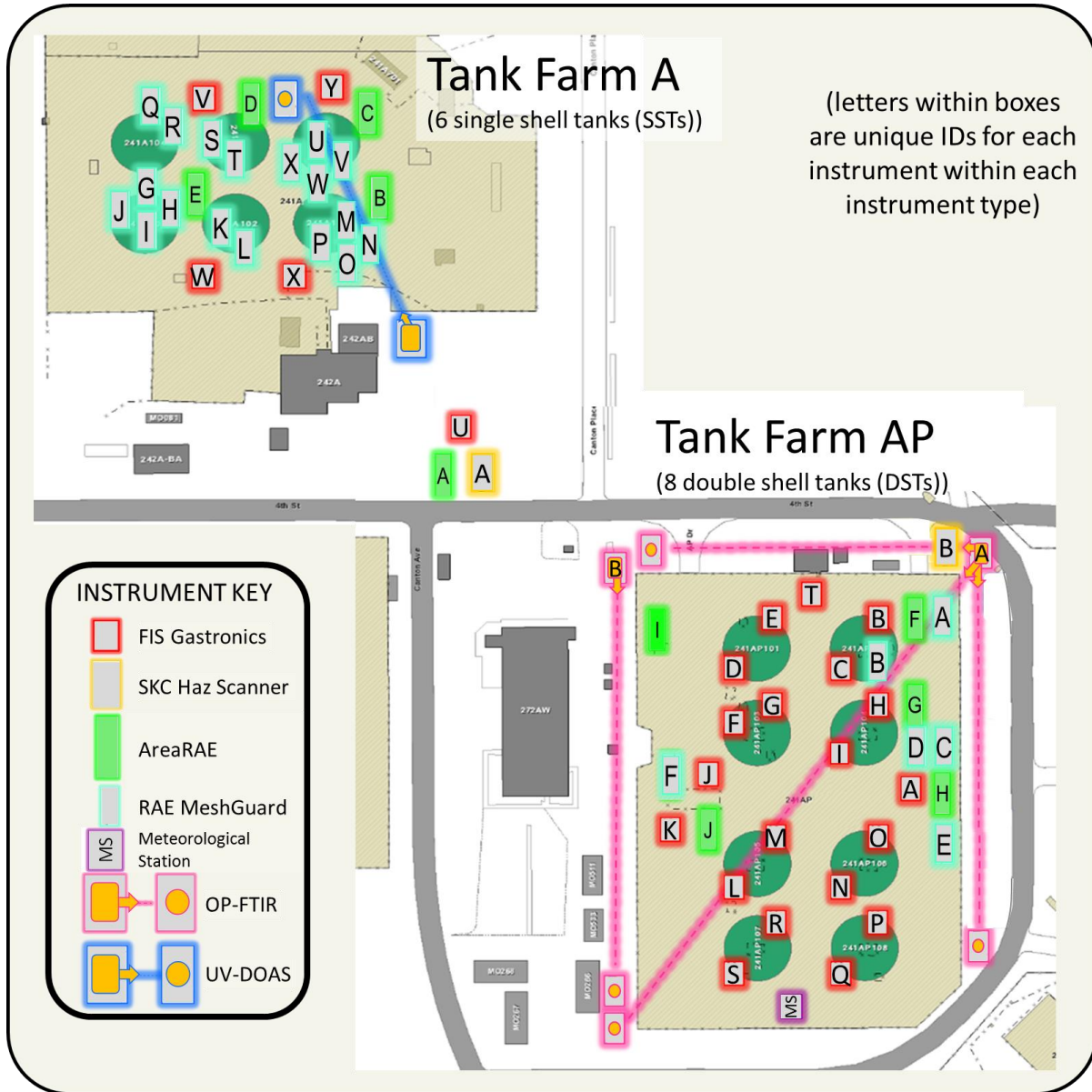


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Instrument/Sampling Locations –A & AP-Tank Farms (north is up)



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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

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 (3/1/2017 at 6:00 a.m. through 3/8/2017 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 Gastronics (512) units with sensors for detecting NH₃ and VOCs.

