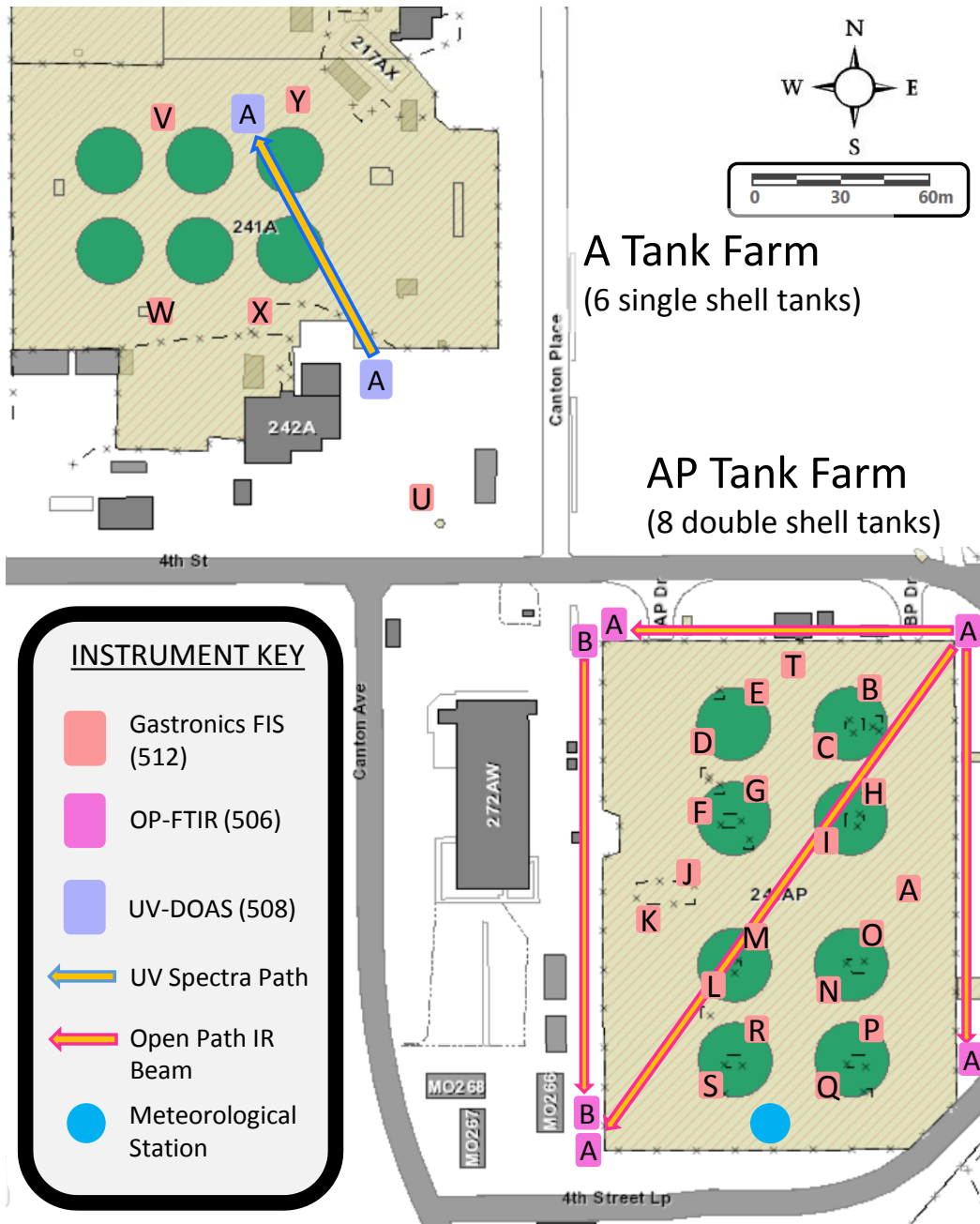


Vapor Monitoring Detection System Weekly Report - A and AP Tank Farm Field Instrument Report

Revision 0 – Initial Release of Report

3/15/2017 6:00 – 3/22/2017 6:00

Instrument/Sampling Locations –A & AP-Tank Farms



Vapor Monitoring Detection System Weekly Report

3/15/2017 6:00 – 3/22/2017 6:00

Abbreviations and Units

| | | |
|------------------|---|---|
| CH ₄ | = | methane |
| COPC | = | chemicals of potential concern |
| DRI | = | direct reading instrument |
| FIS | = | fixed instrument skid |
| IR | = | infrared |
| 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 | = | ultraviolet |
| UV-DOAS | = | ultraviolet differential optical absorption spectrometer ² |
| VMDS | = | vapor monitoring and detection system |
| VOC | = | volatile organic compounds, which include both volatile and semi-volatile compounds |

