Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/AM-24/11		

4. Title and Subtitle	5. Report Date
Chemical Analysis of Bleed Air Samples from Simulated Contamination Events: Ground-Based Aircraft Test	28 May 2024
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Krisiam Ortiz-Martinez, Ph.D.	ARITR-24-002
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Naval Air Warfare Center Aircraft Division Human Systems Engineering Department Patuxent River, MD 20670	11. Contract or Grant No.
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Office of Aerospace Medicine Federal Aviation Administration 800 Independence Ave., S.W. Washington, DC 20591	Technical Report
	14. Sponsoring Agency Code AAM-600

15. Supplementary Notes

Author's ORCID: https://orcid.org/0000-0001-9360-8186

DOI: https://doi.org/10.21949/1529671
Associated DOI: https://doi.org/10.21949/1529639

16. Abstract

This report presents the chemical analysis results on bleed air samples collected during ground-based aircraft tests led by the Federal Aviation Administration's Civil Aerospace Medical Institute (FAA/CAMI) as part of a congressionally mandated air quality study. The tests were carried out on a Boeing 747 aircraft at the FAA William J. Hughes Technical Center to simulate fluid leaks on an airplane's Environmental Control System (ECS) using either a propulsion engine or an Auxiliary Power Unit (APU). The Naval Air Warfare Center Aircraft Division (NAWCAD) supported these efforts by providing analytical chemistry expertise. During the tests, NAWCAD collected and analyzed 52 air samples to identify Volatile Organic Compounds (VOCs) from these contamination events. The chemical analysis demonstrated that VOCs were released into the bleed air when fluids entered the aircraft's ECS, regardless of whether the fluid leak occurred in the propulsion engine or the APU. It was also found that the VOC emission profile varied depending on the fluid category involved in the contamination event. Carboxylic acid emissions increased during the engine oil events, while organophosphate and alkene emissions increased during the hydraulic fluid event. The study findings provide insights into the chemical emissions in the bleed air during some in-flight failure events to improve bleed air contamination detection and aircraft safety.

17. Key Word	18. Distribution Statement
	Document is available to the public through the National Transportation Library: https://ntl.bts.gov/ntl

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages
Unclassified	Unclassified	154

Naval Air Warfare Center Aircraft Division
Human Systems Engineering Department
Patuxent River, MD 20670

Technical Report

Chemical Analysis of Bleed Air Samples from Simulated Contamination Events: Ground-Based Aircraft Test

Federal Aviation Administration Civil Aerospace Medical Institute (FAA/CAMI)

by

Krisiam Ortiz-Martinez, Ph.D.
Chemical Engineer

28 May 2024

NAVAIR Public Release 2024-0350.

Naval Air Warfare Center Aircraft Division
Human Systems Engineering Department
Patuxent River, MD 20670

Date: 28 May 2024

ARITR-24-002

CHEMICAL ANALYSIS OF BLEED AIR SAMPLES FROM SIMULATED CONTAMINATION EVENTS: GROUND-BASED AIRCRAFT TEST

Prepared By

Krisiam Ortiz-Martinez, Ph.D.
Chemical Engineer
Aeromedical Research & Integration Branch

Reviewed By

Leah R. Eller, Ph.D.
Senior Organic Chemist
Aeromedical Research & Integration Branch

Sam Trepp
Branch Head
Aeromedical Research & Integration Branch

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Human Systems Engineering Department
Aeromedical Research & Integration Technical Report

CHEMICAL ANALYSIS OF BLEED AIR SAMPLES FROM SIMULATED CONTAMINATION EVENTS: GROUND-BASED AIRCRAFT TEST

EXECUTIVE SUMMARY

This report presents the chemical analysis results on bleed air samples collected during ground-based aircraft tests led by the Federal Aviation Administration's Civil Aerospace Medical Institute (FAA/CAMI) as part of a congressionally mandated air quality study. The tests were carried out on a Boeing 747 aircraft at the FAA William J. Hughes Technical Center to simulate fluid leaks on an airplane's Environmental Control System (ECS) using either a propulsion engine or an Auxiliary Power Unit (APU). The Naval Air Warfare Center Aircraft Division (NAWCAD) supported these efforts by providing analytical chemistry expertise. During the tests, NAWCAD collected and analyzed 52 air samples to identify Volatile Organic Compounds (VOCs) from these contamination events. The chemical analysis demonstrated that VOCs were released into the bleed air when fluids entered the aircraft's ECS, regardless of whether the fluid leak occurred in the propulsion engine or the APU. It was also found that the VOC emission profile varied depending on the fluid category involved in the contamination event. Carboxylic acid emissions increased during the engine oil events, while organophosphate and alkene emissions increased during the hydraulic fluid event. The study findings provide insights into the chemical emissions in the bleed air during some in-flight failure events to improve bleed air contamination detection and aircraft safety.

1. BACKGROUND

The FAA/CAMI recently conducted a series of tests to study the potential impact of contaminated air events on commercial aircraft. The first series of experiments, called engine stand tests, were conducted in May 2022 at Kansas State University, where a small turbine engine on a test stand was used to simulate bleed air contamination events. These engine stand experiments aimed to refine the test plan for the second series of experiments called ground-based aircraft tests, which were conducted in May 2023 at the FAA William J. Hughes Technical Center in Atlantic City, NJ. This report focuses only on the ground-based aircraft tests. Results and details on the engine stand tests from May 2022 were addressed in a separate report (ARITR-24-001).

For the ground-based aircraft tests, a commercial airplane that was no longer in operation was used to simulate bleed air contamination events in a more representative system. The experiments aimed to characterize the composition of the resulting bleed air, identify chemical markers, and attempt to correlate specific markers with specific failure events. The ground-based aircraft tests involved injecting controlled amounts of fluids into the aircraft's ECS via either the propulsion engine or APU to mimic contamination events at different operating conditions. The bleed air was then sampled and analyzed to characterize its chemical composition.

The NAWCAD provided analytical chemistry expertise to assist in test planning, sampling collection, and conducting chemical analysis of the captured air samples for VOCs per an adapted EPA TO-17 method. Between May 15th and 18th, NAWCAD collected 52 air samples from the ground-based aircraft tests. These samples were transported to the Gas & Fluid Flow Integration Laboratory at NAS Patuxent River on May 19th for further processing and analysis.

2. PROCEDURE

2.1. Test Procedure and Conditions

This section describes the testing procedure and experimental conditions for the ground-based aircraft tests conducted on a Boeing 747SP. The aircraft was equipped with four propulsion engines, three air conditioning packs, three ozone converters, and an APU. However, only one propulsion engine, one air conditioning pack, one ozone converter, and the APU were utilized for these experiments.

Two bleed air flow paths were tested to assess the contamination events. The first path involved using the APU to introduce the fluid contamination and supply bleed air to the aircraft's ECS. In contrast, the second path utilized the propulsion engine. A schematic diagram of the aircraft's ECS components, bleed air paths, and sampling location is presented in **Figure 1.**

The tests were carried out to evaluate three aircraft fluids, two injection systems, and three bleed air temperatures. Additionally, the effect of two different fluid injection rates on the contaminant emissions was investigated. However, only MJO II was tested this way because it is the most commonly used standard-class oil in commercial aviation. **Table 1** provides details of the selected aircraft fluids, while **Table 2** summarizes the tested conditions.

Table 1: Tested aircraft fluids.

Classification	Fluid Name	Additional Description/Properties[1]
Engine Oils	Mobil Jet Oil II (**MJO II**)	Standard oil; μ=5cST at 100°C
	Eastman Turbo Oil 2197 (**ETO 2197**)	High Thermal Stability oil; μ=5cST at 100°C
Hydraulic Fluid	Skydrol PE-5 (**PE 5**)	5000 PSI fluid

μ = viscosity
[1]More information on the selected fluids are in the **Appendix G**

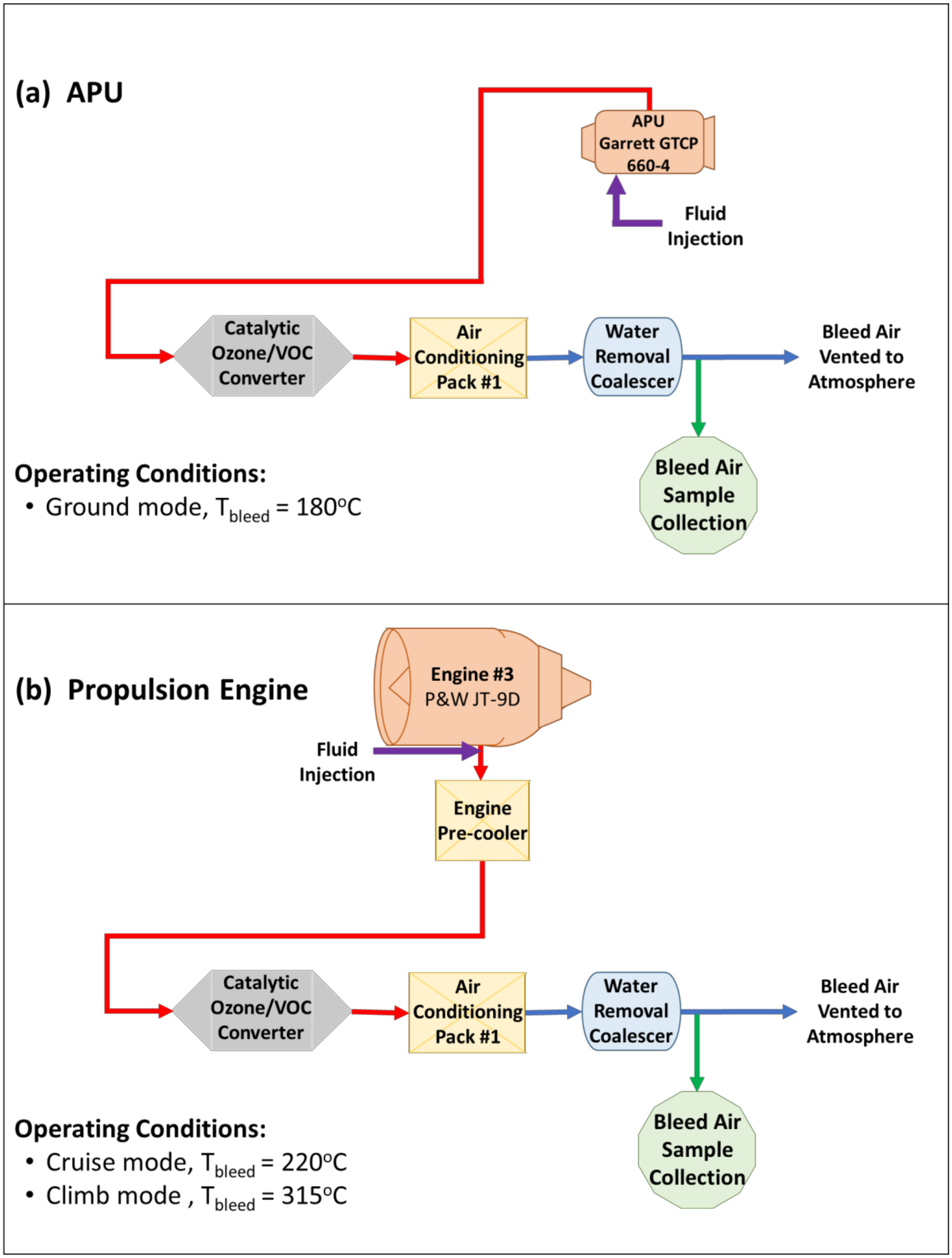


Figure 1: Schematic of the aircraft's ECS, bleed air path and sampling location for (a) the Auxiliary Power Unit and (b) Propulsion Engine experiments.

Table 2: Test conditions during the contamination events.

Injection System	Operating Condition	Bleed Temperature (°C)	Injection rates (mL/hr)	Estimated Concentration (ppmW)	Tested Fluids
APU	Ground mode	180	200	5	Day 1: **MJO II** Day 4: **PE 5**
			400	10[1]	Day 4: **MJOII**
ENG	Cruise mode	220	35	5	Day 2: **MJO II** Day 3: **ETO 2197**
	Climb mode	315	35	5	Day 2: **MJO II** Day 3: **ETO 2197**

APU: Auxiliary Power Unit; **ENG**: Propulsion Engine; **ppmW**: Parts per million by weight
[1] Fluid injection was conducted to simulate a maximum leak in the APU. This condition was selected because, at this rate, the engine should be taken out of service and inspected for excessive oil consumption.

Table 3 provides a summary of the test sequence for each contamination event. First, the engine system and aircraft's ECS were turned on and set to the desired operating conditions. After approximately 40 minutes of system stabilization, baseline sample collection started and continued for 60 minutes. No fluid was injected under these baseline conditions. Once baseline sampling was completed, fluid injection began. Once constant bleed emission was established downstream of the ECS, the fluid emission sampling started for 60 minutes. After 60 minutes of fluid emission sampling, the fluid injection was stopped, and the system was purged for approximately 40 minutes before moving to the next set of conditions.

It should be noted that the particulate and chemical sensors available on site were used to determine the system's stabilization and purge times. NAWCAD also conducted pre-runs before the actual testing with the APU to estimate the system's delay time for the VOCs. Additional information about these pre-tests can be found in **Appendix A.**

Table 3: Test Sequence of a contamination event.

Test Sequence	Time (min)	Chemical Sampling
1. System On & System Stabilization[1]	40	No
2. Baseline Sampling	60	Yes
3. Fluid Injection Start & System Stabilization[1]	60 - 70	No
4. Fluid Injection Sampling	60	Yes
5. Fluid Injection Stop	-	No
6. System Purge	40	No

[1] Particulate and VOC sensors on-site determined the system stabilization and purge times.

2.2. Air Measurement Equipment

A combination of chemical sampling and air monitoring was used to measure the bleed emissions resulting from the contamination events. This dual approach was implemented to prevent underestimations and ensure accurate emission measurements of the aircraft's ECS.

Tri-bed sorbent tubes were used for chemical sampling, while Hydro-Carbon Detectors (HCD) equipped with a Photoionization Detector (PID) were used for air monitoring. HCDs provided real-time readings of the total VOC levels in the bleed air. These HCD readings for the contamination events can be found in **Appendix B.**

These readings were taken only as qualitative measurements to establish when the system reached a constant VOC emission level before initiating the chemical sampling. HCDs continuously monitored the emissions throughout the contamination events, while sorbent tubes were only used to sample for a period of 60 minutes once constant VOC emission was confirmed. **Figure 2** illustrates the bleed air measurement configuration for both approaches downstream of the aircraft's ECS.

During measurements, HCDs and sorbent tubes were attached to sampling pumps to maintain a constant flow rate of 50mL/min. The pumps and HCDs were calibrated and zeroed daily, while sorbent tubes were pre-conditioned and pre-evaluated before sampling. Additionally, sorbent tubes were kept sealed and refrigerated after sampling. It should be noted that all the samples were collected using the chemical sampling approach. Only the bleed air samples were also measured using the real-time monitoring approach**.**

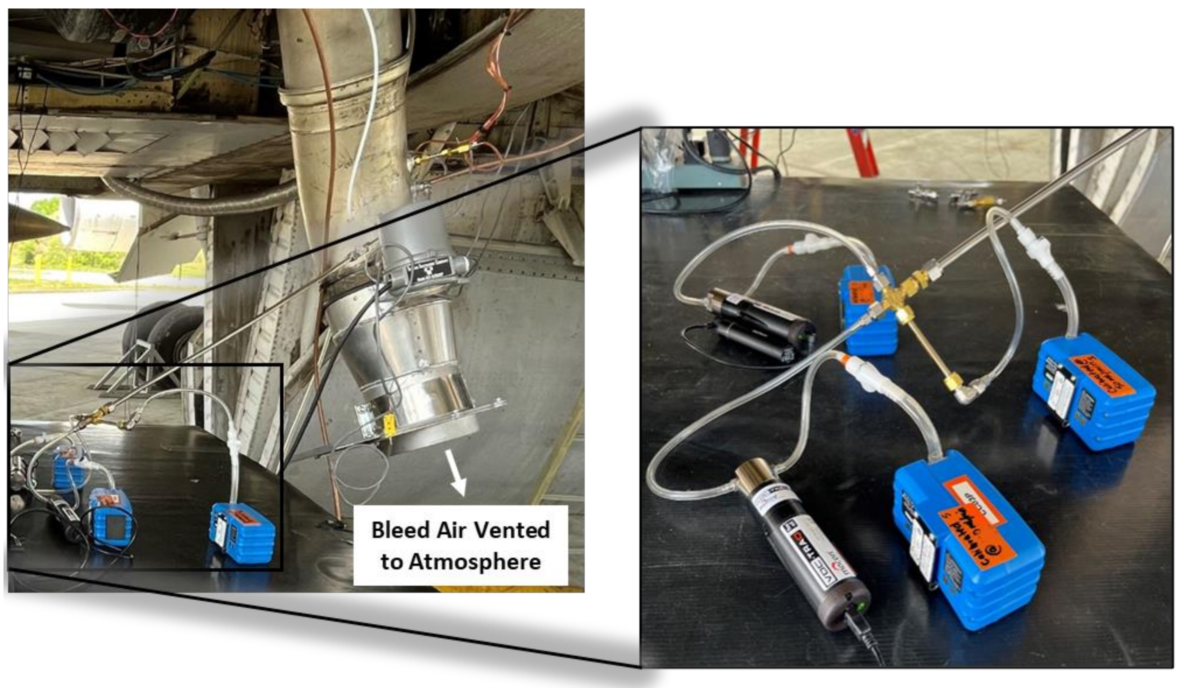


Figure 2: Bleed air measurements downstream of the aircraft's ECS configuration.

