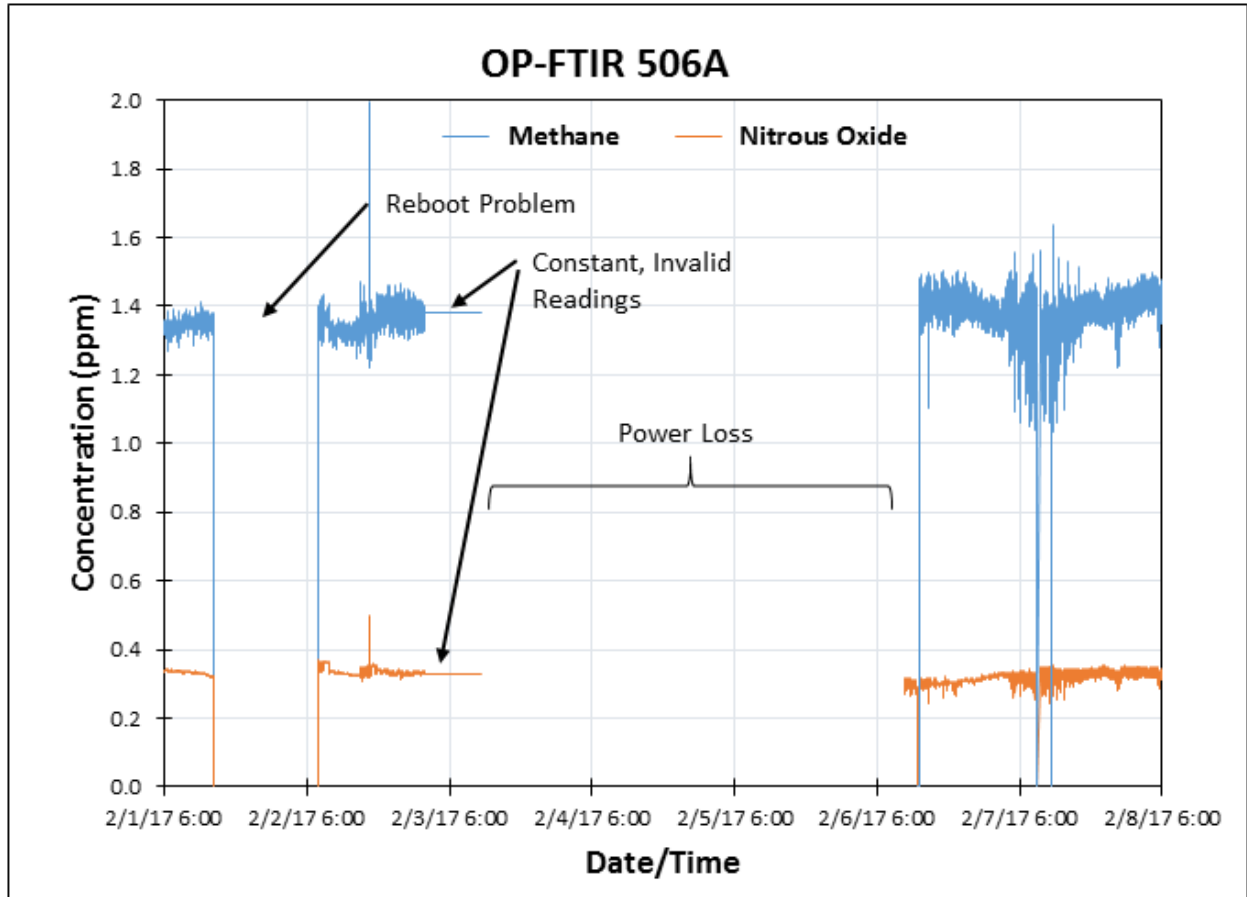
Chemical Compound	506A: OP-FTIR Multipath (ppm)	506B: OP-FTIR Singlepath (ppm)
Nitrous Oxide*	0.24 – 0.50 ^b	0.13 – 0.42 ^b
Ammonia*	ND	ND – 0.024
Methane	1.0 – 2.0 ^b	0.64 – 1.7 ^b
1-3-Butadiene*	ND	ND
1-Butanol*	ND	ND – 1.4 ^c
2-Hexanone*	ND	ND
3-Buten-2-one*	ND	ND
Acetaldehyde*	ND	ND
Acetonitrile*	ND	ND
Benzene*	ND	ND
Butanal*	ND	ND
Butyl Nitrite*	ND	ND
Ethylamine*	ND	ND
Formaldehyde*	ND	ND
Furan*	ND	ND
Methanol*	ND	ND
Methyl Isocyanate*	ND	ND
Methyl Nitrite*	ND	ND – 0.097 ^c
N-Nitrosodiethylamine*	ND	ND
N-Nitrosodimethylamine*	ND	ND
N-Nitrosomorpholine*	ND	ND
Propanenitrile*	ND	ND
Pyridine*	ND	ND
Tributyl Phosphate*	ND	ND