VMDS Instruments

| | | |
|------|---|--|
| 506A | = | OP-FTIR Multi-Path |
| 506B | = | OP-FTIR Single-Path |
| 508A | = | UV-DOAS |
| 512 | = | FIS Gastronics Direct Reading Instrument |

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>

Vapor Monitoring Detection System Weekly Report

3/15/2017 6:00 – 3/22/2017 6:00

Introduction

This summary contains Vapor Monitoring and Detection System (VMDS) pilot-scale data collected over one week (3/15/2017 at 6:00 a.m. through 3/22/2017 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 visible in the data as spikes. Raw spectra (data) may need to be reprocessed and reviewed as understanding of the particular instruments being used as part of the VMDS pilot test are deployed and the company's ability to align the instruments with the overall objectives of the pilot test improves.

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 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 an instrument software library (library) that specifies which absorption features are analyzed, how analysis is performed, and reporting criteria. Revisions to the library are periodically performed to improve accuracy of analysis for analytes; the optimization of the library is iterative 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., methyl 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.

Vapor Monitoring Detection System Weekly Report

3/15/2017 6:00 – 3/22/2017 6:00

Summary for 3/15/2017 through 3/22/2017

The following sections summarize data reporting for vapor monitoring and detection instruments at AP and A Tank Farms for the 3/15/2017 through 3/22/2017 period. Instruments at AP Tank Farm include open path FTIR instruments (multi-path and single-path) and the Gastronics direct reading instruments. Instruments at A Tank Farm include UV-DOAS and Gastronics direct reading instruments. No waste retrieval activities occurred during this reporting period.

AP TANK FARM

AP Tank Farm OP-FTIR Instruments

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 0.33 ppm for N₂O and 1.8 ppm for CH₄³. The recurring pattern of simultaneous N₂O and CH₄ spikes on this instrument was noted again this week.

Instruments 506A and 506B went offline and stopped reporting data at 09:35 and 14:47, respectively, on 3/16/2017 due to a communication/power interruption. This interruption lasted until 08:40 on 3/20/2017, when power was restored and communication was re-established. Near the end of the week, starting at ~22:00, 3/21/2017, the methane and nitrous oxide readings were affected by high relative humidity conditions (Figures 1 and 2). The detection of 1-butanol during high humidity/precipitation conditions is considered suspect.

Most compounds detected by both 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>