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Summary for 3/1/2017 through 3/8/2017

The following sections summarize data reporting for vapor monitoring and detection instruments at AP and A Tank Farms for the 3/1/2017 through 3/8/2017 period. Instruments at AP Tank Farm include open path FTIR instruments (multi-path and single-path) and Gastronics direct reading instruments. A Tank Farm includes the UV-DOAS spectrographic instrument 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), methane (CH₄), and 1-butanol (BuOH). 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. Because of the software being locked, instrument 506A reported non-representative data considered suspect, until 06:54 on 3/1/2017. At 10:18 on 3/6/2017, the instrument was powered down to allow the vendor to evaluate the system and reported zero readings during this time. During the evaluation, 1-butanol, methane and nitrous oxide were reported and these data are considered suspect. At 07:43 on 3/7/2017, the system was shut down and stopped reporting data to the OSI PI System. The purpose of the shutdown was to convert the power source from a generator to shore (main) power for both the OP-FTIR instruments. Instrument 506B did not report data to the OSI PI system during this week due to power interruptions.

Most compounds detected by the 506A instrument are typically present in air at detectable levels. Consistency in these measured values for these compounds indicates that the OP-FTIR unit is effectively measuring composition of the gas components within its path. Specific instrument information is reported in Table 1 and Figure 1 below.

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

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

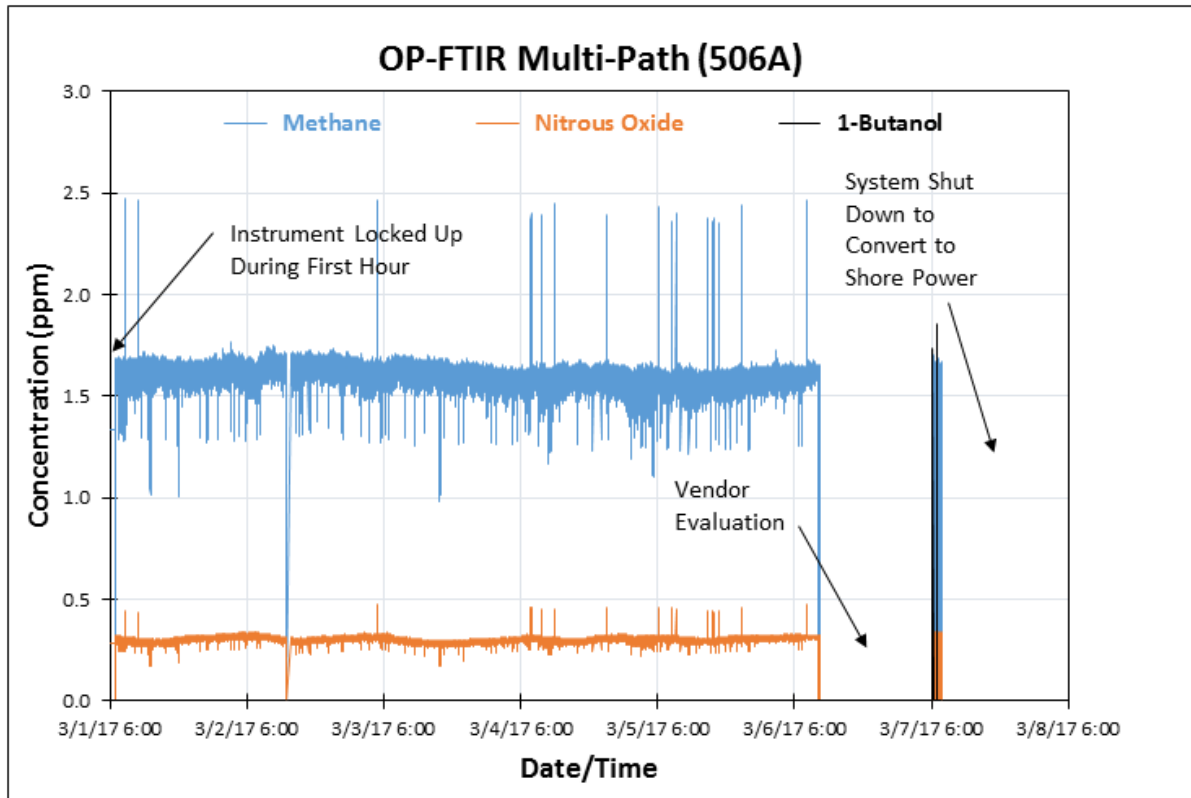
Chemical	506A: OP-FTIR Multi-Path (ppm)	506B: OP-FTIR Single-Path (ppm)
Nitrous Oxide*	0.17 – 0.48 ^b	NR
Ammonia*	ND	NR
Methane	0.98 – 2.5 ^b	NR
1-3-Butadiene*	ND	NR
1-Butanol*	ND – 1.9 ^c	NR
2-Hexanone*	ND	NR
3-Buten-2-one*	ND	NR
Acetaldehyde*	ND	NR
Acetonitrile*	ND	NR
Benzene*	ND	NR
Butanal*	ND	NR
Butyl Nitrite*	ND	NR
Ethylamine*	ND	NR
Formaldehyde*	ND	NR
Furan*	ND	NR
Methanol*	ND	NR
Methyl Isocyanate*	ND	NR
Methyl Nitrite*	ND	NR
N-Nitrosodiethylamine*	ND	NR
N-Nitrosodimethylamine*	ND	NR
N-Nitrosomorpholine*	ND	NR
Propanenitrile*	ND	NR
Pyridine*	ND	NR
Tributyl Phosphate*	ND	NR