- Notes:
- (a) Based on data retrieved from OSI PI; OSI PI System is a data visualization software package from OSIsoft.
 - (b) Disrupted data due to weather events and instrument problems not included in the table for these compounds
 - (c) Suspect data
- *Chemical is on COPC list
 ND – Not detected

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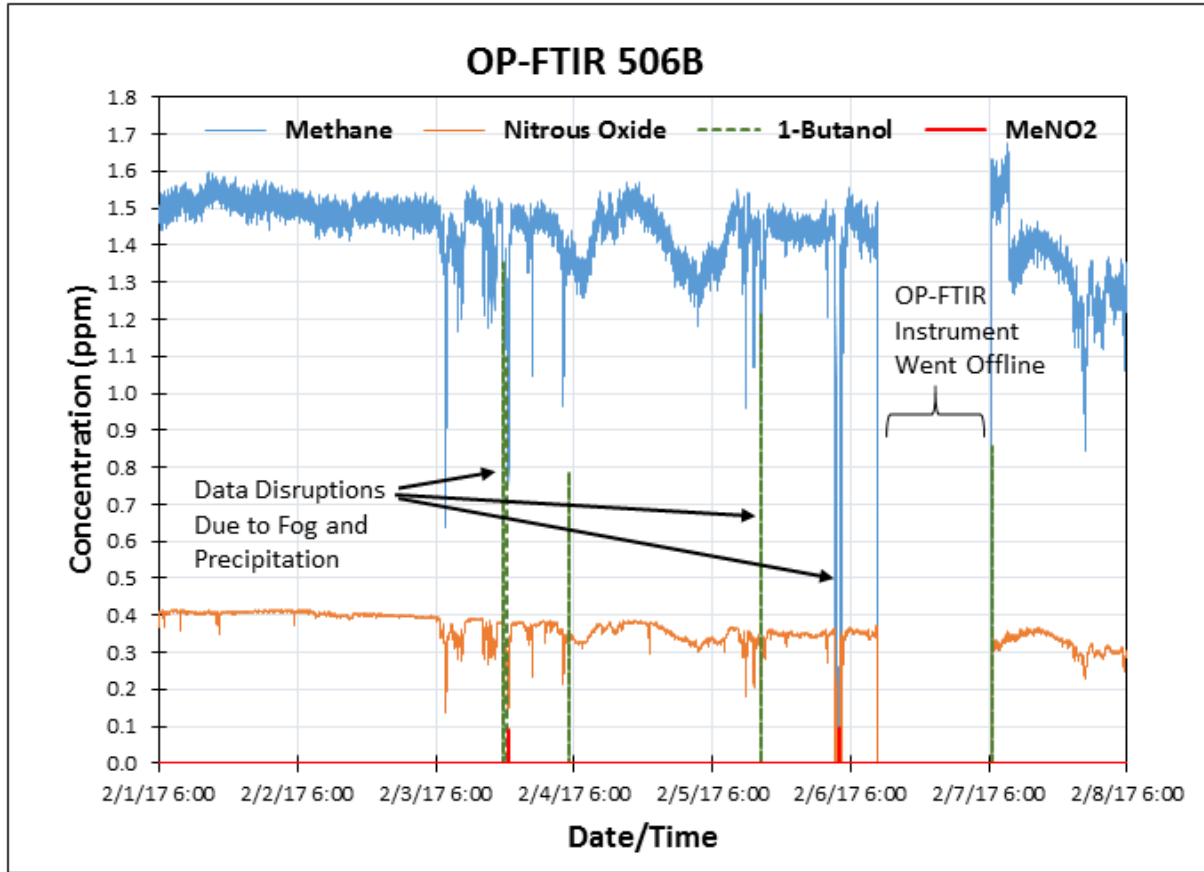
Figure 1. Chemical Compounds Detected by the OP-FTIR (506A) Instrument.