Vapor Monitoring Detection System Weekly Report

3/15/2017 6:00 – 3/22/2017 6:00

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

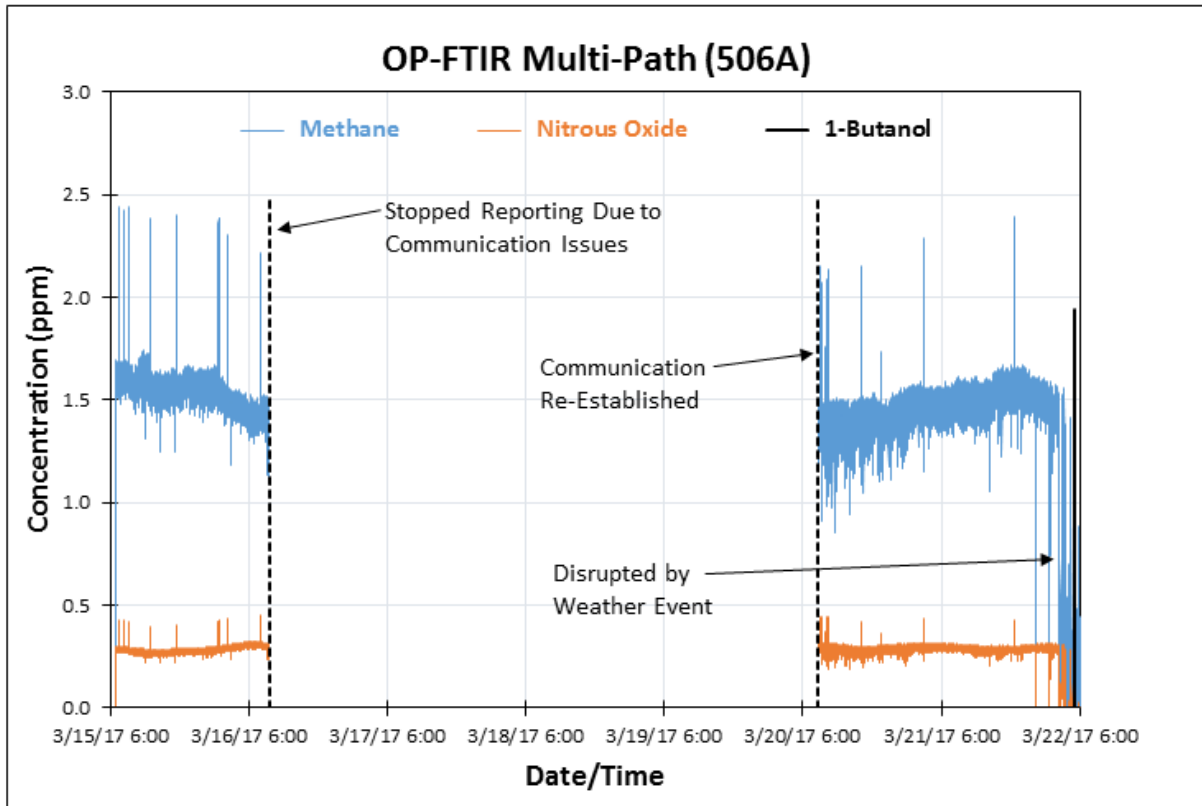
| Chemical | 506A: OP-FTIR Multi-Path (ppm) | 506B: OP-FTIR Single-Path (ppm) |
|-------------------------|---------------------------------------|--|
| Nitrous Oxide* | 0.19 – 0.46 ^b | 0.30 – 0.39 ^b |
| Ammonia* | ND | ND |
| Methane | 0.86 – 2.4 ^b | 1.3 – 1.7 ^b |
| 1-3-Butadiene* | ND | ND |
| 1-Butanol* | ND – 1.9 ^b | ND |
| 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 |
| 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) Data affected by atmospheric conditions not included in the table for these compounds
 *Chemical is on COPC list
 ND – Not detected

Vapor Monitoring Detection System Weekly Report

3/15/2017 6:00 – 3/22/2017 6:00

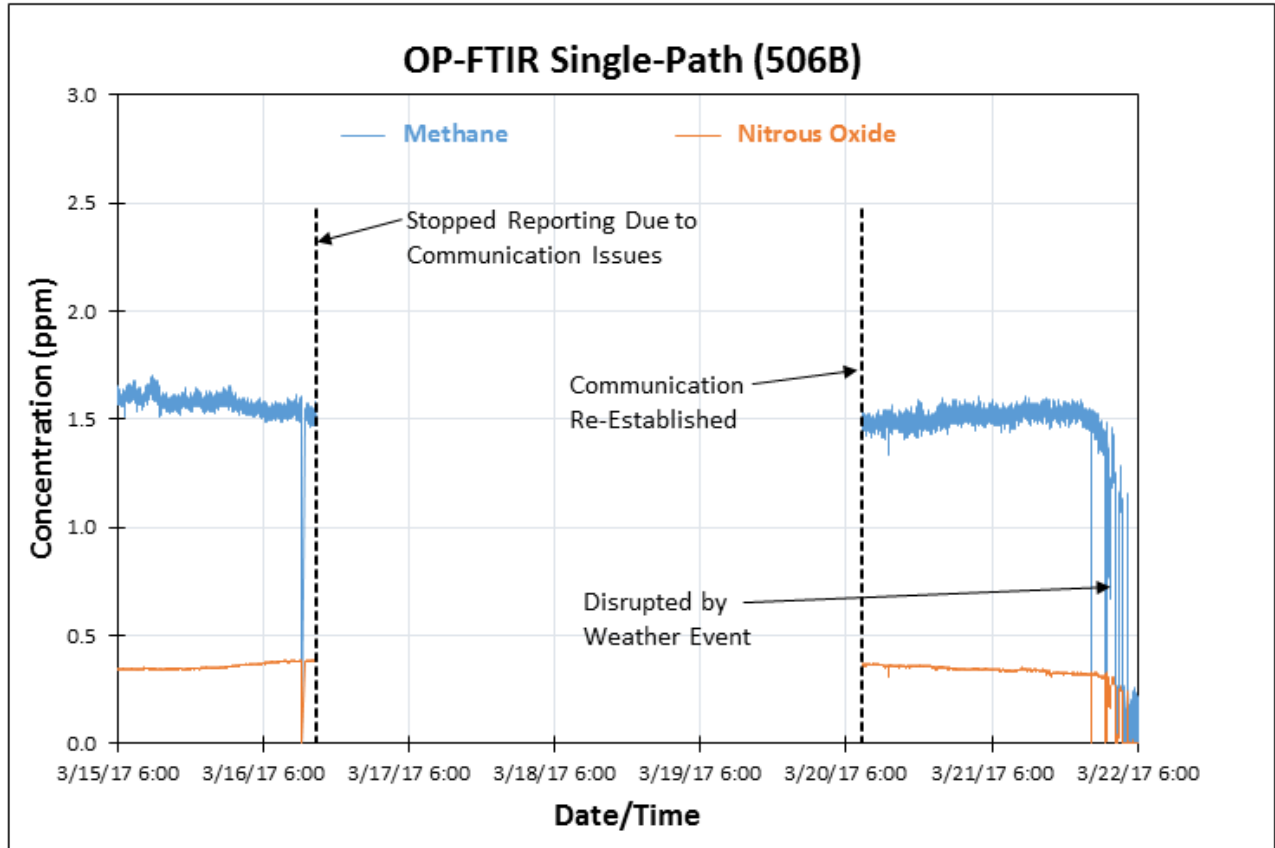
Figure 1. Chemical Compounds Detected by the OP-FTIR (506A) Instrument.