2.3. Sample Collection

Sample collection was divided into seven batches, each corresponding to a specific contamination event. **Table 4** summarizes all the samples collected for this ground-based aircraft test. The table shows that ECS was sampled before and during fluid injections for each event. Samples collected before fluid injections were labeled as baselines (BL samples), while those taken during injections were labeled with their fluid names. In both cases, ambient air entering from beneath the aircraft (Inlet samples) and bleed air exiting downstream of the ECS (Bleed samples) were sampled.

Table 4: Samples collected during the ground-based aircraft test.

		Day 1: 15MAY	Day 2: 16MAY	Day 3: 17MAY	Day 4: 18MAY
Morning	Contamination Event		**MJO II** (ENG 220°C; 5ppmW)	**ETO 2197** (ENG 315°C; 5ppmW)	**MJO II** (APU 180°C; 10ppmW)
	Baseline		BL Inlet1 ENG 220°C	BL Inlet1 ENG 315°C	BL Inlet1 APU 180°C
			BL Inlet2 ENG 220°C	BL Inlet2 ENG 315°C	BL Inlet2 APU 180°C
			BL Bleed ENG 220°C	BL Bleed ENG 315°C	BL Bleed APU 180°C
	Injection		MJO II Inlet1 ENG 220°C	ETO 2197 Inlet1 ENG 315°C	MJO II Inlet1 APU 180°C
			MJO II Inlet2 ENG 220°C	ETO 2197 Inlet2 ENG 315°C	MJO II Inlet2 APU 180°C
			MJO II Bleed ENG 220°C	ETO 2197 Bleed ENG 315°C	MJO II Bleed APU 180°C
	CTRL		Trailer Sample1		Trailer Sample2
Afternoon	Contamination Event	**MJOII** (APU 180°C; 5ppmW)9xd	**MJO II** (ENG 315°C; 5ppmW)	**ETO 2197** (ENG 220°C; 5ppmW)	**PE 5** (APU 180°C; 5ppmW)
	Baseline	BL Inlet1 APU 180°C	BL Inlet1 ENG 315°C	BL Inlet1 ENG 220°C	BL Inlet1 APU 180°C
		BL Inlet2 APU 180°C	BL Inlet2 ENG 315°C	BL Inlet2 ENG 220°C	BL Inlet2 APU 180°C
		BL Bleed APU 180°C	BL Bleed ENG 315°C	BL Bleed ENG 220°C	BL Bleed APU 180°C
	Injection	MJO II Inlet1 APU 180°C	MJO II Inlet1 ENG 315°C	ETO 2197 Inlet1 ENG 220°C	PE 5 Inlet1 APU 180°C
		MJO II Inlet2 APU 180°C	MJO II Inlet2 ENG 315°C	ETO 2197 Inlet2 ENG 220°C	PE 5 Inlet2 APU 180°C
		MJO II Bleed APU 180°C	MJO II Bleed ENG 315°C	ETO 2197 Bleed ENG 220°C	PE 5 Bleed APU 180°C
	CTRL	Field Blank1	Field Blank2	Field Blank3	Field Blank4
		Shipping Blank1	Shipping Blank2	Shipping Blank3	Shipping Blank4

BL: Baseline samples collected before fluid injections.
CTRL: Control samples collected during contamination events.
Inlet samples were collected from beneath the aircraft during baseline and fluid injection. Inlet samples were taken in duplicates.
Bleed samples were collected downstream of the ECS during baseline and fluid injection.
More details for each sample are available in the Chain of Custody Record in **Appendix F**.

Additional control samples were also collected. These controls account for artifacts from the aircraft's ECS surroundings and shipping process. **Table 5** summarizes the control samples taken during the test.

Table 5: Control samples collected during contamination events.

Control Name		Sample Description
Control Samples	Field blank	Tube that was exposed to the ambient air, but no air was drawn in through the tube. Field blanks were handled like the sample tubes but without the actual air sample.
	Shipping blank	Tube that accompanied the samples throughout the storage and transportation process, but no air was drawn in through the tube. Shipping blanks remained closed the entire time.
	Trailer sample	Control room ambient air that was collected during testing.[1]

[1] Trailer samples were only collected on the second and fourth day.

2.4. Sample Processing

Air samples were run by the GCMS unit in the Gas & Fluid Flow Integration Lab at NAS Patuxent River. The GCMS run was performed using an Agilent 7890B GC System equipped with an Agilent 5977B MSD series quadrupole mass spectrometer. The method used is an adapted version of the TO-17 EPA Compendium Method. The processing run used an electron impact ionization at an ionization energy of 70eV. A mass range of 30 to 400 amu was scanned. The source was maintained at 280°C, and the quadrupole was fixed at 150°C. The oven temperature was ramped from 35°C to 325°C. A final hold of 3 minutes was applied for a total run time of 42 minutes. A Restek Rtx-1 60m x 320µm x 1µm column was used, with helium carrier gas at a constant flow of 2mL/min. Samples were introduced into the GC column at a split ratio 10:1 using a Markes TD100-xr Automated Thermal Desorber. Each tube was desorbed at 300°C for 10 minutes.

Each contamination batch was processed with GCMS blanks, Laboratory blanks, and Certified Reference Standards (CRS). These additional controls were run to track carryover from sample to sample and to account for any interferences from the laboratory instrumentation, laboratory environment, and technician. Similarly, CRS tubes loaded with calibration gases were run at the start and end of each batch sequence to ensure proper GCMS response and to semi-quantify the air samples.

2.5. VOC Identification

Compound identification was based on mass spectrum deconvolution and mass spectrum matches against the NIST library. In general, the identified compounds are within a computed match factor greater than 80%. It should be noted that these identifications are considered tentative since each compound was not compared against its corresponding standard. Additionally, per this method, only compounds up to a retention time of 36.5 minutes were identified.

2.6. VOC Semi-quantification

Since not all compounds are commercially available and generating a calibration curve for each detected compound would be impractical, concentrations of identified compounds were based on a single point-toluene calibration line (i.e., toluene equivalents). In general, this technique relates the area of each compound peak in the chromatograms to the area of toluene response from the CRS by a scaling factor. It should be noted that this method introduces a level of uncertainty since each compound ionizes differently in the mass spectrometer. Therefore, these calculated concentrations should be considered an estimate.

3. DATA AND ANALYSIS

This section discusses the chemical analysis of the bleed air samples collected downstream of the ECS as a result of the fluid injections. The data has been corrected to facilitate the accurate identification of the chemical markers directly related to the fluid injections.

Data corrections followed the same method applied in the first series of experiments (report ARITR-24-001). For each contamination event, the GCMS results obtained from the inlet, baseline, and control samples were used to adjust the bleed samples. This process aimed to address fluid carryovers between events and minimize other sources of contamination external to the injections observed during testing, such as engine and aircraft-refueling exhausts.

It should be noted that although the data presented here has been corrected, the results for all samples taken without correction are provided in **Appendix C**.

3.1. Turbo Engine Oils

Testing began with the engine oils. MJO II was the first oil tested, followed by ETO 2197. On the first day of testing, MJOII was introduced into the ECS through the APU, while on the second day, it was injected via the propulsion engine. ETO 2197 was then evaluated on the third day, using only the propulsion engine. All these events were carried out at a low fluid injection rate. However, on the fourth day, an additional MJO II event was performed, where MJO II was injected at a higher injection rate to simulate a maximum oil leak using the APU system.

During these oil events, it was demonstrated that VOCs are present in the bleed airstream when fluids enter the aircraft's ECS. Overall, no significant differences in chemical emissions were observed between the oils tested despite belonging to different classes (Standard and High Thermal Stability types). However, this outcome was not surprising given the chemical nature of the oils and sampling methods used. The two oils have similar chemical compositions, with the main difference being the additives present in very low concentrations relative to their base stocks.

The data also shows that carboxylic acids were the most frequently identified chemical markers during the events. This observation compares well with the expected byproducts of the degradation of these polyol ester oils. These oils can break down into oxygenated compounds, which react further to form carboxylic acids under the exposed conditions. The results were also consistent with those obtained during the engine stand tests.

Below are additional observations on the different operational conditions evaluated for the oils.

3.1.1. Effects of Bleed Air Temperature on Oil Contamination Emissions

The propulsion engine was used in these experiments to simulate cruise and climb flight-operating modes and to generate higher temperatures in the ECS. These conditions resulted in bleed air temperatures of 220°C and 315°C, which were achieved by adjusting the engine speed. For these events, the fluids were introduced at the lower injection rate of 35mL/hr to achieve an estimated oil concentration of 5ppmW in the bleed air.

The VOCs identified at both evaluated bleed air temperatures are presented in **Tables 6** and **7**. The concentrations of these compounds are also shown in units of parts per billion by volume (ppbV) and micrograms per cubic meter (µg/m^3). Additional details on the full emission profiles and the Total Ion Chromatograms (TICs) for these injection events are found in **Appendix C** and **D**, respectively.

Table 6: VOC tentatively identified in the bleed samples as a result of the MJO II injection into the ECS via the propulsion engine. Data are corrected results.

RT (min)	Compound Name	CAS #	Concentration[1]			
			µg/m^3		ppbV	
			MJO II ENG 220 °C	MJO II ENG 315 °C	MJO II ENG 220 °C	MJO II ENG 315 °C
4.69	Acetone	67-64-1	4.1	5.5	1.7	2.3
6.20	Methacrolein	78-85-3	2.4	3.9	0.8	1.4
6.69	Butanal	123-72-8	3.3	14.7	1.1	5.0
6.79	2-Butanone	78-93-3	8.1	26.2	2.8	8.9
6.94	Acetic acid	64-19-7	15.9	38.4	6.5	15.6
9.65	Pentanal	110-62-3	7.9	13.0	2.2	3.7
12.16	Butanoic acid	107-92-6	4.3	16.3	1.2	4.5
12.50	Butynediol	110-65-6	26.4	23.8	7.5	6.8
12.61	Hexanal	66-25-1	17.3	22.7	4.2	5.6
14.24	2-Methylbutanoic acid	116-53-0	137.8	210.0	33.4	50.3
15.10	Pentanoic acid	109-52-4	306.0	496.2	73.3	118.9
15.34	Heptanal	111-71-7	4.0	9.9	0.9	2.1
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	4.4	9.2	1.1	2.2
17.03	Hexanoic acid	142-62-1	30.7	34.2	6.5	7.2
18.33	2-Methylhexanoic acid	4536-23-6	10.9	11.7	2.1	2.2
19.22	p/m/o-Cresol	1319-77-3	45.2	24.0	10.2	5.4
19.39	Heptanoic acid	111-14-8	510.9	812.7	96.0	152.7
20.02	Nonanal	124-19-6	3.4	4.9	0.6	0.9
20.68	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	7.3	13.1	1.4	2.5
21.23	Octanoic acid	124-07-2	192.3	246.6	32.6	41.8
21.59	3,5-Dimethyl-4-heptanone	19549-84-9	36.8	54.2	6.3	9.3
22.56	Allyl isovalerate	2835-39-4	48.7	74.0	8.4	12.7
24.80	Decanoic acid	334-48-5	64.8	89.3	9.2	12.7
26.09	Allyl heptanoate	142-19-8	53.3	79.0	7.7	11.4
27.74	Allyl octanoate	4230-97-1	24.5	13.8	3.3	1.8
30.74	Allyl decanoate	57856-81-2	9.3	--	1.1	--

RT=Retention time; CAS#=Chemical Abstract Service registry number; -- =below the detection limits of the method used.
[1]Toluene-equivalent concentration

Table 7: VOC tentatively identified in the bleed samples as a result of the ETO 2197 injection into the ECS via the propulsion engine. Data are corrected results.

RT (min)	Compound Name	CAS #	Concentration[1]			
			µg/m³		ppbV	
			ETO 2197 ENG 220 °C	**ETO 2197** ENG 315°C	**ETO 2197** ENG 220 °C	**ETO 2197** ENG 315 °C
4.69	Acetone	67-64-1	--	8.5	--	3.6
6.19	Methacrolein	78-85-3	1.4	4.4	0.5	1.5
6.68	Butanal	123-72-8	4.1	9.5	1.4	3.2
6.91	Acetic acid	64-19-7	7.9	36.3	3.2	14.8
9.65	Pentanal	110-62-3	3.2	10.6	0.9	3.0
12.16	Butanoic acid	107-92-6	5.3	14.1	1.5	3.9
12.24	4,4-Dimethyl-2-pentanone	590-50-1	2.1	19.2	0.4	4.1
12.50	Butynediol	110-65-6	18.2	26.7	5.2	7.6
12.60	Hexanal	66-25-1	4.3	17.9	1.1	4.4
14.01	2-Methylbutanoic acid	116-53-0	6.1	12.9	1.5	3.1
15.29	Pentanoic acid	109-52-4	573.0	827.9	137.3	198.3
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	3.4	10.1	0.8	2.5
17.04	Hexanoic acid	142-62-1	3.8	11.3	0.8	2.4
17.77	Octanal	124-13-0	4.3	12.8	0.8	2.4
19.22	p/m/o-Cresol	1319-77-3	16.3	11.8	3.7	2.7
19.39	Heptanoic acid	111-14-8	372.0	566.9	69.9	106.5
20.75	3,5,5-Trimethylhexanoic acid	3302-10-1	113.5	282.0	17.5	43.6
21.18	Octanoic acid	124-07-2	14.1	33.8	2.4	5.7
22.56	Allyl isovalerate	2835-39-4	101.8	153.4	17.5	26.4
23.10	Nonanoic acid	112-05-0	109.9	277.8	17.0	43.0
24.78	Decanoic acid	334-48-5	2.3	17.1	0.3	2.4
26.08	Allyl heptanoate	142-19-8	41.4	71.0	5.9	10.2
27.08	Allyl octanoate	4230-97-1	20.4	47.0	2.7	6.2
29.26	Allyl nonanoate	7493-72-3	3.4	19.1	0.4	2.4

RT=Retention time; CAS#=Chemical Abstract Service registry number; -- =below the detection limits of the method used.
[1]Toluene-equivalent concentration

The tables show that the emissions contain a range of oxygenated compounds, with carboxylic acids being the most prominent contaminants. **Figure 3** groups the identified compounds by their chemical classes for easy comparison. The data reveals that carboxylic acid emissions increased when the bleed air temperature rose from 220°C to 315°C for both oils tested. In contrast, when no fluid was injected, the chemical emissions were minimal when the temperature increased from 220°C to 315°C (refer to baseline runs in **Appendix C** and **E**).

This increase in carboxylic acids with rising temperatures may have been influenced by two factors: more volatilization of the generated VOCs and greater thermal-oxidative decomposition of the fluids. However, due to insufficient control variables during the testing, it is difficult to determine which factors played a more significant role in this behavior. Therefore, further research and comprehensive testing are necessary to draw definitive conclusions.

