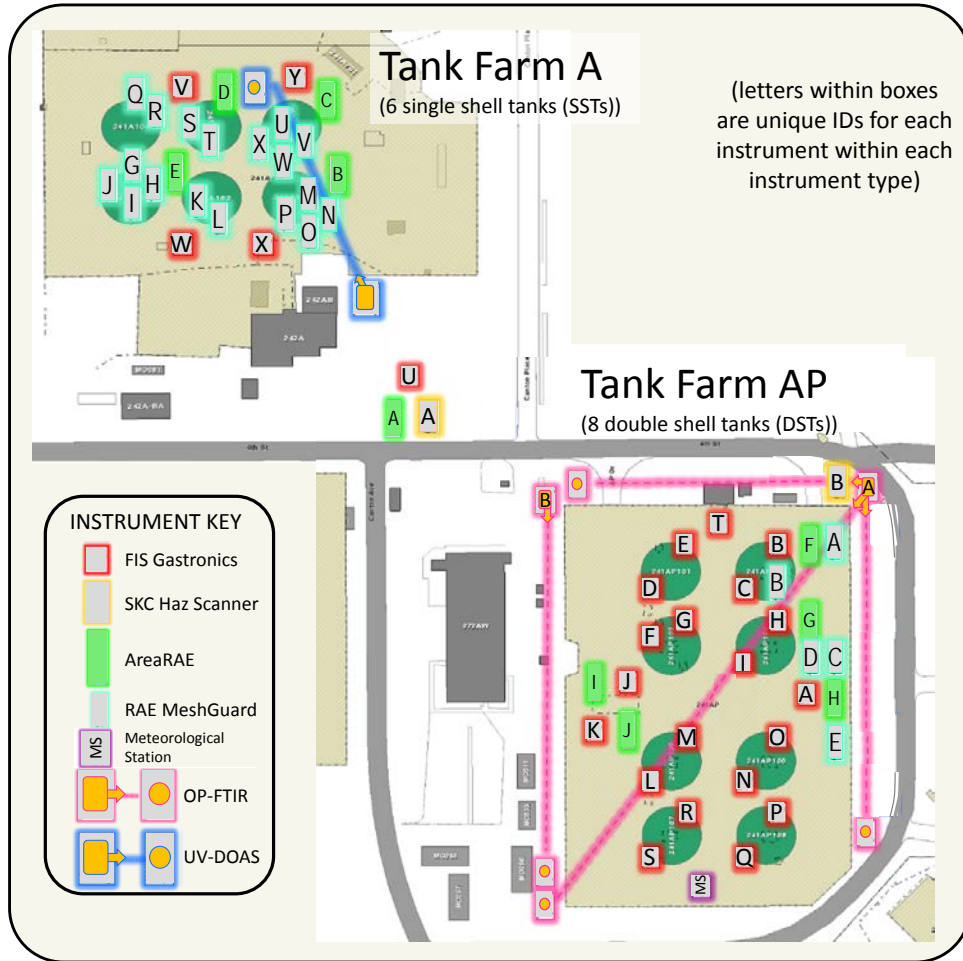


UV-DOAS Weekly Summary

9/14/16 6:00 – 9/21/16 6:00



The following information is for the time period from September 14th at 6:00am through September 21st at 6:00am. This summary contains Vapor Monitoring and Detection System (VMDS) Phase 1 pilot-scale data collected over one week for the ultraviolet differential optical absorption spectrometer (UV-DOAS). Phase 1 testing is focused on evaluating component integration and functionality. Data shown may include results from calibration and bump tests performed to verify sensors function. These tests result in data spikes.

- Abbreviations:
- NH₃ = ammonia
 - CO = carbon monoxide
 - CO₂ = carbon dioxide
 - LEL = lower explosive limit
 - ND = not detected
 - NO = nitric oxide
 - N₂O = nitrous oxide
 - NO₂ = nitrogen dioxide
 - OP-FTIR = open path Fourier transform infrared spectrometer
 - 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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Weekly Summary Analysis: The UV-DOAS spectrometer provides real-time multi-gas measurement (qualification and quantification) of gases¹. While sampling during the period under review, ammonia (NH₃), nitric oxide (NO), oxygen (O₂), and ozone (O₃) were detected by the sensor. These compounds are typically available in detectable quantities in air².