Vapor Monitoring Detection System Weekly Report

3/15/2017 6:00 – 3/22/2017 6:00

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



AP Tank Farm Direct Reading Instruments

Instruments located between AP and A tank farms, just southeast of the 242-A evaporator and northwest of 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 all these Gastronics instruments during this week (3/20/2017) and only instruments 512L, N, S, and T passed calibration for VOC. Instruments 512A, B, C, D, E, F, G, H, I, J, K, L, M, O, P, Q, T, and U passed calibration for NH₃. 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. Two units 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

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](#)

Vapor Monitoring Detection System Weekly Report

3/15/2017 6:00 – 3/22/2017 6:00

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 <ul style="list-style-type: none"> Out of Calibration*: 512N, R, S | 25 | 12 | 1 – 100 |
| VOC (ppm) | <ul style="list-style-type: none"> Out of Calibration*: 512A, B, C, D, E, F, G, H, I, J, K, M, O, P, Q, R and U Instruments that reported no VOCs detected: 512N and S Instruments that reported a maximum value of <2 ppm: 512L and T Instruments that reported maximum values ≥2 ppm: None | N/A | 2 | 0.005 – 50.0 ⁵ |

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

⁵ One-Page Fact Sheet for Gastronics Fixed Instrument Skid, Tank Farm Vapors Control Team, Version 1.0 2016/7/21 RBC.

Vapor Monitoring Detection System Weekly Report

3/15/2017 6:00 – 3/22/2017 6:00

A TANK FARM

A Tank Farm UV-DOAS Instrument

Ammonia, nitric oxide (NO), and ozone (O₃) were reported by the instrument during the period under review (Table 3). These chemicals are typically found in detectable quantities in air⁶. The 508A UV-DOAS instrument stopped running at 14:47 on 3/16/2017, due to software communication/power issues, but began reporting again at 08:40 on 3/20/2017. Analyte concentrations are reported in Table 3 and Figure 3 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 – 0.020 | Methyl Nitrite* | ND |
| Nitric Oxide | ND – 0.075 | Pyridine* | ND |
| Ozone | 0.026 – 0.11 ^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 to zero do not follow the general trend for ozone, therefore these spikes are not included in the table