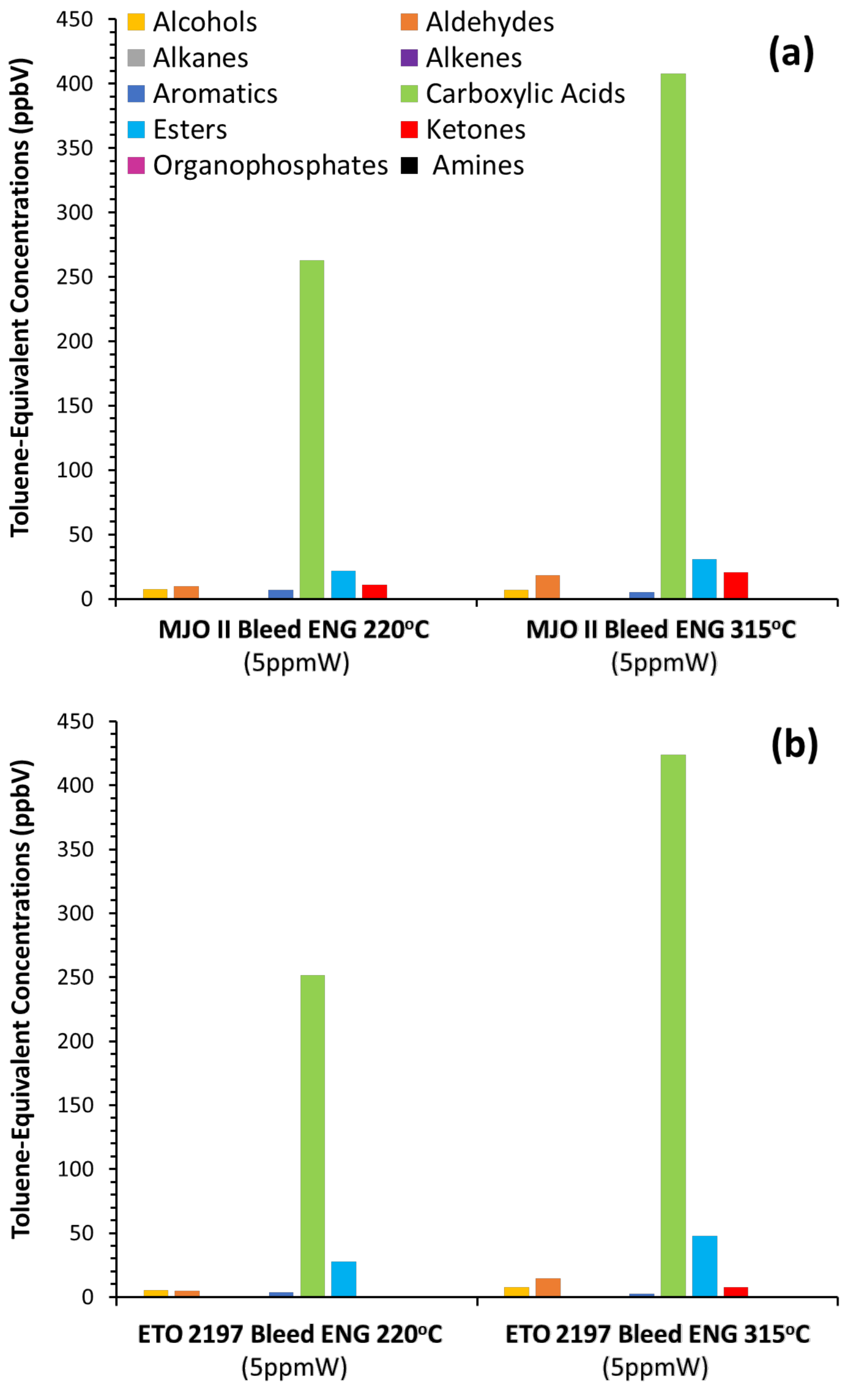


Figure 3: Major Classes of VOCs identified in the bleed samples for (a) MJO II, and (b) ETO 2197 injections via the propulsion engine system. Data are corrected results.

3.1.2. Effects of Injection Rates on Oil Contamination Emissions

The APU was utilized in these experiments to simulate low and high levels of oil leaks into the bleed system on ground settings. These leaks resulted in estimated oil concentrations of 5ppmW and 10ppmW, which were achieved by adjusting the injection rates of oil going through the APU compressor. The compounds identified at both evaluated oil concentrations are shown in **Table 8**, while **Figure 4** compares the identified compounds based on their chemical classes.

Table 8: VOC tentatively identified in the bleed samples as a result of the MJO II injection into the ECS via APU. Data are corrected results.

RT (min)	Compound Name	CAS #	Concentration[1]			
			µg/m³		ppbV	
			MJO II APU 180 °C 5ppmW	MJO II APU 180 °C 10ppmW	MJO II APU 180 °C 5ppmW	MJO II APU 180 °C 10ppmW
4.64	Acetone	67-64-1	6.9	4.8	2.9	2.0
6.18	Methacrolein	78-85-3	7.3	12.6	2.6	4.4
6.68	Butanal	123-72-8	18.2	13.6	6.2	4.6
6.83	2-Butanone	78-93-3	30.1	18.1	10.2	6.1
6.90	Acetic acid	64-19-7	62.3	42.6	25.4	17.3
9.65	Pentanal	110-62-3	25.3	28.4	7.2	8.1
12.16	Butanoic acid	107-92-6	--	10.9	4.1	3.0
12.35	2-Hexanone	591-78-6	7.6	8.7	1.9	2.1
12.51	Butynediol	110-65-6	44.9	105.6	12.8	30.0
12.63	Hexanal	66-25-1	44.4	59.3	10.9	14.5
14.43	2-Methylbutanoic acid	116-53-0	242.8	427.1	58.2	102.3
15.34	Heptanal	111-71-7	18.8	38.9	4.0	8.3
15.44	Pentanoic acid	109-52-4	569.1	1480.8	136.3	347.5
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	9.8	8.9	2.4	2.2
17.14	Hexanoic acid	142-62-1	71.2	98.9	15.0	20.8
17.79	Octanal	124-13-0	10.0	14.0	1.9	2.7
18.37	2-Methylhexanoic acid	4536-23-6	28.5	33.1	5.4	6.2
19.26	p/m/o-Cresol	1319-77-3	33.2	91.6	7.5	20.7
19.68	Heptanoic acid	111-14-8	855.2	2744.5	160.7	515.8
20.02	Nonanal	124-19-6	17.4	22.7	3.0	3.8
20.68	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	17.5	14.8	3.3	2.8
20.75	3,5,5-Trimethylhexanoic acid	3302-10-1	--	94.5	--	14.6
21.38	Octanoic acid	124-07-2	377.4	822.5	64.0	139.5
21.59	3,5-Dimethyl-4-heptanone	19549-84-9	58.4	189.1	10.0	32.5
22.52	Allyl isovalerate	2835-39-4	72.7	255.4	12.5	44.0
22.83	2(3H)-Furanone, 5-butyldihydro-	104-50-7	8.4	7.2	1.5	1.2
23.04	Nonanoic acid	112-05-0	6.4	50.9	1.0	7.9
24.83	Decanoic acid	334-48-5	168.8	241.4	24.0	34.3
26.09	Allyl heptanoate	142-19-8	74.9	343.8	10.8	49.4
27.74	Allyl octanoate	4230-97-1	43.1	82.9	5.7	11.0
30.74	Allyl decanoate	57856-81-2	37.2	22.2	4.3	2.6
36.22	N-phenyl-1-naphthalenamine	90-30-2	--	33.6	--	3.8

RT=Retention time; CAS#=Chemical Abstract Service registry number; -- =below the detection limits of the method used.
[1]Toluene-equivalent concentration

According to the data, many oxygenated compounds were also released in the bleed air when oils entered the ECS through the APU under these ground operating conditions. As shown in **Figure 4**, carboxylic acids were also the predominant VOCs in the events. Additionally, it was found that doubling the oil concentration in the bleed air from 5ppmW to 10ppmW resulted in a significant increase in carboxylic acid emissions. A more detailed discussion of this notable increase in emissions is provided in the following section.

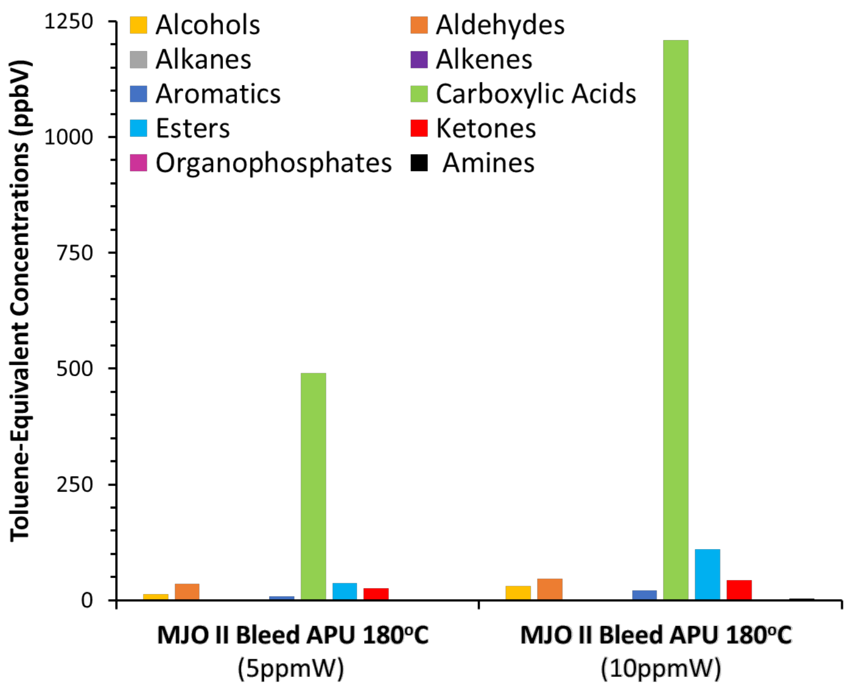


Figure 4: Major Classes of VOCs identified in the bleed samples for MJO II injections via the APU system. Data are corrected results.

3.1.3. Oil Contamination Emissions between APU and Propulsion Engine

A closer view of the contamination events between the APU and the propulsion engine shows that VOC emissions were considerably higher when oils entered the ECS via the APU. For instance, **Figure 4** indicates that carboxylic acid emissions obtained at the injection of 5ppmW were twice as high with the APU compared to the propulsion engine in **Figure 3**. This result was unexpected, considering the oils were exposed to more extreme conditions when the propulsion engine was used, as opposed to the APU. However, this difference in emissions could have been influenced by a combination of factors.

One plausible factor for the APU's higher emissions was that the bleed air coming from the APU did not pass through the engine pre-cooler, which could have been an additional source of VOC condensation. As shown in **Figure 1**, only the bleed air from the propulsion engine went through the engine pre-cooler before being directed to the rest of the ECS components. This difference could have explained why the emissions from the propulsion engine were lower even when the conditions were harsher.

Another variable that may have affected the emissions was possible inconsistencies in oil injection rates between the two engines. Due to varying pressure conditions and safety concerns, each engine used a different injection system and location to introduce the fluids into the ECS. For instance, the APU injections were conducted at the inlet of the compressor, while the propulsion engine injections were conducted downstream of the engine compressor bleed ports. It is possible that these differences could have caused discrepancies in the way the oil was delivered in the bleed air, resulting in unequal injection rates. However, no cross-validations were conducted between both systems to confirm that the intended concentrations were achieved in the bleed air for each event. As a result, it is difficult to determine which factors played a significant role in the contamination events between the two engine flow paths.

3.2. Hydraulic Fluid

The hydraulic fluid was tested last on day four to minimize fluid carryovers between the oil events in the ECS. For this event, the PE 5 fluid was introduced using only the APU at the lower estimated fluid concentration (5ppmW). The introduction of PE 5 resulted in a distinct chemical emission profile from the engine oils due to differences in the chemical nature of the fluids. The identified compounds during this contamination event are listed in **Table 9.** Additionally, **Figure 5** compares these compounds by their chemical classes.

Table 9: VOC tentatively identified in the bleed samples as a result of the PE 5 injection into the ECS via the APU. Data are corrected results.

RT (min)	Compound Name	CAS #	Concentration[1]	
			μg/m^3	ppbV
			PE 5 APU 180 °C	**PE 5** APU 180 °C
3.80	Isobutylene[2]	115-11-7	151.1	65.9
3.85	cis-2-Butene[2]	624-64-6	36.7	16.0
4.08	trans-2-Butene[2]	590-18-1	35.8	15.6
4.69	Acetone	67-64-1	3.2	1.3
6.19	Methacrolein	78-85-3	3.9	1.3
6.67	Butanal	123-72-8	40.3	13.7
6.78	Acetic acid	64-19-7	11.1	4.5
8.84	1-Butanol	71-36-3	104.7	34.5
17.10	Phenol	108-95-2	31.4	8.2
18.45	2-Ethylhexanol	104-76-7	40.8	7.7
27.01	2,6-Di-tert-butylbenzoquinone	719-22-2	30.4	3.4
27.25	Triisobutyl phosphate	126-71-6	637.1	58.5
27.63	Butylated Hydroxytoluene	128-37-0	56.7	6.3
28.09	Tributyl phosphate[3]	126-71-6	102.6	9.4
29.23	Tributyl phosphate[3]	126-73-8	2146.1	197.1
30.53	2-Ethylhexyl benzoate	5444-75-7	71.1	7.4
32.39	3-Cyclopentylpropionic acid, 2-ethylhexyl ester[4]	1000293-47-0	137.4	13.2
32.62	3-Cyclopentylpropionic acid, 2-ethylhexyl ester[4]	1000293-47-0	90.3	8.7

RT=Retention time; CAS#=Chemical Abstract Service registry number; -- =below the detection limits of the method used.
[1] Toluene-equivalent concentration
[2] Closely related butene compounds
[3] Closely related organophosphate compounds
[4] Closely related 7-oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester compound

The data indicates a greater release of semi-volatile organic compounds (SVOCs), with organophosphates being the chemical markers identified at higher levels. This result aligns with the main constituents of PE 5, which is a blend of organophosphorus compounds (refer to **Appendix G**).

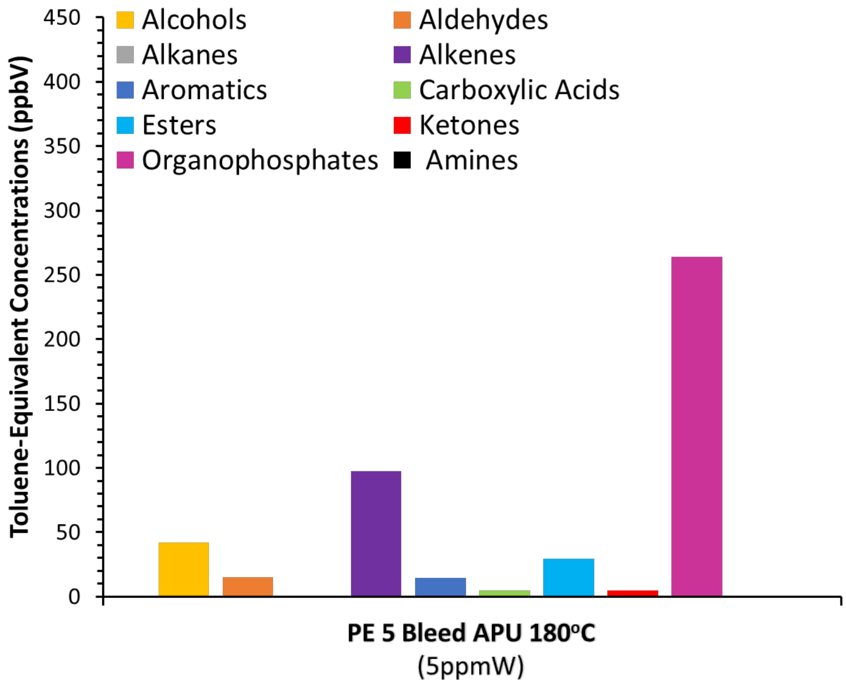


Figure 5: Major Classes of VOCs identified in the bleed samples for PE 5 injection via the APU system. Data are corrected results.

Although pure organophosphate constituents contained in PE 5 were identified in more significant amounts, a few degradation products were also found during the injection event, which increased the alkene and alcohol classes. For instance, an increase of C_4 hydrocarbons was observed, specifically in butene isomers, most likely related to the tributyl phosphate and triisobutyl phosphate breakdown. Based on both emission trends, this finding suggests that the hydraulic fluid underwent some degradation under the exposed conditions. This mild degradation can be attributed to the high thermal-oxidative stability of organophosphates and the lower operating conditions of the APU.

4. CONCLUSION

The chemical analysis was intended to characterize the composition of emissions from contamination events and identify possible chemical markers that could be correlated with specific in-flight failure events. From the data, it was demonstrated that volatilized fluid and associated degradation products were released into the bleed air when fluids entered the aircraft's ECS, regardless of whether the fluid leak occurred in the propulsion engine or the APU. It was also found that the VOC emission profiles varied depending on the fluid category involved in the contamination event. Carboxylic acid emissions increased during the engine oil events, while organophosphate and alkene emissions increased during the hydraulic fluid event. The VOC emissions also increased as the bleed air temperature and oil leak rate increased in the ECS. However, due to the lack of enough control variables and validations between the systems during the testing, it was challenging to compare the engine flow paths or determine how each ECS component and condition affected the VOC emissions.

Overall, this chemical analysis seems a promising method for identifying the type of fluid that has leaked in the bleed air when it comes to turbine engine oils or hydraulic fluids. The chromatogram profiles of the fluids demonstrated distinct differences, which can be used as indicators of system failures. However, it should be noted that this air analysis does not achieve the goal of the FAA/CAMI, which is to provide real-time readings of the contaminants in the bleed air. This limitation hinders the method’s effectiveness as an early warning system during flight.