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Figure 2. Chemical Compounds Detected by the OP-FTIR (506B) Instrument.



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AP Tank Farm Direct Reading Instruments

Instruments located between A and AP Tank Farm, are included.

RAE MeshGuards (505 - NH₃): The 505 sensors reporting from AP Tank Farm are 505A, C, D, and F. Sensors A, C, D, and F were bump test checked on 2/1/2017 and readings from two of them were not within 10% of the test gas concentration (Table 2). The RAE MeshGuard sensors went offline on 2/5/2017 due to communication software errors. Initial attempts to restart the system were unsuccessful. No NH₃ was detected by the RAE MeshGuards during the time data were reported this week.

Table 2. AP Tank Farm RAE MeshGuard (505) Comments.

Compound (units)	Comment	OEL	Action Level	Detection Range
NH ₃ (ppm)	<ul style="list-style-type: none">• Instruments reporting: 505A, C, D, and F• Out of calibration*: 505D and F• No ammonia detected	25	12.5	1 – 50

* Only instruments reading within 10% of the calibration gas concentration during their most recent bump/calibration test are considered in calibration and reported here.

Gastronics (512 - NH₃, VOCs, N₂O): Units located in AP Tank Farm include: 512A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, and T. Unit 512U is located between AP Tank Farm and the A Tank farm. Instruments 512A, C, E, F, G, H, I, J, K, L, M, O, P, Q, R, and T were calibrated during this week (2/6/2017 to 2/8/2017). No ammonia was detected by Gastronics instruments that were in calibration and reporting this week. Four of the 512 units reported non-detectable levels of VOC. Ten units reported VOC at <2 ppm. Instrument 512F began drifting following calibration and reported VOC readings at saturation (>50 ppm). This sensor was malfunctioning and was considered out of calibration. Concurrent VOC peaks (<1 ppm) detected by instruments 512B, I, K, M, and O occurred at approximately 7:00 pm, 2/4/2017 (Figure 3). No instruments detected VOCs ≥2 ppm (Table 3). A total VOC limit of 2 ppm currently is employed by the Industrial Hygiene Program Technical Basis⁵.

⁵ RPP-22491, Rev 1, "Industrial Hygiene Chemical Vapor Technical Basis": <http://hanfordvapors.com/wp-content/uploads/2016/10/Industrial-Hygiene-Chemical-Vapor-Technical-Basis-RPP-22491 - Rev 1.pdf>

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Table 3. AP Tank Farm Gastronics (512) Comments.