*Chemical is on COPC list

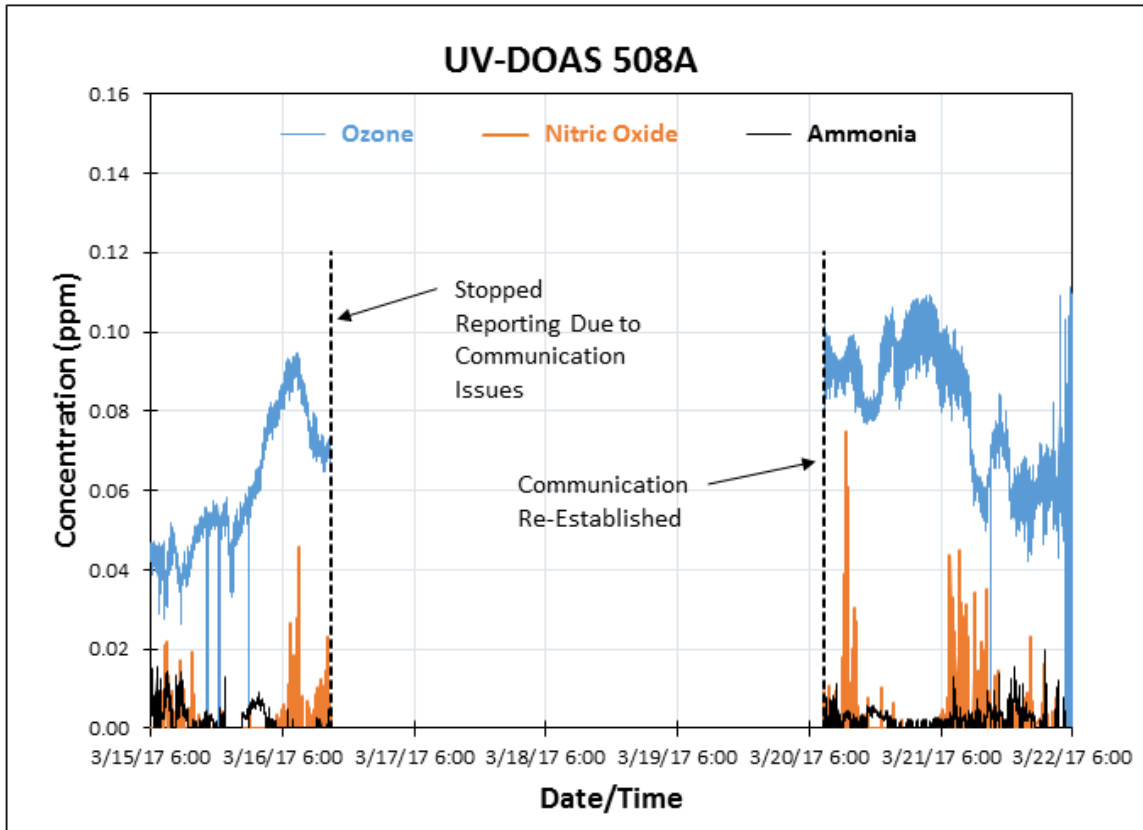
ND – Not detected

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

Vapor Monitoring Detection System Weekly Report

3/15/2017 6:00 – 3/22/2017 6:00

Figure 3. Concentrations of Chemicals Detected by UV-DOAS (508A).



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 during this week (3/20/2017) and none of them were within 10% of the test gas concentration for VOC.

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

| Compound (units) | Comment | OEL | Action Level | Detection Range |
|-----------------------|--|-----|--------------|---------------------------|
| NH ₃ (ppm) | No data reported on any instrument | 25 | 12 | 1 – 100 |
| VOC (ppm) | <ul style="list-style-type: none"> Out of Calibration*: 512V, W, X, and Y No data reported on any instrument | N/A | 2 | 0.005 – 50.0 ⁷ |

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

⁷ One-Page Fact Sheet for Gastronics Fixed Instrument Skid, Tank Farm Vapors Control Team, Version 1.0 2016/7/21 RBC.

Vapor Monitoring Detection System Weekly Report

3/15/2017 6:00 – 3/22/2017 6:00

3/15/2017 – 3/22/2017 Instrument Operational Status:

Time reporting is calculated using the time sensors are reporting to OSI PI System⁸ for each instrument (Tables 5 and 6).

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

| Instrument | % Time Reporting | Instrument | % Time Reporting |
|------------|------------------|------------|------------------|
| 512A | 44 | 512N | 22 |
| 512B | 0 | 512O | 22 |
| 512C | 0 | 512P | 0 |
| 512D | 22 | 512Q | 43 |
| 512E | 0 | 512R | 13 |
| 512F | 18 | 512S | 0 |
| 512G | 20 | 512T | 43 |
| 512H | 9 | 512U | 21 |
| 512I | 0 | 512V | 0 |
| 512J | 0 | 512W | 0 |
| 512K | 45 | 512X | 0 |
| 512L | 46 | 512Y | 0 |
| 512M | 44 | | |

a) % time reporting based on NH₃.

Table 6. Spectrometer Instruments Time Reporting.

| Instrument | % Time Reporting |
|------------|------------------|
| 506A | 43 |
| 506B | 46 |
| 508A | 46 |

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