Additionally, it is important to note that although VOCs were identified during these contamination events, the identifications and quantifications are tentative. The absence of a particular chemical in the data should not be taken as proof that the chemical was not present in the bleed air. These findings should be treated with caution and not considered absolute.

5. RECOMMENDATIONS

Based on the findings, the following recommendations are suggested to improve the understanding of these bleed air contamination events:

5.1. Testing Recommendations

- Conduct regular verifications between the fluid injection systems to ensure accurate and consistent fluid delivery and concentrations in the bleed air during testing.
- Conduct regular sampling and monitoring equipment validations (calibration, zeroing, and cross-sensitivity checks) to ensure they perform accurately between events.
- Increase the number of control samples collected for each run to establish multiple points of comparison for the variables being tested. These controls will help identify any experimental deviations and make corrections for any possible source of error in the interpretation of the bleed air contamination events.
- Collect more bleed air samples in multiple locations in the ECS for each event to understand and improve the tracking of VOCs in the bleed air.
- Conduct multiple replicates of fluid injection to increase confidence in the integrity of the VOC emissions generated by the ECS. A standard minimum of two replicates is recommended.

- Evaluate the impact of individual ECS components with chemical markers of interest in more controlled environments to better understand their contribution to the overall contamination events.
    - For instance, the ozone converter is a critical component in the ECS that could have significantly affected the observed emissions due to the considerable amount of degradation products identified. In these tests, the converter used had a dual capacity to remove ozone and VOCs. These units are typically designed for "normal" operating conditions, which involve low levels of VOCs and humidity in the presence of ozone at high altitudes. However, the conditions evaluated in these experiments were not "normal" as they simulated a system failure condition on ground settings. As a result, levels of VOCs (mostly long-chain hydrocarbons) and humidity were higher in the presence of low ozone levels. Therefore, further studies on failure scenarios could provide more insight into bleed air emissions. More specifically, how these differences in the bleed air passing through the converter could affect the catalytic performance of these units and, consequently, the negative impact on the bleed air in the case of a contamination incident.

5.2. Chemical Analysis Recommendations

- Improve identification accuracy and quantification for compounds of interest by running specific standards.

6. ACRONYMS AND ABBREVIATIONS

Acronyms/Abbreviations	Definition
μ	Viscosity
$\mu g/m^3$	Micrograms per Cubic Meter
amu	Atomic Mass Unit
APU	Auxiliary Power Unit
a.u.	Arbitrary Unit
CAS#	Chemical Abstract Service Registry Number
CRS	Certified Reference Standards
cST	Centistoke
CTRL	Controls
ENG	Propulsion Engine
EPA	Environmental Protection Agency
ETO 2197	Eastman Turbo Oil 2197
FAA/CAMI	Federal Aviation Administration’s Civil Aerospace Medical Institute
GCMS	Gas Chromatography-Mass Spectrometry
HCD	Hydrocarbon Detector
IPA	Isopropyl Alcohol
MJO II	Turbine engine oil - Mobil Jet Oil II
NAS	Naval Air Station
NAWCAD	Naval Air Warfare Center Aircraft Division
NGML	National Gas Machinery Laboratory
PE 5	Hydraulic fluid - Skydrol PE-5
PID	Photoionization Detector
ppbV	Parts per Billion by Volume
PSI	Pounds per Square Inch
ppmW	Parts per Million by Weight
RT	Retention Time
SDS	Safety Data Sheet
SVOC	Semi-Volatile Organic Compound
T_{Bleed}	Bleed Air Temperature
TIC	Total Ion Chromatograms
TO-17	Toxic Organic Compendium of Methods - 17 Determination of Volatile Organic Compounds in Ambient Air using Active Sampling onto Sorbent Tubes
VOC	Volatile Organic Compound

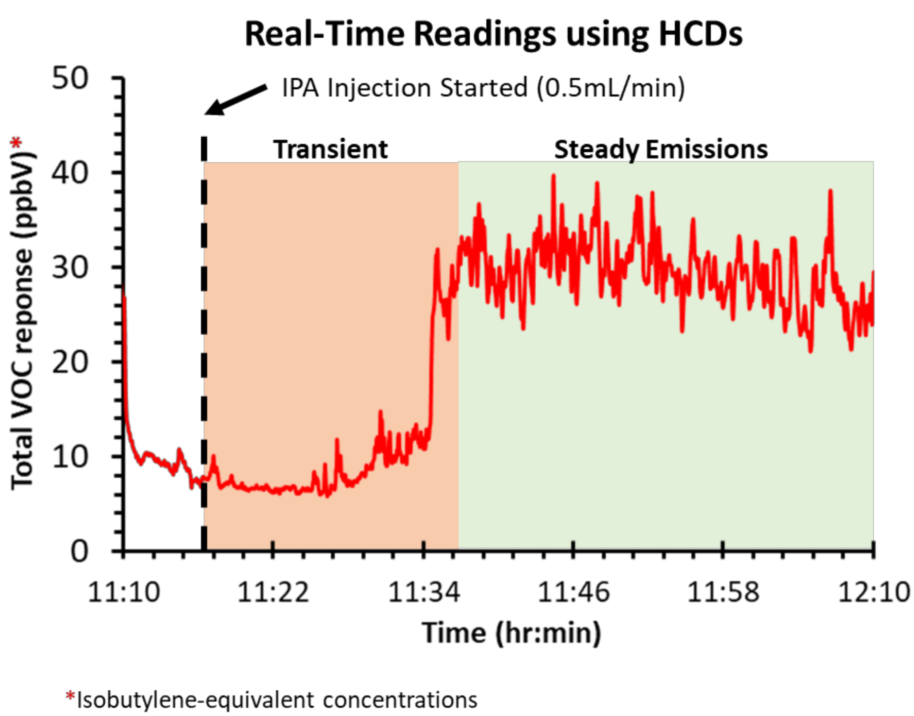
Appendix A: Isopropyl Alcohol (IPA) Aircraft Pre-Runs

Isopropyl Alcohol (IPA) Aircraft Pre-Runs

In April 2023, control runs were conducted to evaluate aircraft before the actual testing. These tests involved injecting a standard marker into the system using the APU. Isopropyl alcohol (IPA) was chosen as the standard marker because it gives good signal responses on the HCDs and does not introduce extra potential contaminants into the aircraft's system.

The primary purpose of this evaluation was to track and time the movement of IPA through the ECS flow path. Apart from the main objective, these pre-runs were also conducted to:

- Test sampling methods and one of two system flow paths.
- Check the APU injection system.
- Estimate the time it takes for the system to produce steady marker emissions.
- Avoid any underestimations of the chemical emissions.



The attached slides summarize the results obtained from the IPA pre-runs that were presented to FAA/CAMI on May 3rd, 2023.

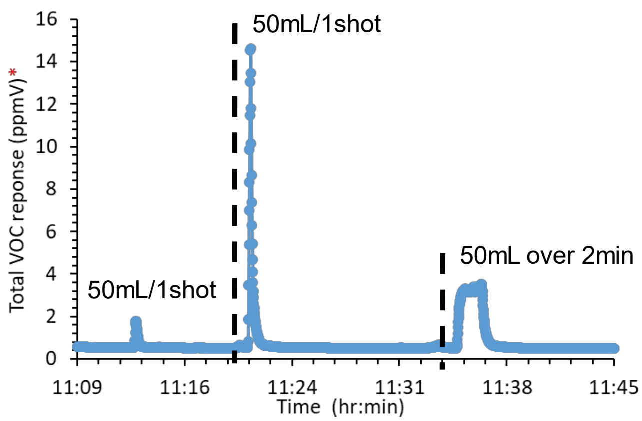
Hydro-Carbon Detector (HCD) Results

(April 19, 2023 - Morning)

IPA runs - HCDs

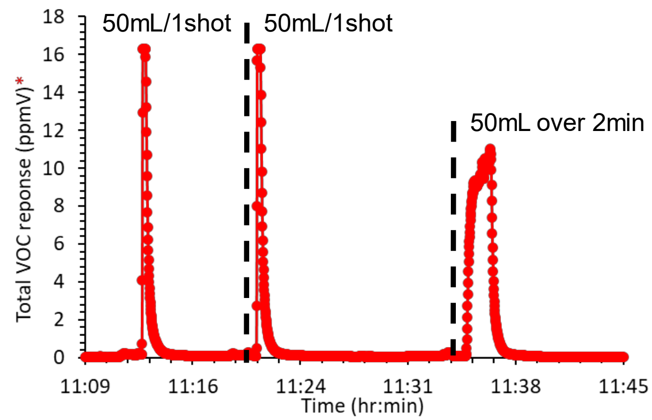
Sequence of experiments (Morning):
1st injection – 50mL/1shot
2nd injection –50mL/1shot
3rd injection – 50mL over 2 min

Pre-O_3 location



*Isobutylene equivalent concentrations

Post-Pack location



*Isobutylene equivalent concentrations

- Sensors responded after approximately 30sec of injection.
- Sensor at the Pre-O_3 location is not performing as consistently as the Post-Pack.
- Variability in air stream temperatures could be affecting the sensor readings.

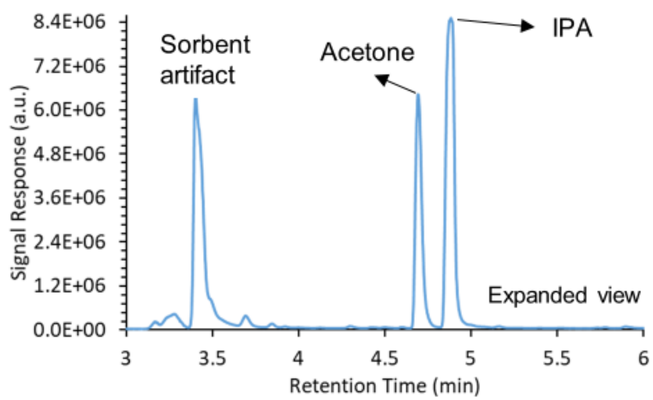
Chemical Analysis Results (Sorbent Tubes)

(April 19, 2023 - Morning)

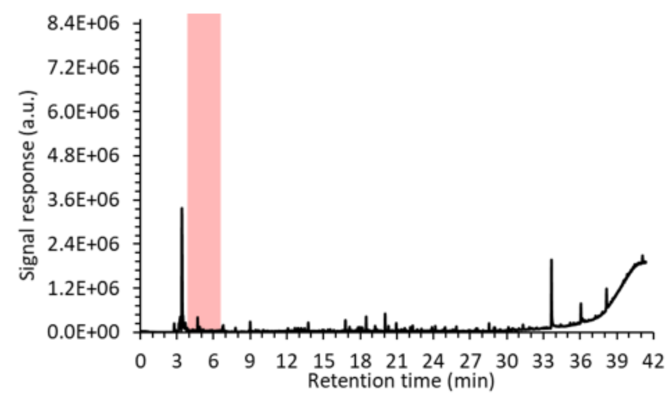
IPA runs - Sorbent tubes

Sorbent tube at the Pre-O_3 location

(50mL/1shot; sampling time:10min)



Field Sample



	RT (min)	Compound	Field SPLE ppbV*	Shipping BLK ppbV*	Pre-O_3 ppbV*
Injection 50mL/1shot	4.69	Acetone	1.5	1.9	83.0
	4.87	IPA	0.5	nd	144.8
Injection 50mL over 2 min	4.69	Acetone	1.5	1.9	99.1
	4.87	IPA	1.5	nd	167.5

*Toluene equivalent concentrations; nd=not detected

- Only acetone and IPA compounds were detected at significant concentrations as a result of the injection.
- Acetone is probably showing up as a result of IPA oxidation.

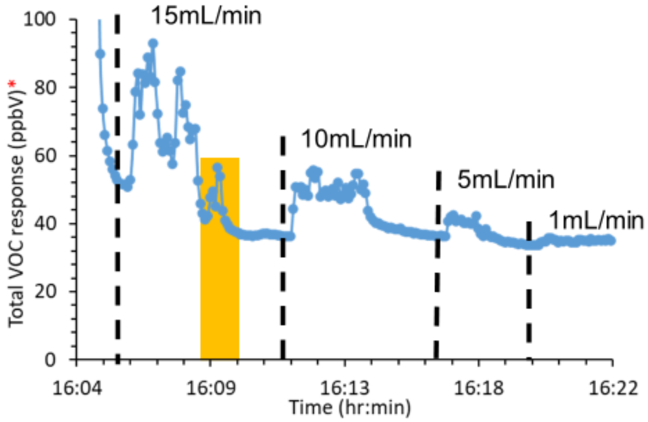
Hydro-Carbon Detector (HCD) Results

(April 19, 2023 - Afternoon)

IPA runs – HCDs

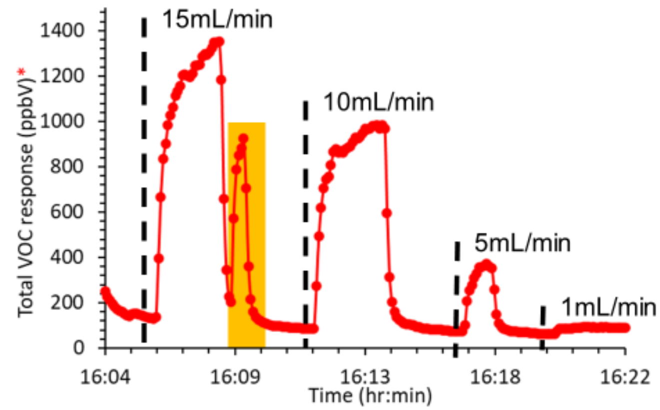
Sequence of experiments (Afternoon):
1st injection – 15mL/min
2nd injection – 10mL/min
3rd injection – 5mL/min
4th injection – 1mL/min

Pre-O_3 location



*Isobutylene equivalent concentrations

Post-Pack location



*Isobutylene equivalent concentrations

- Sensors responded after approximately 30sec of injection.
- Post-Pack results are approximately an order of magnitude larger than the Pre-O_3.
- Measurement conditions are different between both locations (temperature and pressure).

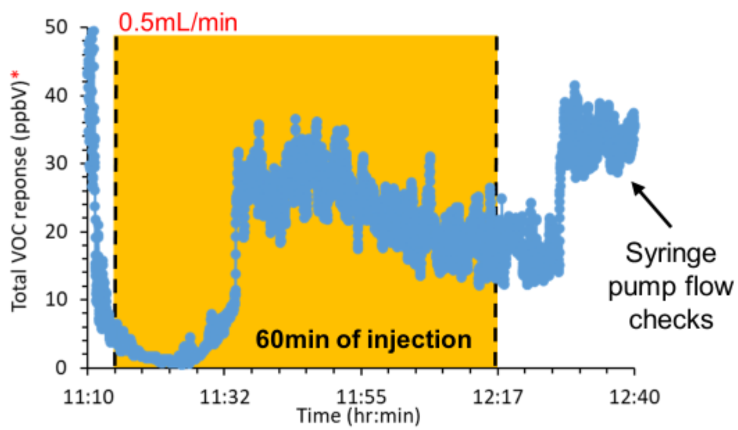
Hydro-Carbon Detector (HCD) Results

(April 20, 2023)

IPA runs - HCDs

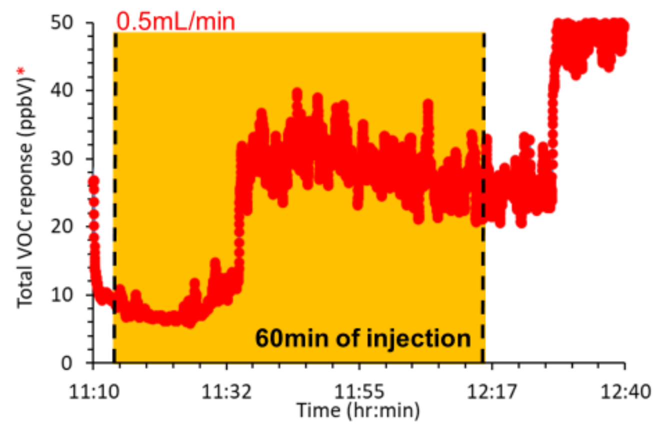
Sequence of experiments:
1st injection: 0.5mL/min over 60 min
2nd injection: Syringe pump flow checks

Pre-O_3 location



*Isobutylene equivalent concentrations

Post-Pack location



*Isobutylene equivalent concentrations

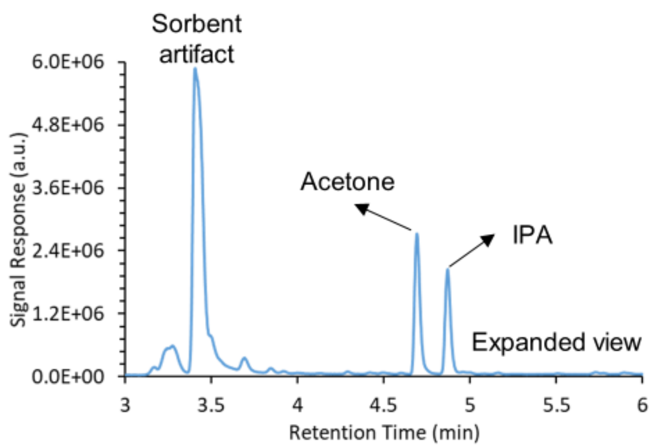
- Sensors responded after approximately 10min of injection.
- Steady VOC emission readings were observed after approximately 20min of injection.
- Syringe pump does not seem to maintain a constant injection rate (i.e., 0.2mL/min versus 0.5mL/min).

