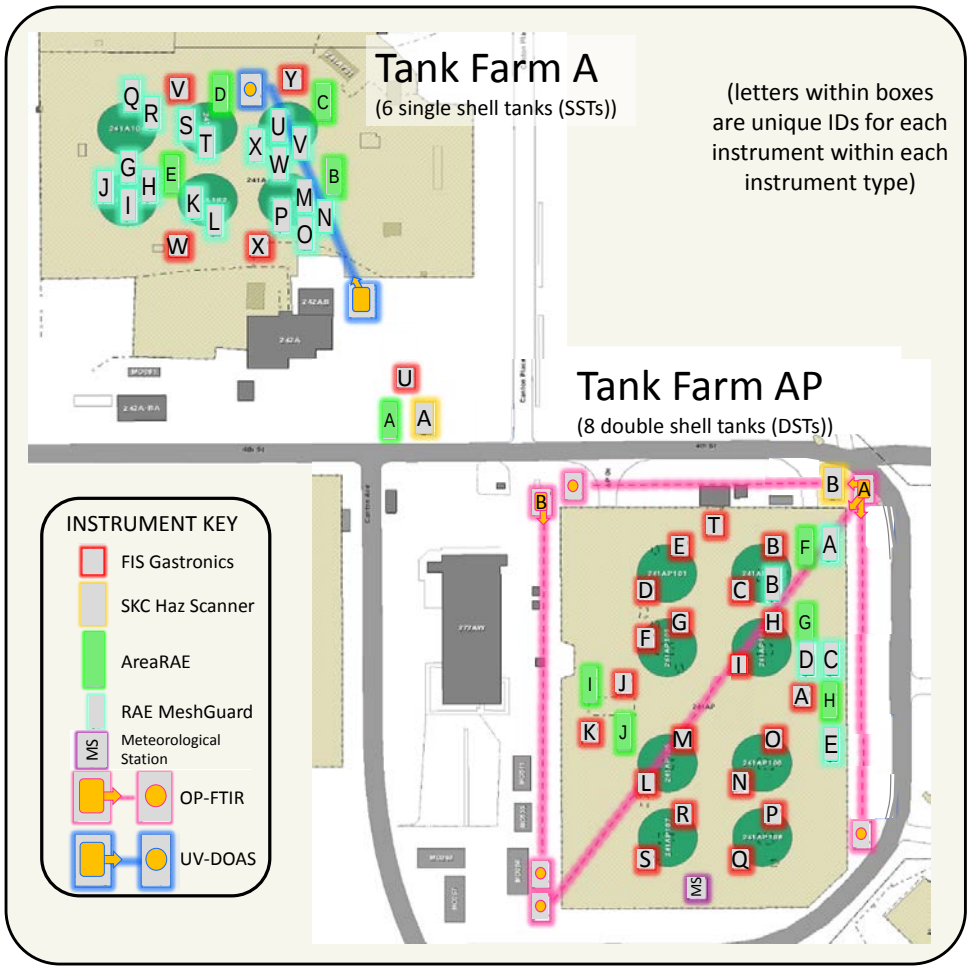
OP-FTIR Weekly Summary

9/21/16 6:00 – 9/28/16 6:00



The following information is for the time period from September 21st at 6:00am through September 28th at 6:00am. This summary contains Vapor Monitoring and Detection System (VMDS) Phase 1 pilot-scale data collected over one week for the open path Fourier transform infrared spectrometer (OP-FTIR). Phase 1 testing is focused on evaluating component integration and functionality. Data shown may include results from calibration and bump tests performed verify instruments function. These tests result in data spikes.

Abbreviations:
NH_3 = ammonia
CO = carbon monoxide
CO_2 = carbon dioxide
LEL = lower explosive limit
ND = not detected
NO = nitric oxide
N_2O = nitrous oxide
NO_2 = nitrogen dioxide
OP-FTIR = open path Fourier transform infrared spectrometer
PM 2.5 / PM 10 = particle monitors for >2.5µm and >10µm particles respectively
H_2S = hydrogen sulfide
SO_2 = sulfur dioxide
VOC = volatile organic carbons, which include both volatile and semi-volatile compounds.

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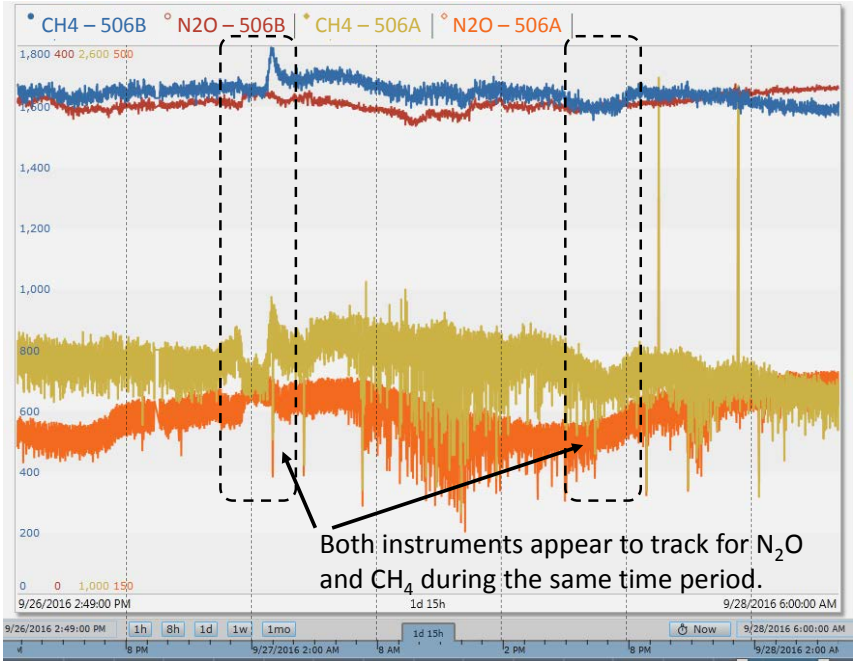
Weekly Summary Analysis: The OP-FTIR spectrometer provides real-time multi-gas measurement (qualitative and quantitative) of gases[1]. Even though the instrument is very accurate regarding the quantification of compounds, reported results cannot be directly calculated into a concentration for a specific 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.