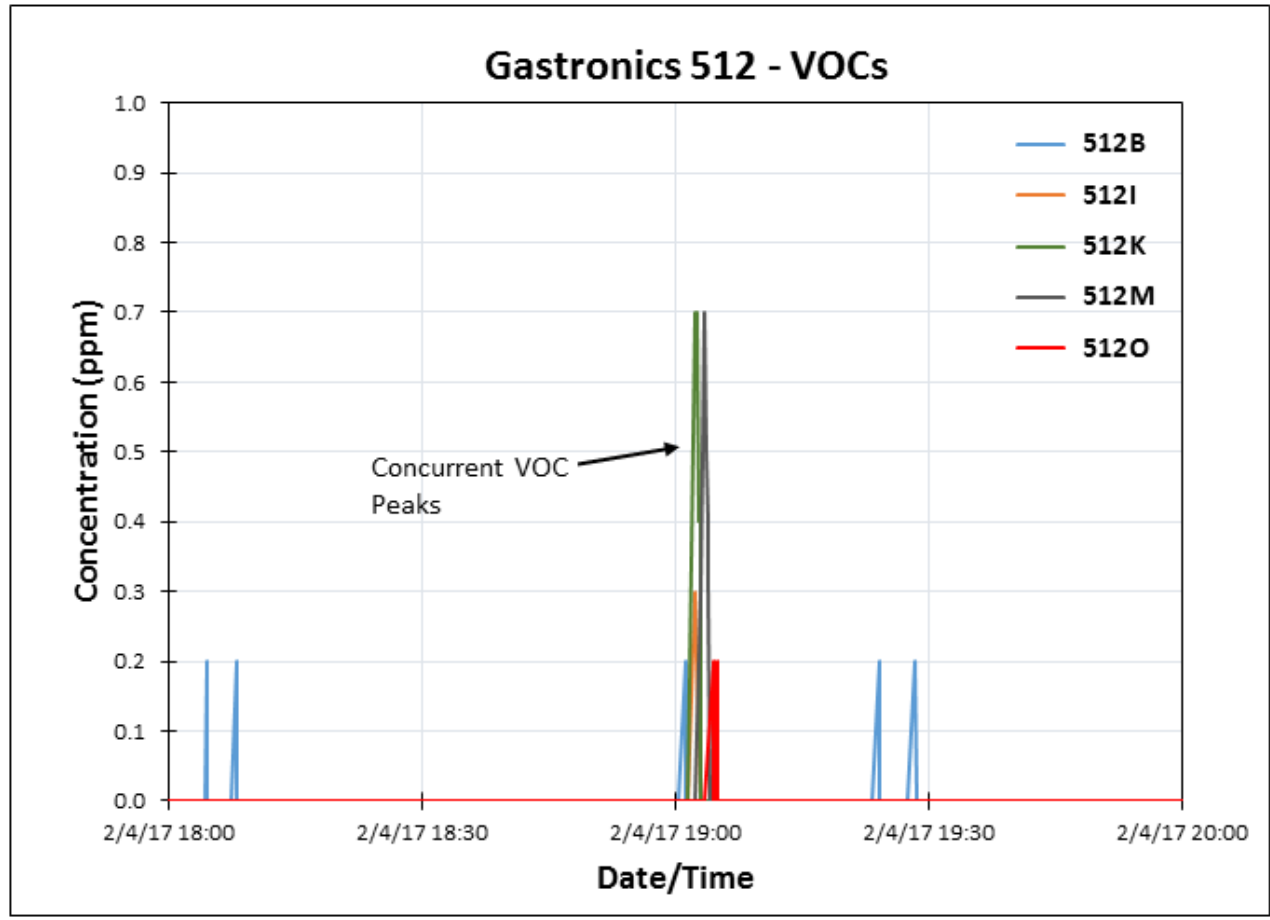
Compound (units)	Comment	OEL	Action Level	Detection Range
NH ₃ (ppm)	<ul style="list-style-type: none"> Out of calibration*: None No ammonia detected 	25	12.5	1 – 100
VOC (ppm)	<ul style="list-style-type: none"> Out of calibration*: 512E, F, J, T, and U Instruments that reported no VOCs detected: 512G, M, N, and Q Instruments that reported a maximum value of <2 ppm: A, B, D, H, I, K, L, M, O, and R Instruments that reported maximum values ≥2 ppm: None 	N/A	2	0.001 – 50.0

* NH₃/VOC: Only instruments reading within 10% of the calibration gas concentration during their most recent bump/calibration test are reported here.

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Figure 3. Concurrent VOC Peaks Detected by the Gastronics 512 Direct Reading Instruments.



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A TANK FARM

UV-DOAS

Ammonia, nitric oxide (NO), ozone (O₃), and p-xylene (pXy) were reported by the instrument during the period under review (Table 4). Many of these compounds are typically found in detectable quantities in background air⁶. The PEL for p-xylene⁷ is 100 ppm. Analyte concentrations are reported in Table 4 and Figure 4 below. Figure 4 indicates that the p-xylene spikes occurred at the same time that ammonia was reporting negative spikes, and therefore are considered suspect.