Chemical Analysis Results (Sorbent Tubes)

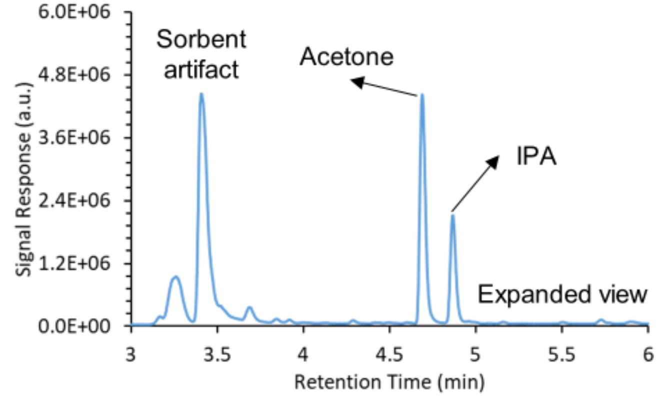
(April 20, 2023)

IPA runs – Sorbent Tubes

Pre-O_3 location
(0.5mL/min; sampling time:60min)



Post-Pack location
(0.5mL/min; sampling time:60min)



			Field SPLE	Shipping BLK	Pre-O3			Post-Pack		
					15 min	45 min	60 min	15 min	45 min	60 min
	RT (min)	Compound	ppbV*	ppbV*	ppbV*	ppbV*	ppbV*	ppbV*	ppbV*	ppbV*
Injection (0.5mL/min)	4.69	Acetone	0.8	0.9	3.7	7.7	7.4	3.7	12.6	11.4
	4.87	IPA	0.3	nd	nd	5.3	9.4	0.6	5.4	7.1

*Toluene equivalent concentrations ; nd=not detected

- Higher concentrations of the compounds are observed in the air stream at the Post-Pack location.
  - Possible explanations for this behavior could be due to higher conditions at the Pre-O_3 location, dilution of compounds due to the distribution box, or oxidation reactions.

Main Observations

- HCDs responded after 30 sec of injection at high injection rates.
- HCDs responded after 10 min of injection at low injection rates.
- Steady VOC emission readings were observed after approximately 20 min of injection (i.e., low injection rates).
- Variability in air stream conditions negatively impacts the sensor readings, and VOC captures.
- The syringe pump for the APU system does not seem to maintain a constant injection rate at low injection rates (at least for IPA injections).

Appendix B: Hydrocarbon Detector (HCD) Readings

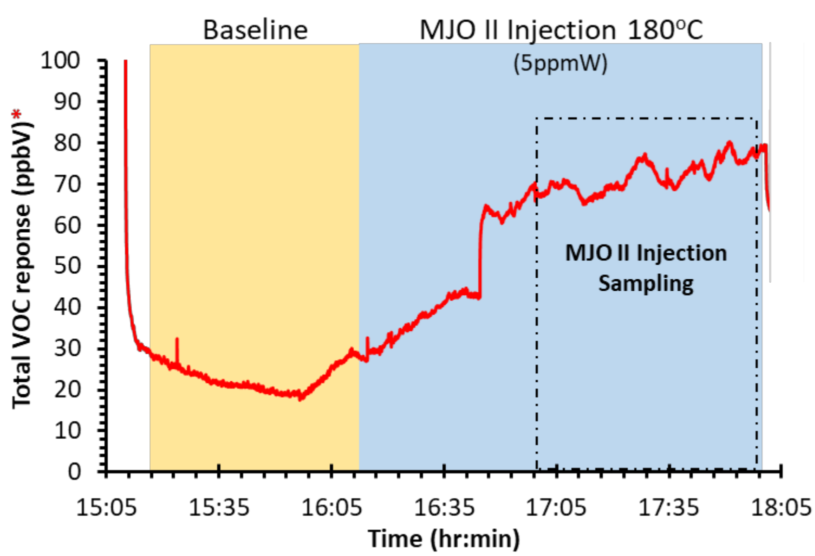
Hydrocarbon Detector (HCD) Readings

HCDs were used to monitor the bleed air downstream of the ECS during the contamination events. However, these readings were only used as qualitative measurements to determine when the system reached equilibrium before collecting samples. This was due to certain limitations in the HCDs. For instance, they only measure total hydrocarbon concentration and do not identify actual VOCs, meaning they cannot differentiate between different compounds. In addition, the HCD response is highly sensitive to pressure changes and the presence of other chemicals in the analyzed airstream. This behavior is attributed to the fact that different compounds have various sensitivities to the PID sensor. As a result, the total response of the sensor is less accurate when analyzing an environment with mixtures of compounds, specifically of unknown chemical composition. Therefore, it is critical to zero-check, calibrate, and warm up the sensors before each test to obtain more meaningful measurements. It is also essential to verify the HCD by running standards through the system to be tested (in this case, the aircraft) at intended conditions to understand better how the system can affect the HCD response.

It should be noted that several HCD units were used to monitor the bleed air across different concentration regions. During the contamination events, certain sensors exhibited reduced sensitivity and greater signal drift as the event progressed. These changes were probably due to contamination of the sensors' lamp window and variations in pressure and humidity. This contamination was likely caused by the heavy compounds and particles generated in the bleed air. Therefore, clean units were utilized on each test day, and regular calibrations were conducted.

The following data shows the readings from the units that performed better during the contamination events. Isobutylene was used as the calibration gas, and therefore, total VOC concentrations are based on isobutylene equivalents. The data was adjusted to account for the signal drift and better visualize the transient event. As a result, it should be interpreted cautiously, as the data is only an approximation.

Day 1 - Afternoon: MJO II Contamination Event using APU at 180oC



Test Sequence:

14:00 APU & Pack On w/ conditions set

14:40 System Stabilization

15:14 Baseline Sampling Started

16:14 Baseline Sampling Stopped
MJO II Injection Started
System Stabilization

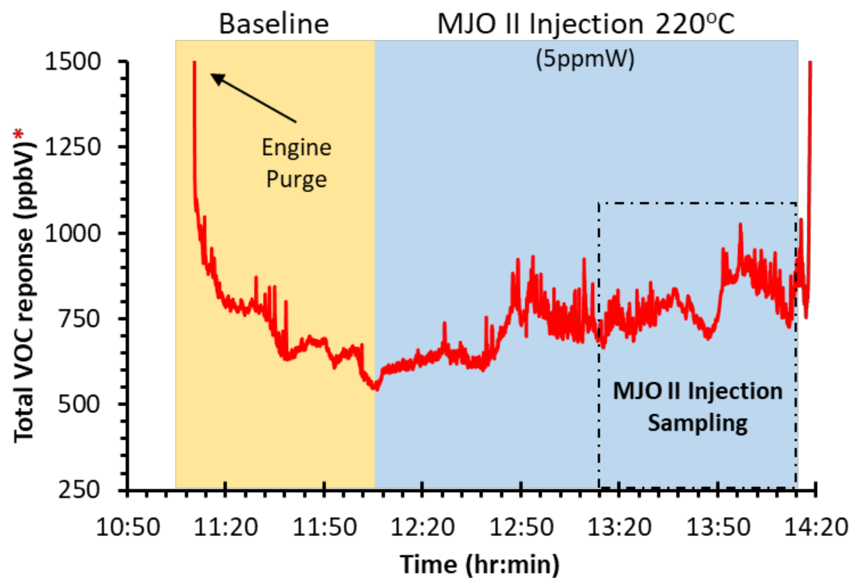
17:00 Injection Sampling Started

18:00 Injection Sampling Stopped

18:34 APU & Pack Off

*Isobutylene-equivalent concentrations.

Day 2 -Morning: MJO II Contamination Event using ENG at 220°C



Test Sequence:

09:50 APU, ENG & Pack On

10:12 System Purged @ 315°C

10:50 Conditions Set @ 220°C
System Stabilization

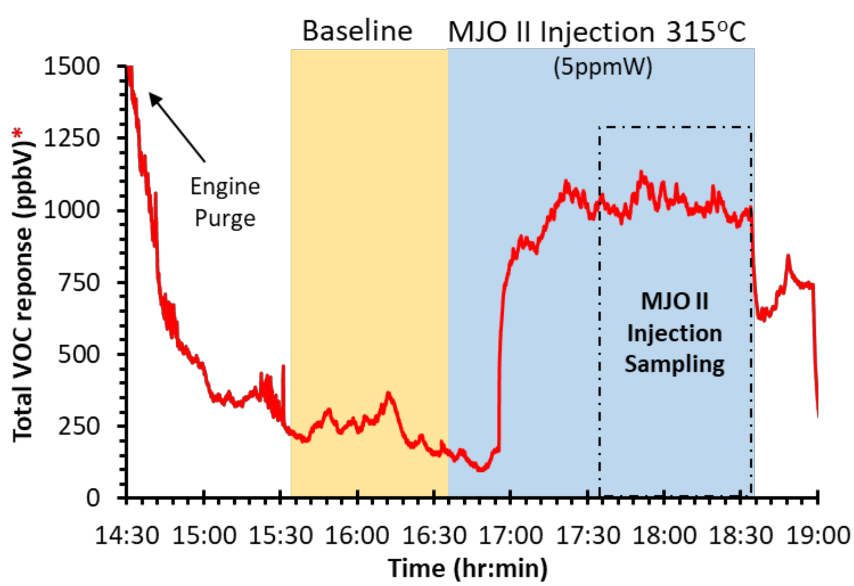
11:01 Baseline Sampling Started

12:05 Baseline Sampling Stopped
MJO II Injection Started
System Stabilization

13:15 Injection Sampling Started

14:15 Injection Sampling Stopped

Day 2 -Afternoon: MJO II Contamination Event using ENG at 315°C



Test Sequence:

14:15 System Purged @ 315°C

15:00 Conditions Set @ 315°C
System Stabilization

15:35 Baseline Sampling Started

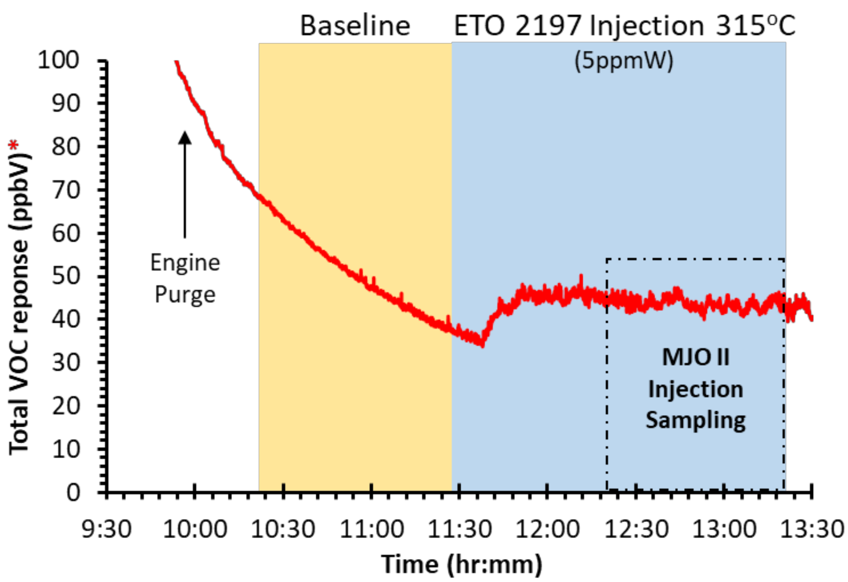
16:35 Baseline Sampling Stopped
MJO II Injection Started
System Stabilization

17:35 Injection Sampling Started

18:35 Injection Sampling Stopped

19:00 ENG, APU & Pack Off

Day 3 -Morning: ETO 2197 Contamination Event using ENG at 315°C



Test Sequence:

09:17 APU, ENG & Pack On

09:30 System Purged @ 315°C

10:00 Conditions Set @ 315°C
System Stabilization

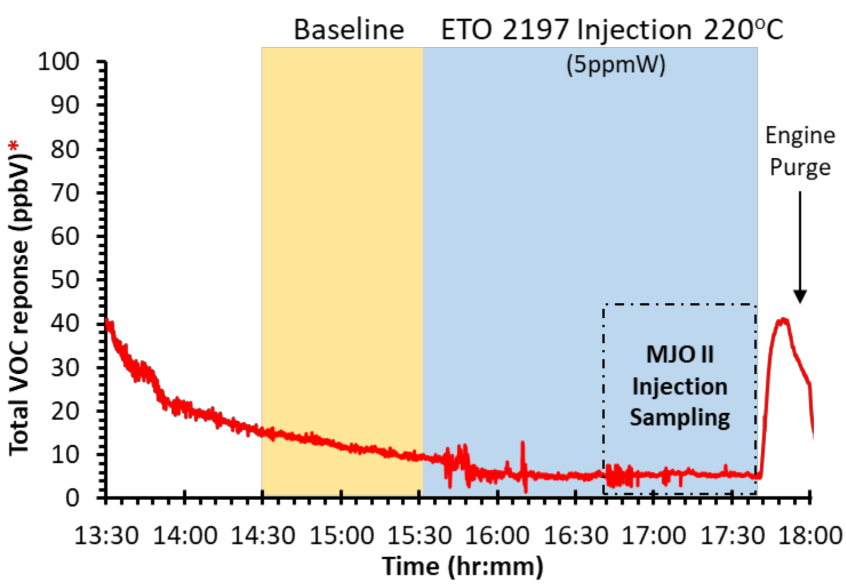
10:28 Baseline Sampling Started

11:28 Baseline Sampling Stopped
ETO 2197 Injection Started
System Stabilization

12:20 Injection Sampling Started

13:20 Injection Sampling Stopped

Day 3 -Afternoon: ETO 2197 Contamination Event using ENG at 220°C



Test Sequence:

13:20 System Purged @ 315°C

13:50 Conditions Set @ 220°C
System Stabilization

14:30 Baseline Sampling Started

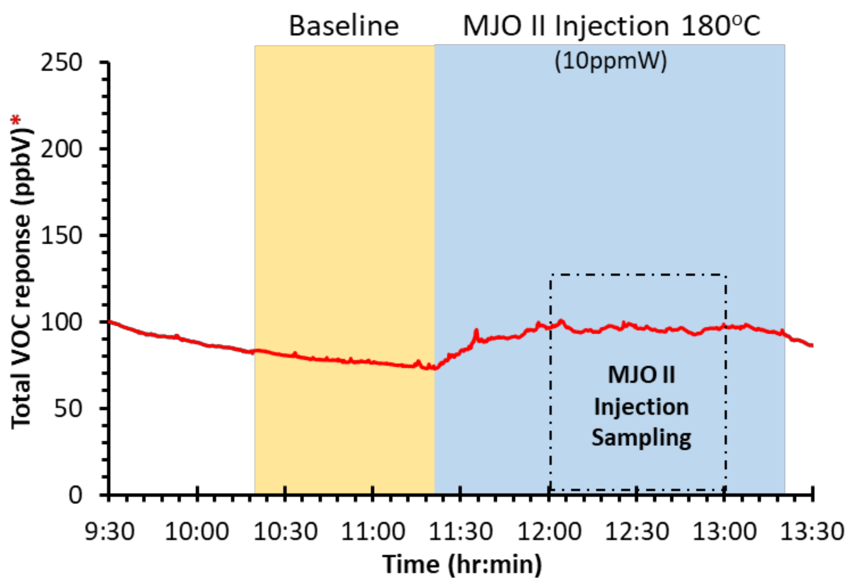
15:30 Baseline Sampling Stopped
ETO 2197 Injection Started
System Stabilization

16:40 Injection Sampling Started

17:40 Injection Sampling Stopped
System Purged @ 315°C

18:08 ENG, APU & Pack Off

Day 4 -Morning: MJO II Contamination Event using APU at 180°C



Test Sequence:

08:55 APU & Pack On w/ conditions set

10:00 System Stabilization

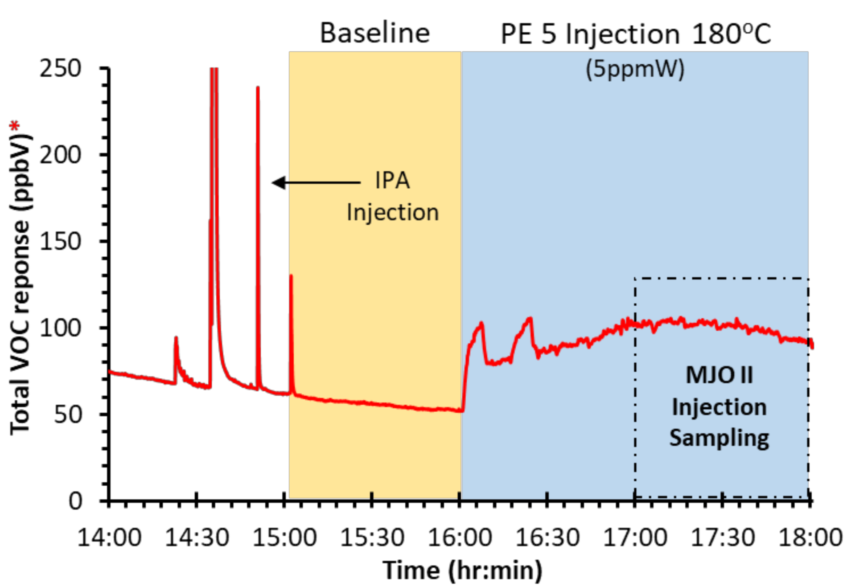
10:20 Baseline Sampling Started

11:20 Baseline Sampling Stopped
MJO II Injection Started
System Stabilization

12:00 Injection Sampling Started

13:00 Injection Sampling Stopped

Day 4 -Afternoon: PE 5 Contamination Event using APU at 180°C



Test Sequence:

13:00 ENG Failed
(system not purged)

14:30 IPA Injection
(to help purge the system)

14:40 System Stabilization

15:00 Baseline Sampling Started

16:00 Baseline Sampling Stopped
PE 5 Injection Started
System Stabilization

17:00 Injection Sampling Started

18:00 Injection Sampling Stopped

18:04 APU & Pack Off

Appendix C: VOC Results for all Samples before Corrections

Day 1- Afternoon: MJO II Contamination Event using APU at 180°C (Concentration results in units of parts per billion volume, ppbV)

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline APU 180°C			MJO II APU 180°C; 5ppmW		
			Shipping Blank 1[2]	Field Blank 1[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	3.91	--	--	--	--	--	--
4.69	Acetone	67-64-1	1.63	1.42	1.82	0.62	1.11	0.97	0.93	--	5.01
6.24	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	2.55
6.72	Butanal	123-72-8	--	--	--	--	--	--	--	--	6.19
6.83	2-Butanone	78-93-3	--	--	--	--	--	--	--	--	10.22
7.42	Acetic acid	64-19-7	2.61	2.96	--	0.52	1.14	0.56	0.59	--	26.73
7.88	Tetrahydrofuran	109-99-9	--	--	1.22	--	--	--	--	--	--
8.97	Benzene	71-43-2	1.03	1.06	0.55	0.37	0.74	2.02	0.40	0.77	--
9.65	Pentanal	110-62-3	--	--	--	--	--	--	--	--	7.18
12.06	Toluene	108-88-3	--	--	--	--	--	0.59	--	--	--
12.35	2-Hexanone	591-78-6	--	--	--	--	--	--	--	--	1.86
12.58	Butynediol	110-65-6	--	--	--	--	--	--	--	--	12.76
12.63	Hexanal	66-25-1	--	--	--	--	--	--	--	--	10.86
14.84	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	--	--	--	58.17
15.05	Cyclohexanone	108-94-1	--	--	0.61	--	--	--	--	--	--
15.34	Heptanal	111-71-7	--	--	--	--	--	--	--	--	4.04
15.81	Nonane	111-84-2	--	--	--	--	--	0.53	--	--	--
15.90	Pentanoic acid	109-52-4	--	--	--	--	--	--	0.46	0.73	136.56
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	--	--	--	2.39
16.76	Benzaldehyde	100-52-7	0.63	0.71	0.42	0.55	0.76	0.42	0.68	0.55	--
17.10	Phenol	108-95-2	--	0.50	--	0.30	--	--	0.43	--	--
17.37	Hexanoic acid	142-62-1	--	--	--	--	--	--	--	--	15.01
17.79	Octanal	124-13-0	--	--	--	--	--	--	--	--	1.91
18.15	Decane	124-18-5	--	--	--	0.14	1.04	0.86	0.22	0.60	--
18.45	2-Ethylhexanol	104-76-7	0.45	--	--	--	--	--	--	--	--
18.51	2-Methylhexanoic acid	4536-23-6	--	--	--	--	--	--	--	--	5.35
19.19	Acetophenone	98-86-2	--	--	--	0.42	0.58	--	0.51	0.45	--
19.22	p/m/o-Cresol	1319-77-3	--	--	--	--	--	--	--	--	7.50
19.90	Heptanoic acid	111-14-8	--	--	--	--	--	--	0.87	1.09	161.16
20.02	Nonanal	124-19-6	0.30	0.39	0.34	0.21	0.47	--	0.40	--	3.31

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline APU 180°C			MJO II APU 180°C; 5ppmW		
			Shipping Blank 1[2]	Field Blank 1[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
20.29	Undecane	1120-21-4	--	--	--	0.18	0.65	0.74	0.31	0.57	1.21
20.73	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	--	--	--	3.33
21.01	Benzoic acid	65-85-0	1.04	--	--	1.19	1.32	--	1.52	0.81	--
21.61	Octanoic acid	124-07-2	--	--	--	--	--	--	0.34	--	64.20
21.63	3,5-Dimethyl-4-heptanone	19549-84-9	--	--	--	--	--	--	--	--	10.04
22.07	Decanal	112-31-2	--	0.30	--	0.19	--	--	0.43	--	--
22.27	Dodecane	112-40-3	--	--	0.28	0.17	0.35	0.45	0.31	0.35	--
22.56	Allyl isovalerate	2835-39-4	--	--	--	--	--	--	--	--	12.51
22.83	2(3H)-Furanone, 5-butyldihydro-	104-50-7	--	--	--	--	--	--	--	--	1.45
23.10	Nonanoic acid	112-05-0	--	--	--	--	--	--	--	--	0.98
24.12	Tridecane	629-50-5	--	--	0.25	0.16	--	0.27	0.30	--	--
24.89	1,3-Diisocyanato-2-methylbenzene	91-08-7	3.53	--	--	--	--	--	--	--	--
24.93	2,4-Diisocyanato-1-methylbenzene	584-84-9	7.65	--	--	--	--	--	--	--	--
24.96	Decanoic acid	334-48-5	--	--	--	--	--	--	0.26	--	24.10
25.85	Tetradecane	629-59-4	--	--	--	0.16	--	0.18	0.29	--	--
26.12	Allyl heptanoate	142-19-8	--	--	--	--	--	--	--	--	10.76
27.74	Allyl octanoate	4230-97-1	--	--	--	--	--	--	--	--	5.73
28.52	Diethyl Phthalate	84-66-2	--	--	--	--	--	0.94	--	--	--
30.74	Allyl decanoate	57856-81-2	--	--	--	--	--	--	--	--	4.28
31.30	n-Butylbenzenesulfonamide	3622-84-2	0.26	--	--	--	0.30	--	--	--	--
33.62	Hexadecanoic acid	57-10-3	1.74	2.86	0.43	1.87	0.36	1.08	2.35	--	1.43
36.03	Octadecanoic acid	57-11-4	--	0.92	--	0.58	--	0.33	0.98	--	--

-- = below the detection limits of the method used.

[1]Toluene-equivalent concentrations.

[2]A volume of 1L was used for blanks to facilitate the VOC quantification.

Day 1- Afternoon: MJO II Contamination Event using APU at 180°C (Concentration results in units of micrograms per cubic meter, µg/m³)

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m³)[1]								
			Controls			Baseline APU 180°C			MJO II APU 180°C; 5ppmW		
			Shipping Blank 1[2]	Field Blank 1[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	9.29	--	--	--	--	--	--
4.69	Acetone	67-64-1	3.87	3.37	4.32	1.48	2.64	2.30	2.20	--	11.89
6.24	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	7.31
6.72	Butanal	123-72-8	--	--	--	--	--	--	--	--	18.24
6.83	2-Butanone	78-93-3	--	--	--	--	--	--	--	--	30.11
7.42	Acetic acid	64-19-7	6.40	7.25	--	1.28	2.80	1.38	1.45	--	65.62
7.88	Tetrahydrofuran	109-99-9	--	--	3.60	--	--	--	--	--	--
8.97	Benzene	71-43-2	3.30	3.39	1.76	1.17	2.37	6.45	1.29	2.46	--
9.65	Pentanal	110-62-3	--	--	--	--	--	--	--	--	25.29
12.06	Toluene	108-88-3	--	--	--	--	--	2.23	--	--	--
12.35	2-Hexanone	591-78-6	--	--	--	--	--	--	--	--	7.63
12.58	Butynediol	110-65-6	--	--	--	--	--	--	--	--	44.91
12.63	Hexanal	66-25-1	--	--	--	--	--	--	--	--	44.45
14.84	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	--	--	--	242.83
15.05	Cyclohexanone	108-94-1	--	--	2.43	--	--	--	--	--	--
15.34	Heptanal	111-71-7	--	--	--	--	--	--	--	--	18.84
15.81	Nonane	111-84-2	--	--	--	--	--	2.79	--	--	--
15.90	Pentanoic acid	109-52-4	--	--	--	--	--	--	1.90	3.04	570.09
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	--	--	--	9.78
16.76	Benzaldehyde	100-52-7	2.74	3.09	1.80	2.40	3.30	1.80	2.96	2.38	--
17.10	Phenol	108-95-2	--	1.91	--	1.14	--	--	1.65	--	--
17.37	Hexanoic acid	142-62-1	--	--	--	--	--	--	--	--	71.25
17.79	Octanal	124-13-0	--	--	--	--	--	--	--	--	10.01
18.15	Decane	124-18-5	--	--	--	0.80	6.05	5.00	1.28	3.47	--
18.45	2-Ethylhexanol	104-76-7	2.40	--	--	--	--	--	--	--	--
18.51	2-Methylhexanoic acid	4536-23-6	--	--	--	--	--	--	--	--	28.49
19.19	Acetophenone	98-86-2	--	--	--	2.08	2.87	--	2.53	2.23	--
19.22	p/m/o-Cresol	1319-77-3	--	--	--	--	--	--	--	--	33.16
19.90	Heptanoic acid	111-14-8	--	--	--	--	--	--	4.65	5.78	857.52
20.02	Nonanal	124-19-6	1.75	2.25	1.95	1.24	2.74	--	2.31	--	19.22

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m³)[1]								
			Controls			Baseline APU 180°C			MJO II APU 180°C; 5ppmW		
			Shipping Blank 1[2]	Field Blank 1[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
20.29	Undecane	1120-21-4	--	--	--	1.12	4.13	4.73	1.96	3.62	7.74
20.73	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	--	--	--	17.46
21.01	Benzoic acid	65-85-0	5.18	--	--	5.95	6.58	--	7.58	4.02	--
21.61	Octanoic acid	124-07-2	--	--	--	--	--	--	2.00	--	378.39
21.63	3,5-Dimethyl-4-heptanone	19549-84-9	--	--	--	--	--	--	--	--	58.38
22.07	Decanal	112-31-2	--	1.91	--	1.20	--	--	2.77	--	--
22.27	Dodecane	112-40-3	--	--	1.94	1.17	2.47	3.13	2.15	2.46	--
22.56	Allyl isovalerate	2835-39-4	--	--	--	--	--	--	--	--	72.73
22.83	2(3H)-Furanone, 5-butyldihydro-	104-50-7	--	--	--	--	--	--	--	--	8.45
23.10	Nonanoic acid	112-05-0	--	--	--	--	--	--	--	--	6.36
24.12	Tridecane	629-50-5	--	--	1.87	1.22	--	2.04	2.29	--	--
24.89	1,3-Diisocyanato-2-methylbenzene	91-08-7	25.16	--	--	--	--	--	--	--	--
24.93	2,4-Diisocyanato-1-methylbenzene	584-84-9	54.47	--	--	--	--	--	--	--	--
24.96	Decanoic acid	334-48-5	--	--	--	--	--	--	1.85	--	169.7
25.85	Tetradecane	629-59-4	--	--	--	1.33	--	1.45	2.32	--	--
26.12	Allyl heptanoate	142-19-8	--	--	--	--	--	--	--	--	74.88
27.74	Allyl octanoate	4230-97-1	--	--	--	--	--	--	--	--	43.12
28.52	Diethyl Phthalate	84-66-2	--	--	--	--	--	8.55	--	--	--
30.74	Allyl decanoate	57856-81-2	--	--	--	--	--	--	--	--	37.18
31.30	n-Butylbenzenesulfonamide	3622-84-2	2.23	--	--	--	2.65	--	--	--	--
33.62	Hexadecanoic acid	57-10-3	18.26	29.93	4.54	19.61	3.80	11.29	24.65	--	14.98
36.03	Octadecanoic acid	57-11-4	--	10.65	--	6.70	--	3.81	11.42	--	--

-- = below the detection limits of the method used.
[1]Toluene-equivalent concentrations.
[2]A volume of 1L was used for blanks to facilitate the VOC quantification.

Day 2- Morning: MJO II Contamination Event using ENG at 220°C (Concentration results in units of parts per billion volume, ppbV)

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline ENG 220°C			MJO II ENG 220°C; 5ppmW		
			Shipping Blank 2[2]	Field Blank 2[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	3.91	--	--	--	--	--	--
4.69	Acetone	67-64-1	1.34	1.24	1.82	0.40	0.48	1.79	0.72	--	3.50
6.24	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	0.82
6.72	Butanal	123-72-8	--	--	--	--	--	--	--	--	1.14
6.83	2-Butanone	78-93-3	--	--	--	--	--	0.43	--	--	3.20
7.09	Acetic acid	64-19-7	1.83	1.31	--	--	0.37	--	1.50	1.02	7.54
7.88	Tetrahydrofuran	109-99-9	--	--	1.22	--	--	--	--	--	--
8.97	Benzene	71-43-2	0.96	0.77	0.55	0.43	0.63	0.66	0.35	1.33	--
9.65	Pentanal	110-62-3	--	--	--	--	--	--	--	--	2.25
12.06	Toluene	108-88-3	--	--	--	--	0.25	0.36	0.25	--	0.89
12.16	Butanoic acid	107-92-6	--	--	--	--	--	--	--	--	1.20
12.58	Butynediol	110-65-6	--	--	--	--	--	--	--	--	7.51
12.63	Hexanal	66-25-1	--	--	--	--	--	--	--	--	4.24
14.58	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	0.38	--	--	33.40
15.05	Cyclohexanone	108-94-1	--	--	0.61	--	--	--	--	--	--
15.34	Heptanal	111-71-7	--	--	--	--	--	--	--	--	0.86
15.64	Pentanoic acid	109-52-4	--	--	--	--	--	1.32	--	--	74.62
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	--	--	--	1.08
16.76	Benzaldehyde	100-52-7	0.44	0.62	0.42	0.46	0.65	0.26	0.54	1.10	--
17.10	Phenol	108-95-2	--	--	--	0.24	0.33	--	0.27	0.84	--
17.23	Hexanoic acid	142-62-1	--	--	--	--	--	--	--	--	6.46
18.43	2-Methylhexanoic acid	4536-23-6	--	--	--	--	--	--	--	--	2.05
18.45	2-Ethylhexanol	104-76-7	--	0.93	--	--	--	--	--	0.79	--
19.19	Acetophenone	98-86-2	--	--	--	0.30	0.46	--	0.39	0.61	--
19.22	p/m/o-Cresol	1319-77-3	--	--	--	--	--	--	--	--	6.69
19.90	Heptanoic acid	111-14-8	--	--	--	--	--	2.48	--	--	101.04
20.02	Nonanal	124-19-6	0.19	0.31	0.34	0.17	--	--	0.27	--	0.94
20.70	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	--	--	--	1.39
21.01	Benzoic acid	65-85-0	--	--	--	1.66	2.30	0.39	0.98	0.87	--
21.61	Octanoic acid	124-07-2	--	--	--	--	--	0.93	--	--	33.56

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline ENG 220°C			MJO II ENG 220°C; 5ppmW		
			Shipping Blank 2[2]	Field Blank 2[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
21.63	3,5-Dimethyl-4-heptanone	19549-84-9	--	--	--	--	--	--	--	--	6.33
22.07	Decanal	112-31-2	0.17	--	--	--	--	--	0.20	--	--
22.27	Dodecane	112-40-3	--	--	0.28	--	0.15	--	--	--	--
22.56	Allyl isovalerate	2835-39-4	--	--	--	--	--	--	--	--	8.39
24.12	Tridecane	629-50-5	--	--	0.25	0.12	0.15	--	--	--	--
24.88	Decanoic acid	334-48-5	--	--	--	--	--	0.79	--	--	10.00
25.85	Tetradecane	629-59-4	--	--	--	0.11	0.15	--	--	--	--
26.12	Allyl heptanoate	142-19-8	--	--	--	--	--	--	--	--	7.66
27.74	Allyl octanoate	4230-97-1	--	--	--	--	--	--	--	--	3.25
28.52	Diethyl Phthalate	84-66-2	--	0.26	--	--	0.68	--	--	0.35	--
28.56	Tributyl phosphate	126-73-8	--	--	0.24	--	--	--	--	--	--
29.23	Tributyl phosphate	126-73-8	--	--	--	--	--	0.09	--	--	--
30.74	Allyl decanoate	57856-81-2	--	--	--	--	--	--	--	--	1.07
31.30	n-Butylbenzenesulfonamide	3622-84-2	0.15	0.38	--	0.11	--	--	0.11	--	--
33.62	Hexadecanoic acid	57-10-3	0.73	3.78	0.43	0.90	0.46	--	0.79	--	0.29
36.03	Octadecanoic acid	57-11-4	0.18	1.07	--	0.27	0.14	--	0.23	--	--

-- = below the detection limits of the method used.
[1]Toluene-equivalent concentrations.
[2]A volume of 1L was used for blanks to facilitate the VOC quantification.