While sampling during the week in review nitrous oxide (N_2O), methane (CH_4), and butadiene (C_4H_6) were detected pm instrument A. As reported in the last weekly, the butadiene R-squared value is typically just below the selected reporting threshold of 0.5. Both N_2O and CH_4 reports are very consistent and, although they do not appear to correlate for the majority of the time, when spikes occur, either below or above their nominal ranges, they occur for both compounds at the same time.

Instrument B detected N_2O and CH_4. Concentrations are consistent with what was seen in the previous week and with instrument A. Any correlation between these two compounds from this instrument appears week. However, when comparing trends between the two OP-FITR units trends between them for both N_2O and CH_4 can be seen.

Figure 1) OP-FTIR instrument to instrument tracking (nitrous oxide signal is weaker)



[1] OP-FTIR Fact Sheet: http://hanfordvapors.com/wp-content/uploads/2016/09/OP-FTIR-Fact-Sheet.pdf

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Compounds detected by both instruments are typically present in air at detectable levels. This information indicates that the OP-FTIR units are effectively measuring composition of the gas components within its path, and it also indicates that there have been minimal fugitive emissions across the fence line path in AP-Tank Farm. Specific instrument information is reported below.

Data reporting is based off R-squared (R^2) 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 OP-FTIR 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 21st – 28th 2016 Instrument Notes:

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

Chemical (ALL PM)	506A: OP-FTIR Multipath[a]	506B: OP-FTIR Single[a]
Nitrous Oxide*	Range: 0.183 – 0.451 ppm	Range: 0.341 – 0.373 ppm
Ammonia*	ND	ND
Methane	Range: 1.2 – 2.6 ppm	Range: 1.6 – 1.8 ppm
1-3-Butadiene*	Range: ND – 0.265 ppm[b]	ND
1-Butanol*	ND	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

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Chemical (ALL PM)	506A: OP-FTIR Multipath[a]	506B: OP-FTIR Single[a]
Pyridine*	ND	ND
Tributyle Phosphate*	ND	ND

*Chemical is on COPC list

a) Chemicals concentrations are only reported for those that meet both of the following criteria:

Notes:

- Detected (i.e., value reported is not 0)
- R^2 value is >0.5

b) R^2 value is ranged from 0.00 to 0.54 with an average of 0.3.

ND – Not detected by instrument (i.e., either value reported was 0 or R^2 value is <0.5)

Figure 2) OP-FTIR A (506A) nitrous oxide and methane tracking.

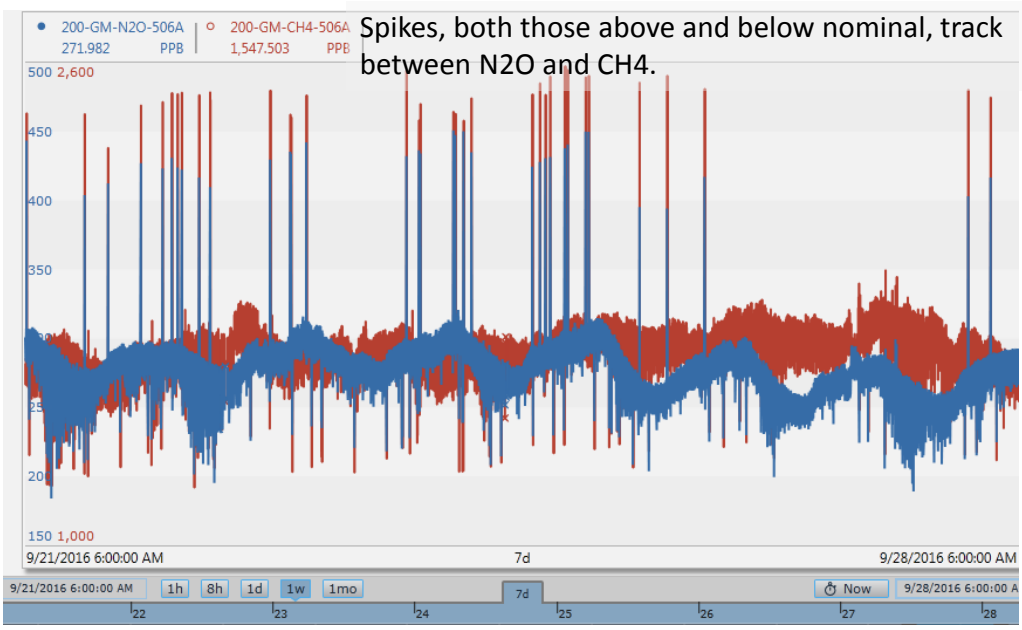

Table 2) OP-FTIR instrument downtime.

Instrument	Comments
506A	The instrument was reporting 99% of the time.
506B	The instrument was reporting 25% of the time. Initially not reporting due to a bad power supply; rebooted and realigned, data reliably reporting 9/26 14:30.

Notes: a) % down is based on hourly interval data as exported from OSI PI[2]

[2] OSI PI is a data visualization software package from OSIsoft.