Even though the instrument is very accurate regarding the quantification of 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 10s to 100s of meters apart. Therefore discussion for these instrument types will not be with regards to Operational Exposure Limits (OELs) and Action Levels.

Data reporting is based off R-squared (R²) values calculated by the model, the model in this case consists of the data gathered and reported by the instrument versus specific predetermined IR traces for each compound in the instruments library. R-squared is the “percent of variance explained” by the model, or an estimate of how the two traces match each other. That is, R-squared is the fraction by which the variance of the errors is less than the variance of the dependent variable. R-squared values range from 0 to 1 with higher values indicating a better fit. R-squared values for UV-DOAS data are dependent on sample concentration, chemical compounds (chemicals present can interfere/overlap with each other at key locations; typically those having the same functional groups (e.g., methane or ketone groups)), and many other factors. Results presented here are for compounds having an R-squared value of greater than 0.5.

September 14th – 21st 2016 Instrument Notes:

Table 1. Chemical Species Detected on UV-DOAS at A Tank Farm

Chemical	508A: UV-DOAS	Chemical	508A: UV-DOAS
Ammonia*	ND – 0.041 ppm	Mercury*	ND
Nitric Oxide	ND – 0.076 ppm	Methyl Nitrite*	ND
Oxygen	22.3%	Pyridine*	ND
Ozone	ND – 0.051 ppm	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

¹ UV-DOAS Quick Sheet: <http://hanfordvapors.com/wp-content/uploads/2016/09/UV-DOAS-Fact-Sheet.pdf>

² Air Composition from “The Engineering ToolBox”: http://www.engineeringtoolbox.com/air-composition-d_212.html

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Chemical	508A: UV-DOAS	Chemical	508A: UV-DOAS
Ethylamine*	ND	Styrene	ND
Formaldehyde*	ND	Sulfur Dioxide	ND
Furan*	ND	Toluene	ND

Notes: *Chemical is on COPC list
 ND – Not detected by instrument (either 0 was reported or the R² value was <0.5)

Figure 1) UV-DOAS report on observations.

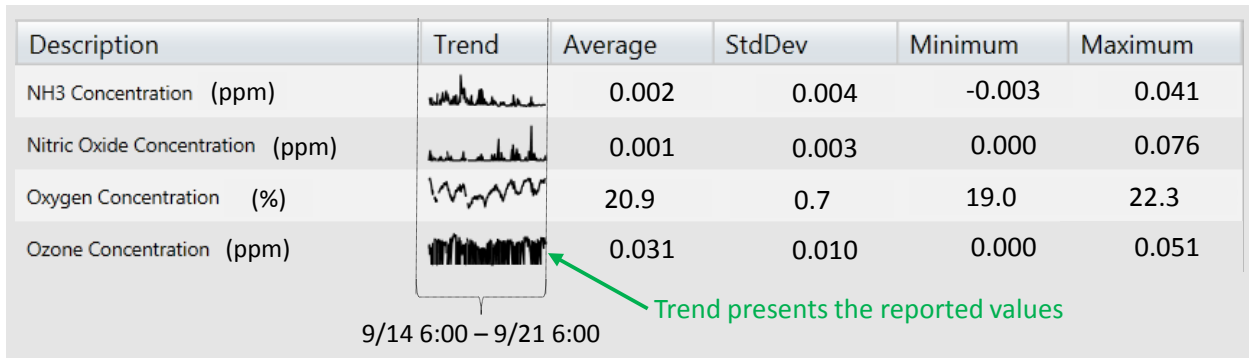


Table 2) UV-DOAS instrument Time Reporting.

Instrument	Comments
508A	The instrument was reporting 98% of the time.

Notes: a) % down is based on hourly interval data as exported from OSI PI³

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