Notes: a – Based on data retrieved from OSI PI; OSI PI System is a data visualization software package from OSIsoft.
 b – Data reported between 06:54, 3/1/2017 and 10:18, 3/6/2017 were used for the detectable range
 c – Suspect data
 *Chemical is on COPC list
 ND – Not detected
 NR – Did not report to the OSI PI System

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



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AP Tank Farm Direct Reading Instruments

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

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. Calibration checks were performed on instruments 512A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, T, and U during this week (3/6/2017). No ammonia was detected by Gastronics instruments that were in calibration and reporting this week. Two of the 512 units reported non-detectable levels of VOC. One unit reported VOC at <2 ppm and no units reported VOCs ≥2 ppm (Table 2). A total VOC action limit of 2 ppm currently is prescribed by Fact Sheet EH-09-001.⁴ N₂O sensors are suspect and no data are reported. Only instruments that are reporting to OSI PI and in calibration are reported on here.

Table 2. AP Tank Farm Gastronics (512) Comments.

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

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

⁴ [Fact Sheet for Action Limit for Volatile Organic Compounds, Washington River Protection Solutions, Richland, Washington: \\ap014\EnvironmentalHealth\Fact Sheets\EH-09-001 Turnback value for VOCs.pdf](#)

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A TANK FARM

UV-DOAS

Ammonia, nitric oxide (NO), and ozone (O₃) were reported by the instrument during the period under review (Table 3). Many of these chemicals are typically found in detectable quantities in background air⁵. Analyte concentrations are reported in Table 3 and Figure 2 below.

Table 3. Chemical Species Detected^a on UV-DOAS at A Tank Farm

Chemical	508A: UV-DOAS (ppm)	Chemical	508A: UV-DOAS (ppm)
Ammonia*	ND – 0.050	Methyl Nitrite*	ND
Nitric Oxide	ND – 0.095	Pyridine*	ND
Ozone	0.053 – 0.12 ^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
Ethylamine*	ND	Styrene	ND
Formaldehyde*	ND	Sulfur Dioxide	ND
Furan*	ND	Toluene	ND
Mercury*	ND		