Day 2- Morning: MJO II Contamination Event using ENG at 220°C (Concentration results in units of micrograms per cubic meter, µg/m³)

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m³)[1]								
			Controls			Baseline ENG 220°C			MJO II ENG 220°C; 5ppmW		
			Shipping Blank 2[2]	Field Blank 2[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	9.29	--	--	--	--	--	--
4.69	Acetone	67-64-1	3.18	2.94	4.32	0.94	1.14	4.25	1.72	--	8.31
6.24	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	2.35
6.72	Butanal	123-72-8	--	--	--	--	--	--	--	--	3.35
6.83	2-Butanone	78-93-3	--	--	--	--	--	1.27	--	--	9.42
7.09	Acetic acid	64-19-7	4.49	3.21	--	--	0.92	--	3.69	2.51	18.50
7.88	Tetrahydrofuran	109-99-9	--	--	3.60	--	--	--	--	--	--
8.97	Benzene	71-43-2	3.07	2.45	1.76	1.37	2.01	2.10	1.12	4.23	--
9.65	Pentanal	110-62-3	--	--	--	--	--	--	--	--	7.92
12.06	Toluene	108-88-3	--	--	--	--	0.93	1.37	0.94	--	3.36
12.16	Butanoic acid	107-92-6	--	--	--	--	--	--	--	--	4.31
12.58	Butynediol	110-65-6	--	--	--	--	--	--	--	--	26.44
12.63	Hexanal	66-25-1	--	--	--	--	--	--	--	--	17.35
14.58	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	1.59	--	--	139.42
15.05	Cyclohexanone	108-94-1	--	--	2.43	--	--	--	--	--	--
15.34	Heptanal	111-71-7	--	--	--	--	--	--	--	--	4.01
15.64	Pentanoic acid	109-52-4	--	--	--	--	--	5.51	--	--	311.51
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	--	--	--	4.43
16.76	Benzaldehyde	100-52-7	1.90	2.70	1.80	2.00	2.80	1.14	2.36	4.75	--
17.10	Phenol	108-95-2	--	--	--	0.93	1.26	--	1.03	3.22	--
17.23	Hexanoic acid	142-62-1	--	--	--	--	--	--	--	--	30.67
18.43	2-Methylhexanoic acid	4536-23-6	--	--	--	--	--	--	--	--	10.92
18.45	2-Ethylhexanol	104-76-7	--	4.92	--	--	--	--	--	4.20	--
19.19	Acetophenone	98-86-2	--	--	--	1.49	2.26	--	1.92	2.99	--
19.22	p/m/o-Cresol	1319-77-3	--	--	--	--	--	--	--	--	29.55
19.90	Heptanoic acid	111-14-8	--	--	--	--	--	13.18	--	--	537.63
20.02	Nonanal	124-19-6	1.12	1.78	1.95	1.00	--	--	1.54	--	5.45
20.70	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	--	--	--	7.30
21.01	Benzoic acid	65-85-0	--	--	--	8.28	11.46	1.93	4.87	4.32	--
21.61	Octanoic acid	124-07-2	--	--	--	--	--	5.49	--	--	197.80

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m^3)[1]								
			Controls			Baseline ENG 220°C			MJO II ENG 220°C; 5ppmW		
			Shipping Blank 2[2]	Field Blank 2[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
21.63	3,5-Dimethyl-4-heptanone	19549-84-9	--	--	--	--	--	--	--	--	36.80
22.07	Decanal	112-31-2	1.12	--	--	--	--	--	1.30	--	--
22.27	Dodecane	112-40-3	--	--	1.94	--	1.02	--	--	--	--
22.56	Allyl isovalerate	2835-39-4	--	--	--	--	--	--	--	--	48.74
24.12	Tridecane	629-50-5	--	--	1.87	0.92	1.15	--	--	--	--
24.88	Decanoic acid	334-48-5	--	--	--	--	--	5.57	--	--	70.40
25.85	Tetradecane	629-59-4	--	--	--	0.92	1.23	--	--	--	--
26.12	Allyl heptanoate	142-19-8	--	--	--	--	--	--	--	--	53.30
27.74	Allyl octanoate	4230-97-1	--	--	--	--	--	--	--	--	24.50
28.52	Diethyl Phthalate	84-66-2	--	2.32	--	--	6.16	--	--	3.14	--
28.56	Tributyl phosphate	126-73-8	--	--	2.80	--	--	--	--	--	--
29.23	Tributyl phosphate	126-73-8	--	--	--	--	--	1.00	--	--	--
30.74	Allyl decanoate	57856-81-2	--	--	--	--	--	--	--	--	9.27
31.30	n-Butylbenzenesulfonamide	3622-84-2	1.35	3.29	--	0.93	--	--	0.98	--	--
33.62	Hexadecanoic acid	57-10-3	7.65	39.60	4.54	9.47	4.81	--	8.29	--	3.01
36.03	Octadecanoic acid	57-11-4	2.09	12.38	--	3.09	1.62	--	2.70	--	--

-- = below the detection limits of the method used.
[1]Toluene-equivalent concentrations.
[2]A volume of 1L was used for blanks to facilitate the VOC quantification.

Day 2- Afternoon: MJO II Contamination Event using ENG at 315°C (Concentration results in units of parts per billion volume, ppbV)

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline ENG 315°C			MJO II ENG 315°C; 5ppmW		
			Shipping Blank 2[2]	Field Blank 2[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	3.91	--	--	--	--	--	--
4.69	Acetone	67-64-1	--	--	1.82	0.84	1.06	2.28	1.05	1.16	4.61
6.20	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	1.36
6.69	Butanal	123-72-8	--	--	--	--	--	--	--	--	4.98
6.79	2-Butanone	78-93-3	--	--	--	--	--	0.55	--	--	9.45
6.94	Acetic acid	64-19-7	2.61	--	--	1.03	--	1.49	--	--	17.59
7.88	Tetrahydrofuran	109-99-9	--	--	1.22	--	--	--	--	--	--
8.97	Benzene	71-43-2	--	--	0.55	0.73	0.79	1.21	1.45	0.99	--
9.65	Pentanal	110-62-3	--	--	--	--	--	--	--	--	3.69
12.16	Butanoic acid	107-92-6	--	--	--	--	--	--	--	--	4.53
12.50	Butynediol	110-65-6	--	--	--	--	--	--	--	--	6.76
12.61	Hexanal	66-25-1	--	--	--	--	--	--	--	--	5.55
14.24	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	0.91	--	--	51.21
15.05	Cyclohexanone	108-94-1	--	--	0.61	--	--	--	--	--	--
15.10	Pentanoic acid	109-52-4	--	--	--	--	--	2.21	--	--	121.06
15.34	Heptanal	111-71-7	--	--	--	--	--	--	--	--	2.12
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	0.51	--	--	2.75
16.76	Benzaldehyde	100-52-7	--	--	0.42	0.39	0.57	--	0.51	0.69	--
17.03	Hexanoic acid	142-62-1	--	--	--	--	--	--	--	--	7.21
17.10	Phenol	108-95-2	--	--	--	--	--	--	--	0.39	--
18.33	2-Methylhexanoic acid	4536-23-6	--	--	--	--	--	--	--	--	2.20
18.45	2-Ethylhexanol	104-76-7	--	1.32	--	--	--	--	0.61	0.93	--
19.19	Acetophenone	98-86-2	--	--	--	0.30	0.41	--	--	0.41	--
19.22	p/m/o-Cresol	1319-77-3	--	--	--	--	--	--	--	--	5.43
19.39	Heptanoic acid	111-14-8	--	--	--	--	--	4.71	--	--	159.33
20.02	Nonanal	124-19-6	--	--	0.34	--	--	--	--	0.22	1.10
20.68	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	0.32	--	--	2.82
21.01	Benzoic acid	65-85-0	--	--	--	1.23	1.24	--	--	1.20	--
21.23	Octanoic acid	124-07-2	--	--	--	--	--	1.31	--	--	43.14
21.59	3,5-Dimethyl-4-heptanone	19549-84-9	--	--	--	--	--	--	--	--	9.33

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline ENG 315°C			MJO II ENG 315°C; 5ppmW		
			Shipping Blank 2[2]	Field Blank 2[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
22.07	Decanal	112-31-2	--	--	--	--	--	--	--	0.18	--
22.27	Dodecane	112-40-3	--	--	0.28	--	--	--	--	--	--
22.56	Allyl isovalerate	2835-39-4	--	--	--	--	--	--	--	--	12.73
24.12	Tridecane	629-50-5	--	--	0.25	--	--	--	--	--	--
24.80	Decanoic acid	334-48-5	--	--	--	--	--	1.03	--	--	13.72
26.09	Allyl heptanoate	142-19-8	--	--	--	--	--	--	--	--	11.36
27.74	Allyl octanoate	4230-97-1	--	--	--	--	--	--	--	--	1.83
28.52	Diethyl Phthalate	84-66-2	--	--	--	--	0.16	--	--	0.34	--
33.62	Hexadecanoic acid	57-10-3	1.04	5.39	0.43	0.49	1.00	0.53	0.56	0.35	--
36.03	Octadecanoic acid	57-11-4	--	1.52	--	0.19	--	--	0.20	--	--

-- = below the detection limits of the method used.

[1]Toluene-equivalent concentrations.

[2]A volume of 1L was used for blanks to facilitate the VOC quantification.

Day 2- Afternoon: MJO II Contamination Event using ENG at 315°C (Concentration results in units of micrograms per cubic meter, µg/m³)

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m³)[1]								
			Controls			Baseline ENG 315°C			MJO II ENG 315°C; 5ppmW		
			Shipping Blank 2[2]	Field Blank 2[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	9.29	--	--	--	--	--	--
4.69	Acetone	67-64-1	--	--	4.32	1.99	2.50	5.42	2.48	2.75	10.94
6.20	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	3.90
6.69	Butanal	123-72-8	--	--	--	--	--	--	--	--	14.69
6.79	2-Butanone	78-93-3	--	--	--	--	--	1.61	--	--	27.84
6.94	Acetic acid	64-19-7	6.40	--	--	2.53	--	3.65	--	--	43.19
7.88	Tetrahydrofuran	109-99-9	--	--	3.60	--	--	--	--	--	--
8.97	Benzene	71-43-2	--	--	1.76	2.32	2.51	3.85	4.64	3.16	--
9.65	Pentanal	110-62-3	--	--	--	--	--	--	--	--	13.00
12.16	Butanoic acid	107-92-6	--	--	--	--	--	--	--	--	16.31
12.50	Butynediol	110-65-6	--	--	--	--	--	--	--	--	23.78
12.61	Hexanal	66-25-1	--	--	--	--	--	--	--	--	22.72
14.24	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	3.80	--	--	213.79
15.05	Cyclohexanone	108-94-1	--	--	2.43	--	--	--	--	--	--
15.10	Pentanoic acid	109-52-4	--	--	--	--	--	9.21	--	--	505.37
15.34	Heptanal	111-71-7	--	--	--	--	--	--	--	--	9.87
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	2.08	--	--	11.24
16.76	Benzaldehyde	100-52-7	--	--	1.80	1.70	2.49	--	2.21	2.99	--
17.03	Hexanoic acid	142-62-1	--	--	--	--	--	--	--	--	34.23
17.10	Phenol	108-95-2	--	--	--	--	--	--	--	1.50	--
18.33	2-Methylhexanoic acid	4536-23-6	--	--	--	--	--	--	--	--	11.72
18.45	2-Ethylhexanol	104-76-7	--	7.02	--	--	--	--	3.26	4.96	--
19.19	Acetophenone	98-86-2	--	--	--	1.49	1.99	--	--	2.02	--
19.22	p/m/o-Cresol	1319-77-3	--	--	--	--	--	--	--	--	24.01
19.39	Heptanoic acid	111-14-8	--	--	--	--	--	25.04	--	--	847.82
20.02	Nonanal	124-19-6	--	--	1.95	--	--	--	--	1.26	6.37
20.68	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	1.65	--	--	14.79
21.01	Benzoic acid	65-85-0	--	--	--	6.15	6.19	--	--	5.98	--
21.23	Octanoic acid	124-07-2	--	--	--	--	--	7.70	--	--	254.30
21.59	3,5-Dimethyl-4-heptanone	19549-84-9	--	--	--	--	--	--	--	--	54.23

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m^3)[1]								
			Controls			Baseline ENG 315°C			MJO II ENG 315°C; 5ppmW		
			Shipping Blank 2[2]	Field Blank 2[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
22.07	Decanal	112-31-2	--	--	--	--	--	--	--	1.14	--
22.27	Dodecane	112-40-3	--	--	1.94	--	--	--	--	--	--
22.56	Allyl isovalerate	2835-39-4	--	--	--	--	--	--	--	--	73.98
24.12	Tridecane	629-50-5	--	--	1.87	--	--	--	--	--	--
24.80	Decanoic acid	334-48-5	--	--	--	--	--	7.28	--	--	96.62
26.09	Allyl heptanoate	142-19-8	--	--	--	--	--	--	--	--	79.04
27.74	Allyl octanoate	4230-97-1	--	--	--	--	--	--	--	--	13.75
28.52	Diethyl Phthalate	84-66-2	--	--	--	--	1.45	--	--	3.07	--
33.62	Hexadecanoic acid	57-10-3	10.91	56.48	4.54	5.10	10.44	5.59	5.84	3.71	--
36.03	Octadecanoic acid	57-11-4	--	17.66	--	2.25	--	--	2.27	--	--

-- = below the detection limits of the method used.

[1]Toluene-equivalent concentrations.

[2]A volume of 1L was used for blanks to facilitate the VOC quantification.