Table 4. Chemical Species Detected^a on UV-DOAS at A Tank Farm

Chemical Compound	508A: UV-DOAS (ppm)	Chemical Compound	508A: UV-DOAS (ppm)
Ammonia*	ND – 0.022	Methyl Nitrite*	ND
Nitric Oxide	ND – 0.065	Pyridine*	ND
Ozone	0.073 – 0.16 ^b	1-2-4 Trimethylbenzene	ND
1-3 Butadiene*	ND	1-3-5 Trimethylbenzene	ND
2-Methyl-2-butenal*	ND	Ethylbenzene	ND
2-Methylfuran*	ND	m-Xylene	ND
Acetaldehyde*	ND	Nitrogen Dioxide	ND
Benzene*	ND	o-Xylene	ND
Butanal*	ND	p-Xylene	ND – 0.037 ^c
Ethylamine*	ND	Styrene	ND
Formaldehyde*	ND	Sulfur Dioxide	ND
Furan*	ND	Toluene	ND
Mercury*	ND		

Notes: (a) Based on data retrieved from OSI PI; OSI PI System is a data visualization software package from OSIsoft.
 (b) Isolated spikes to zero do not follow the general trend for ozone, therefore these spikes are not included in the table
 (c) Suspect data
 *Chemical is on COPC list
 ND – Not detected by the instrument

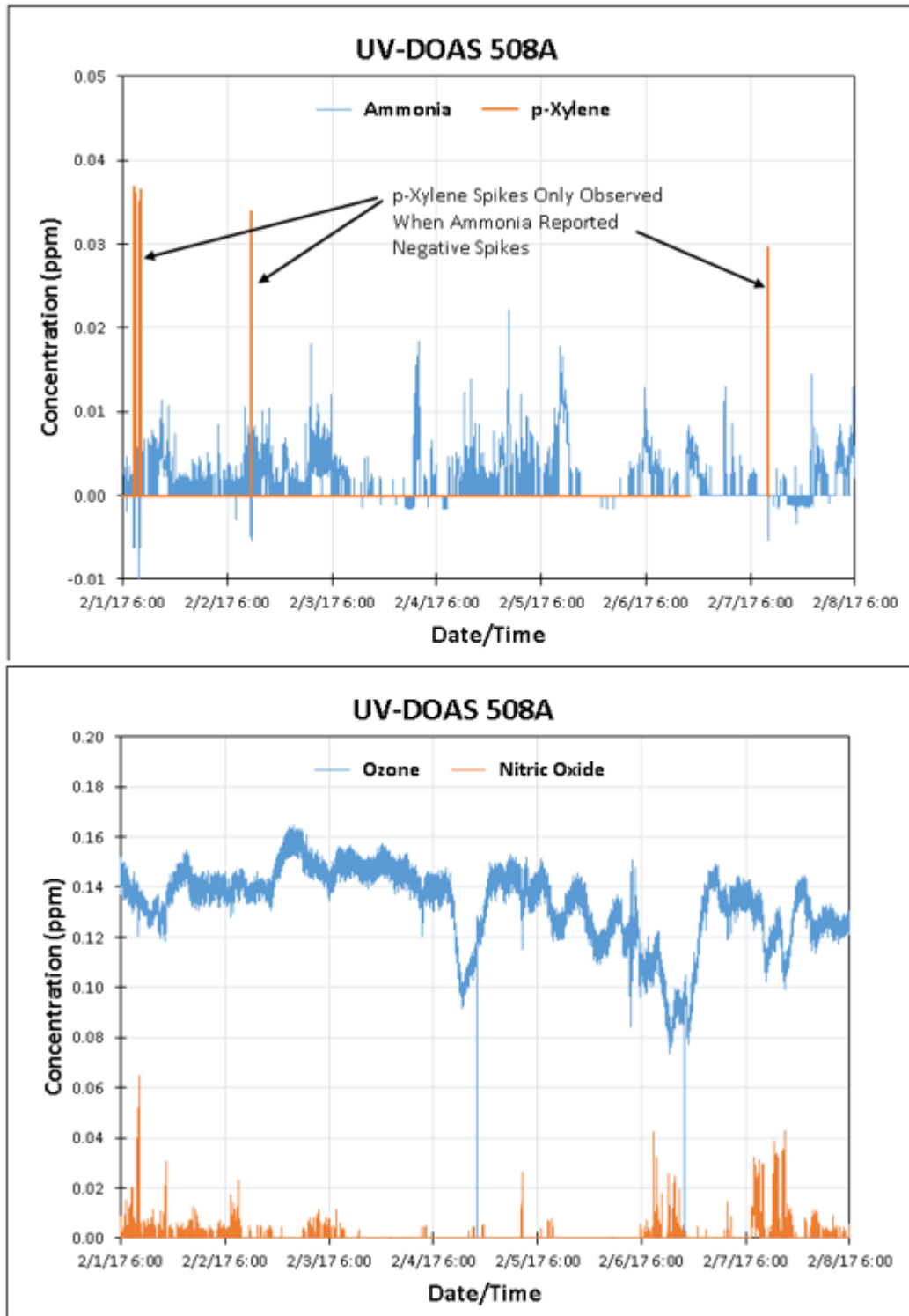
⁶ Air Composition from “The Engineering ToolBox”: http://www.engineeringtoolbox.com/air-composition-d_212.html