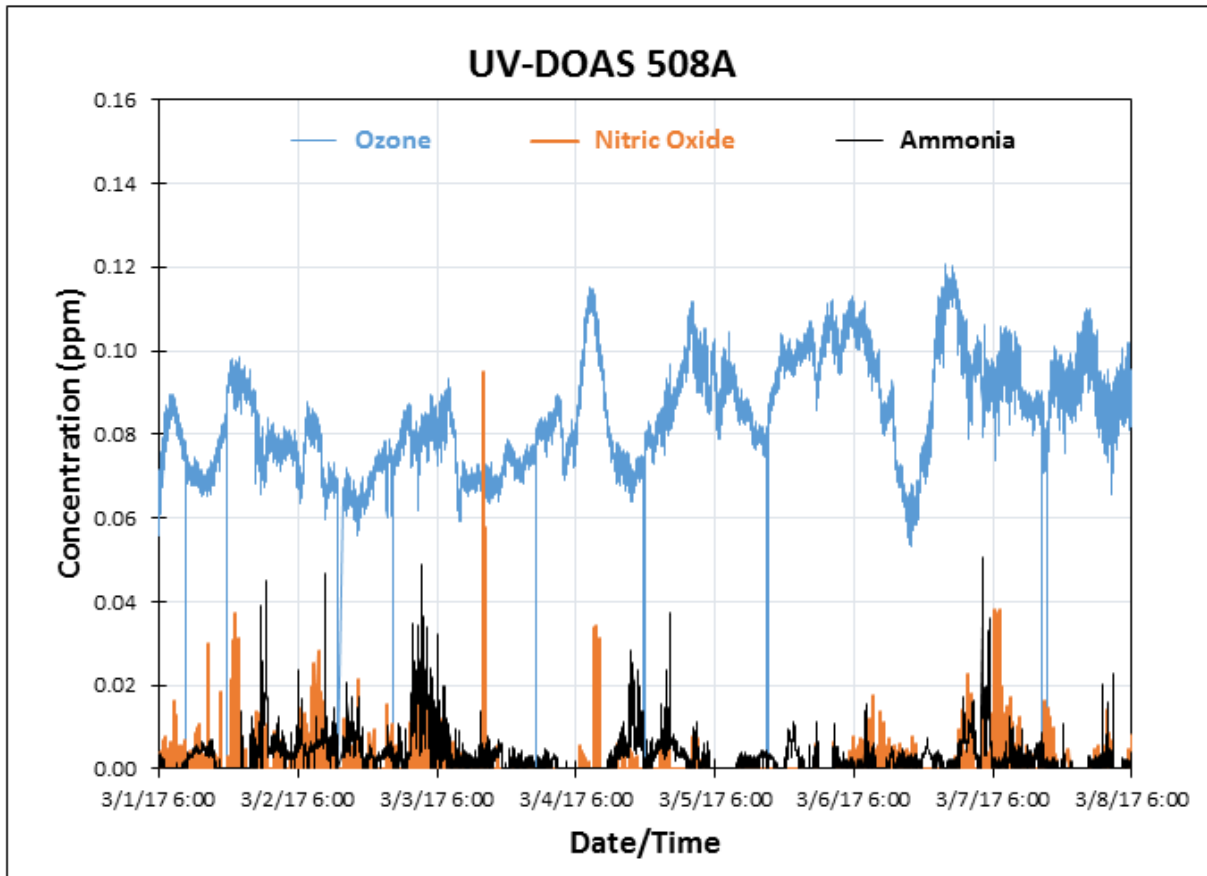
Notes: a - Based on data retrieved from OSI PI; OSI PI System is a data visualization software package from OSIsoft.
b - Isolated spikes equal to zero do not follow the general trend for ozone, and therefore were not included in the table
*Chemical is on COPC list
ND - Not detected

⁵ Air Composition from "The Engineering ToolBox": http://www.engineeringtoolbox.com/air-composition-d_212.html

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Figure 2. Chemical Species Detected by the UV-DOAS (508A) Instrument.



A Tank Farm Direct Reading Instruments

Gastronics (512 - NH₃, VOCs, N₂O): Units located in A Tank Farm include: 512V, W, X, and Y (Table 4). None of these instruments reported data during the week. Calibration checks were performed on 512V, W, X, and Y (3/6/2017) and all of them were within 10% of the test gas concentration for VOC.

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Table 4. A Tank Farm Gastronics (512) Comments.

Compound (units)	Comment	OEL	Action Level	Detection Range
NH ₃ (ppm)	No ammonia reported on any instrument	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

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

3/1/2017 – 3/8/2017 Instrument Operational Status:

Time reporting is calculated using the time sensors are reporting to OSI PI System⁶ for each instrument (Tables 5 and 6).

Table 5. Gastronics (512) % Time Reporting^a.

Instrument	% Time Reporting	Instrument	% Time Reporting
512A	94	512N	26
512B	96	512O	<1
512C	0	512P	0
512D	17	512Q	26
512E	0	512R	52
512F	93	512S	0
512G	0	512T	92
512H	95	512U	>99
512I	49	512V	0
512J	0	512W	0
512K	93	512X	0
512L	94	512Y	0
512M	97		

(a) % time reporting based on NH₃.

⁶ OSI PI System is a data visualization software package from [OSIsoft](http://www.osisoft.com).

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Table 6. Spectrometer Instruments Time Reporting.

Instrument	% Time Reporting
506A	86
506B	0
508A	99