⁷ OSHA: https://www.osha.gov/dts/chemicalsampling/data/CH_276400.html

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Figure 4. Chemical Compounds Detected by the UV-DOAS (508A) Instrument at A Tank Farm.



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A Tank Farm Direct Reading Instruments

RAE MeshGuards (505 - NH₃): Sensors located in A Tank Farm include: 505G, H, I, J, K, L, M, N, O, P, Q, R, S, T U, V, W, and X. Calibration checks were performed on instruments 505G, H, I, J, M, N, O, P, Q, R, T, U, V, W, and X this week (2/1/2017). All these instruments checked within 10% of the test gas concentration except for one of them (see Table 5). The RAE MeshGuard sensors went offline on 2/5/2017 due to communication software errors. No NH₃ was detected by the RAE MeshGuards during the time data were reported this week.

Table 5. A Tank Farm RAE MeshGuard (505) Comments.

Compound (units)	Comment	OEL	Action Level	Detection Range
NH ₃ (ppm)	<ul style="list-style-type: none"> Instruments reporting: 505H, I, J, M, N, O, P, Q, R, T, U, V, W, and X Out of calibration*: 505I No ammonia detected 	25	12.5	1 – 50

* Only instruments reading within 10% of the calibration gas concentration during their most recent bump/calibration test are considered in calibration and reported here.

Gastronics (512 - NH₃, VOCs, N₂O): Units located in A Tank Farm include: 512V, W, X, and Y (Table 6). None of these instruments reported data and no calibrations/checks were performed on these instruments this week. The latest checks were performed on 1/30/2017.

Table 6. A Tank Farm Gastronics (512) Comments.

Compound (units)	Comment	OEL	Action Level	Detection Range
NH ₃ (ppm)	<ul style="list-style-type: none"> Out of calibration*: 512V No ammonia reported 	25	12.5	1 – 100
VOC (ppm)	<ul style="list-style-type: none"> Out of Calibration*: None Instruments that reported no VOCs detected: None Instruments that reported a maximum value of <2 ppm: None Instruments that reported maximum values ≥2 ppm: None 	N/A	2	0.001 – 50.0

* NH₃/VOC: Only instruments reading within 10% of the calibration gas concentration during their most recent bump/calibration test are reported here.

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2/1/2017 – 2/8/2017 Instrument Operational Status:

Time reporting is calculated using the time that sensors are reporting to the OSI PI System⁸ for each instrument (Tables 7 and 8).

Table 7. RAE MeshGuard (505) and Gastronics (512) % Time Reporting^a.

Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting	Instrument	% Time Reporting
505A	50	505M	2	512A	17	512N	57
505B	0	505N	57	512B	94	512O	75
505C	56	505O	57	512C	0	512P	0
505D	50	505P	60	512D	82	512Q	84
505E	0	505Q	61	512E	97	512R	47
505F	48	505R	10	512F	94	512S	47
505G	0	505S	0	512G	<1	512T	95
505H	59	505T	61	512H	93	512U	>99
505I	58	505U	59	512I	94	512V	0
505J	61	505V	60	512J	0	512W	0
505K	0	505W	60	512K	94	512X	0
505L	0	505X	60	512L	18	512Y	0
				512M	97		

(a) % time reporting based on NH₃.

Table 8. Spectrometer Instruments Time Reporting.

Instrument	% Time Reporting
506A	47
506B	>99
508A	77 ^a

(a) % time reporting for 19 of the 26 chemical compounds. Seven compounds reported >99% of the time

⁸ OSI PI System is a data visualization software package from [OSIsoft](http://www.osisoft.com).