Day 3- Morning: ETO 2197 Contamination Event using ENG at 315^oC (Concentration results in units of parts per billion volume, ppbV)

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline ENG 315^oC			ETO 2197 ENG 315^oC; 5ppmW		
			Shipping Blank 3[2]	Field Blank 3[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	3.91	--	--	--	--	--	--
4.69	Acetone	67-64-1	0.75	1.18	1.82	0.50	0.68	1.51	0.63	0.73	5.10
6.19	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	1.54
6.68	Butanal	123-72-8	--	--	--	--	--	0.19	--	--	3.42
6.83	2-Butanone	78-93-3	0.58	--	--	--	--	0.44	--	--	--
6.91	Acetic acid	64-19-7	--	--	--	--	--	--	--	--	14.78
7.88	Tetrahydrofuran	109-99-9	--	--	1.22	--	--	--	--	--	--
8.97	Benzene	71-43-2	--	0.84	0.55	0.28	0.33	0.48	0.31	0.33	--
9.65	Pentanal	110-62-3	--	--	--	--	--	0.20	--	--	3.23
12.16	Butanoic acid	107-92-6	--	--	--	--	--	--	--	--	3.93
12.24	4,4-Dimethyl-2-pentanone	590-50-1	--	--	--	--	--	--	--	--	4.11
12.50	Butynediol	110-65-6	--	--	--	--	--	--	--	--	7.59
12.60	Hexanal	66-25-1	--	--	--	--	--	0.30	--	--	4.66
13.20	Octane	111-65-9	--	--	--	--	0.12	--	--	--	--
14.01	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	0.58	--	--	3.66
15.05	Cyclohexanone	108-94-1	--	--	0.61	--	--	--	--	--	--
15.29	Pentanoic acid	109-52-4	--	--	--	--	--	1.16	0.60	0.54	199.76
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	0.37	--	--	2.84
16.76	Benzaldehyde	100-52-7	--	--	0.42	0.11	0.13	--	0.22	0.21	--
17.04	Hexanoic acid	142-62-1	--	--	--	--	--	--	--	--	2.37
17.77	Octanal	124-13-0	--	--	--	--	--	--	--	--	2.45
18.15	Decane	124-18-5	--	--	--	0.08	0.08	--	--	--	--
18.45	2-Ethylhexanol	104-76-7	0.10	0.27	--	--	0.23	--	--	--	--
19.19	Acetophenone	98-86-2	--	--	--	--	--	--	0.18	0.14	--
19.22	p/m/o-Cresol	1319-77-3	--	--	--	--	--	--	--	--	2.66
19.39	Heptanoic acid	111-14-8	--	--	--	--	--	0.66	0.35	0.20	107.21
20.02	Nonanal	124-19-6	--	--	0.34	0.09	0.12	0.10	0.14	0.16	--
20.29	Undecane	1120-21-4	--	--	--	0.09	0.10	--	--	--	--
20.73	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	0.22	--	--	--
20.75	3,5,5-Trimethylhexanoic acid	3302-10-1	--	--	--	--	--	--	0.10	0.12	43.66

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline ENG 315°C			ETO 2197 ENG 315°C; 5ppmW		
			Shipping Blank 3[2]	Field Blank 3[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
21.01	Benzoic acid	65-85-0	--	--	--	--	--	--	0.71	0.36	--
21.18	Octanoic acid	124-07-2	--	--	--	--	--	0.11	0.11	--	5.84
22.07	Decanal	112-31-2	--	--	--	--	0.06	--	--	--	--
22.27	Dodecane	112-40-3	--	--	0.28	0.08	0.09	--	0.09	0.11	--
22.56	Allyl isovalerate	2835-39-4	--	--	--	--	--	--	--	--	26.39
23.10	Nonanoic acid	112-05-0	--	--	--	--	--	--	0.11	--	43.00
24.12	Tridecane	629-50-5	--	--	0.25	0.07	0.07	--	0.09	0.09	--
24.78	Decanoic acid	334-48-5	--	--	--	--	--	--	0.09	--	2.48
25.85	Tetradecane	629-59-4	--	--	--	0.06	0.07	--	0.08	0.08	--
26.08	Allyl heptanoate	142-19-8	--	--	--	--	--	--	--	--	10.20
27.08	Allyl octanoate	4230-97-1	--	--	--	--	--	--	--	--	6.25
28.52	Diethyl Phthalate	84-66-2	--	0.04	--	--	--	--	--	--	--
29.26	Allyl nonanoate	7493-72-3	--	--	--	--	--	--	--	--	2.35
31.30	n-Butylbenzenesulfonamide	3622-84-2	--	0.10	--	--	--	--	--	--	--
33.62	Hexadecanoic acid	57-10-3	--	0.38	0.43	0.12	0.47	0.17	0.55	0.58	--
36.03	Octadecanoic acid	57-11-4	--	--	--	0.05	0.22	--	0.19	0.19	--

-- = below the detection limits of the method used.
[1]Toluene-equivalent concentrations.
[2]A volume of 1L was used for blanks to facilitate the VOC quantification.

Day 3- Morning: ETO 2197 Contamination Event using ENG at 315°C (Concentration results in units of micrograms per cubic meter, µg/m³)

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m³)[1]								
			Controls			Baseline ENG 315°C			ETO 2197 ENG 315°C; 5ppmW		
			Shipping Blank 3[2]	Field Blank 3[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	9.29	--	--	--	--	--	--
4.69	Acetone	67-64-1	1.77	2.81	4.32	1.20	1.62	3.58	1.50	1.74	12.10
6.19	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	4.42
6.68	Butanal	123-72-8	--	--	--	--	--	0.56	--	--	10.08
6.83	2-Butanone	78-93-3	1.72	--	--	--	--	1.31	--	--	--
6.91	Acetic acid	64-19-7	--	--	--	--	--	--	--	--	36.27
7.88	Tetrahydrofuran	109-99-9	--	--	3.60	--	--	--	--	--	--
8.97	Benzene	71-43-2	--	2.69	1.76	0.90	1.07	1.53	0.98	1.04	--
9.65	Pentanal	110-62-3	--	--	--	--	--	0.72	--	--	11.36
12.16	Butanoic acid	107-92-6	--	--	--	--	--	--	--	--	14.15
12.24	4,4-Dimethyl-2-pentanone	590-50-1	--	--	--	--	--	--	--	--	19.18
12.50	Butynediol	110-65-6	--	--	--	--	--	--	--	--	26.69
12.60	Hexanal	66-25-1	--	--	--	--	--	1.21	--	--	19.08
13.20	Octane	111-65-9	--	--	--	--	0.58	--	--	--	--
14.01	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	2.42	--	--	15.28
15.05	Cyclohexanone	108-94-1	--	--	2.43	--	--	--	--	--	--
15.29	Pentanoic acid	109-52-4	--	--	--	--	--	4.84	2.52	2.27	833.93
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	1.51	--	--	11.63
16.76	Benzaldehyde	100-52-7	--	--	1.80	0.48	0.56	--	0.95	0.93	--
17.04	Hexanoic acid	142-62-1	--	--	--	--	--	--	--	--	11.26
17.77	Octanal	124-13-0	--	--	--	--	--	--	--	--	12.83
18.15	Decane	124-18-5	--	--	--	0.44	0.47	--	--	--	--
18.45	2-Ethylhexanol	104-76-7	0.54	1.43	--	--	1.23	--	--	--	--
19.19	Acetophenone	98-86-2	--	--	--	--	--	--	0.90	0.68	--
19.22	p/m/o-Cresol	1319-77-3	--	--	--	--	--	--	--	--	11.77
19.39	Heptanoic acid	111-14-8	--	--	--	--	--	3.52	1.86	1.04	570.47
20.02	Nonanal	124-19-6	--	--	1.95	0.54	0.70	0.60	0.84	0.90	--
20.29	Undecane	1120-21-4	--	--	--	0.56	0.65	--	--	--	--
20.73	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	1.16	--	--	--
20.75	3,5,5-Trimethylhexanoic acid	3302-10-1	--	--	--	--	--	--	0.68	0.76	282.39

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m³)[1]								
			Controls			Baseline ENG 315°C			ETO 2197 ENG 315°C; 5ppmW		
			Shipping Blank 3[2]	Field Blank 3[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
21.01	Benzoic acid	65-85-0	--	--	--	--	--	--	3.54	1.81	--
21.18	Octanoic acid	124-07-2	--	--	--	--	--	0.67	0.66	--	34.44
22.07	Decanal	112-31-2	--	--	--	--	0.38	--	--	--	--
22.27	Dodecane	112-40-3	--	--	1.94	0.56	0.64	--	0.65	0.74	--
22.56	Allyl isovalerate	2835-39-4	--	--	--	--	--	--	--	--	153.37
23.10	Nonanoic acid	112-05-0	--	--	--	--	--	--	0.72	--	278.10
24.12	Tridecane	629-50-5	--	--	1.87	0.53	0.55	--	0.67	0.67	--
24.78	Decanoic acid	334-48-5	--	--	--	--	--	--	0.66	--	17.43
25.85	Tetradecane	629-59-4	--	--	--	0.53	0.53	--	0.62	0.68	--
26.08	Allyl heptanoate	142-19-8	--	--	--	--	--	--	--	--	71.01
27.08	Allyl octanoate	4230-97-1	--	--	--	--	--	--	--	--	47.04
28.52	Diethyl Phthalate	84-66-2	--	0.41	--	--	--	--	--	--	--
29.26	Allyl nonanoate	7493-72-3	--	--	--	--	--	--	--	--	19.05
31.30	n-Butylbenzenesulfonamide	3622-84-2	--	0.83	--	--	--	--	--	--	--
33.62	Hexadecanoic acid	57-10-3	--	3.94	4.54	1.30	4.93	1.80	5.78	6.05	--
36.03	Octadecanoic acid	57-11-4	--	--	--	0.61	2.57	--	2.18	2.25	--

-- = below the detection limits of the method used.

[1]Toluene-equivalent concentrations.

[2]A volume of 1L was used for blanks to facilitate the VOC quantification.

Day 3- Afternoon: ETO 2197 Contamination Event using ENG at 220°C (Concentration results in units of parts per billion volume, ppbV)

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline ENG 220°C			ETO 2197 ENG 220°C; 5ppmW		
			Shipping Blank 3[2]	Field Blank 3[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	3.91	--	--	--	--	--	--
4.69	Acetone	67-64-1	0.75	1.18	1.82	0.59	0.50	1.57	0.42	0.31	1.80
6.20	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	0.50
6.68	Butanal	123-72-8	--	--	--	--	--	--	--	--	1.39
6.78	Acetic acid	64-19-7	--	--	--	--	--	0.46	--	--	3.67
6.83	2-Butanone	78-93-3	0.58	--	--	--	--	--	--	--	--
7.88	Tetrahydrofuran	109-99-9	--	--	1.22	--	--	--	--	--	--
8.94	Benzene	71-43-2	--	0.84	0.55	0.41	0.39	0.33	0.24	0.33	--
9.63	Pentanal	110-62-3	--	--	--	--	--	--	--	--	0.90
12.06	Toluene	108-88-3	--	--	--	--	--	--	0.07	0.07	--
12.10	Butanoic acid	107-92-6	--	--	--	--	--	--	--	--	1.47
12.24	4,4-Dimethyl-2-pentanone	590-50-1	--	--	--	--	--	0.29	--	--	0.73
12.49	Butynediol	110-65-6	--	--	--	--	--	--	--	--	5.17
12.61	Hexanal	66-25-1	--	--	--	--	--	0.26	--	--	1.32
13.96	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	--	--	--	1.46
15.05	Cyclohexanone	108-94-1	--	--	0.61	--	--	--	--	--	--
15.19	Pentanoic acid	109-52-4	--	--	--	--	--	4.16	--	--	141.43
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	0.36	--	--	1.19
16.76	Benzaldehyde	100-52-7	--	--	0.42	0.14	0.19	--	0.18	0.13	--
16.99	Hexanoic acid	142-62-1	--	--	--	--	--	--	--	--	0.79
17.10	Phenol	108-95-2	--	--	--	--	0.17	--	--	--	--
17.17	Octanal	124-13-0	--	--	--	--	--	--	--	--	0.82
18.15	Decane	124-18-5	--	--	--	0.10	0.09	--	0.06	--	--
18.45	2-Ethylhexanol	104-76-7	0.10	0.27	--	--	--	--	0.24	0.05	--
19.19	Acetophenone	98-86-2	--	--	--	0.12	0.16	--	0.13	0.07	--
19.22	p/m/o-Cresol	1319-77-3	--	--	--	--	--	--	--	--	3.68
19.34	Heptanoic acid	111-14-8	--	--	--	--	--	2.38	--	--	72.30
20.02	Nonanal	124-19-6	--	--	0.34	0.09	0.08	--	0.13	--	--
20.29	Undecane	1120-21-4	--	--	--	0.11	0.11	--	0.06	0.05	--
20.68	3,5,5-Trimethylhexanoic acid	3302-10-1	--	--	--	--	--	0.72	--	--	18.26

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline ENG 220°C			ETO 2197 ENG 220°C; 5ppmW		
			Shipping Blank 3[2]	Field Blank 3[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
20.73	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	0.16	--	--	--
20.97	Benzoic acid	65-85-0	--	--	--	0.41	0.72	0.19	0.13	--	0.50
21.14	Octanoic acid	124-07-2	--	--	--	--	--	0.22	--	--	2.61
22.07	Decanal	112-31-2	--	--	--	--	--	--	0.10	--	--
22.25	Dodecane	112-40-3	--	--	0.28	0.09	0.09	--	0.05	0.04	--
22.52	Allyl isovalerate	2835-39-4	--	--	--	--	--	0.30	--	--	17.82
23.05	Nonanoic acid	112-05-0	--	--	--	--	--	1.27	--	--	18.26
24.12	Tridecane	629-50-5	--	--	0.25	0.07	0.09	--	0.05	0.04	--
24.76	Decanoic acid	334-48-5	--	--	--	--	--	0.22	--	--	0.54
25.85	Tetradecane	629-59-4	--	--	--	0.06	0.07	--	0.05	0.03	--
26.08	Allyl heptanoate	142-19-8	--	--	--	--	--	--	--	--	5.94
27.08	Allyl octanoate	4230-97-1	--	--	--	--	--	--	--	--	2.71
28.52	Diethyl Phthalate	84-66-2	--	0.04	--	--	--	--	--	--	--
29.26	Allyl nonanoate	7493-72-3	--	--	--	--	--	--	--	--	0.41
31.30	n-Butylbenzenesulfonamide	3622-84-2	--	0.10	--	--	0.04	--	--	--	--
33.62	Hexadecanoic acid	57-10-3	--	0.38	0.43	--	--	0.14	0.19	0.11	--
36.03	Octadecanoic acid	57-11-4	0.16	--	--	--	--	--	0.09	--	--

-- = below the detection limits of the method used.

[1]Toluene-equivalent concentrations.

[2]A volume of 1L was used for blanks to facilitate the VOC quantification.

Day 3- Afternoon: ETO 2197 Contamination Event using ENG at 220°C (Concentration results in units of micrograms per cubic meter, μg/m^3)

RT (min)	Compound Name	CAS#	Compound Concentration (μg/m^3)[1]								
			Controls			Baseline ENG 220°C			ETO 2197 ENG 220°C; 5ppmW		
			Shipping Blank 3[2]	Field Blank 3[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	9.29	--	--	--	--	--	--
4.69	Acetone	67-64-1	1.77	2.81	4.32	1.39	1.18	3.73	1.00	0.74	4.26
6.20	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	1.42
6.68	Butanal	123-72-8	--	--	--	--	--	--	--	--	4.10
6.78	Acetic acid	64-19-7	--	--	--	--	--	1.13	--	--	9.02
6.83	2-Butanone	78-93-3	1.72	--	--	--	--	--	--	--	--
7.88	Tetrahydrofuran	109-99-9	--	--	3.60	--	--	--	--	--	--
8.94	Benzene	71-43-2	--	2.69	1.76	1.31	1.25	1.05	0.78	1.06	--
9.63	Pentanal	110-62-3	--	--	--	--	--	--	--	--	3.18
12.06	Toluene	108-88-3	--	--	--	--	--	--	0.25	0.26	--
12.10	Butanoic acid	107-92-6	--	--	--	--	--	--	--	--	5.30
12.24	4,4-Dimethyl-2-pentanone	590-50-1	--	--	--	--	--	1.34	--	--	3.40
12.49	Butynediol	110-65-6	--	--	--	--	--	--	--	--	18.18
12.61	Hexanal	66-25-1	--	--	--	--	--	1.08	--	--	5.41
13.96	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	--	--	--	6.09
15.05	Cyclohexanone	108-94-1	--	--	2.43	--	--	--	--	--	--
15.19	Pentanoic acid	109-52-4	--	--	--	--	--	17.36	--	--	590.39
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	1.46	--	--	4.86
16.76	Benzaldehyde	100-52-7	--	--	1.80	0.60	0.81	--	0.77	0.56	--
16.99	Hexanoic acid	142-62-1	--	--	--	--	--	--	--	--	3.75
17.10	Phenol	108-95-2	--	--	--	--	0.65	--	--	--	--
17.17	Octanal	124-13-0	--	--	--	--	--	--	--	--	4.31
18.15	Decane	124-18-5	--	--	--	0.59	0.54	--	0.33	--	--
18.45	2-Ethylhexanol	104-76-7	0.54	1.43	--	--	--	--	1.30	0.27	--
19.19	Acetophenone	98-86-2	--	--	--	0.57	0.77	--	0.62	0.32	--
19.22	p/m/o-Cresol	1319-77-3	--	--	--	--	--	--	--	--	16.26
19.34	Heptanoic acid	111-14-8	--	--	--	--	--	12.69	--	--	384.71
20.02	Nonanal	124-19-6	--	--	1.95	0.52	0.46	--	0.76	--	--
20.29	Undecane	1120-21-4	--	--	--	0.70	0.69	--	0.38	0.31	--
20.68	3,5,5-Trimethylhexanoic acid	3302-10-1	--	--	--	--	--	4.63	--	--	118.10

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m^3)[1]								
			Controls			Baseline ENG 220°C			ETO 2197 ENG 220°C; 5ppmW		
			Shipping Blank 3[2]	Field Blank 3[2]	Trailer Sample 1	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
20.73	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	0.82	--	--	--
20.97	Benzoic acid	65-85-0	--	--	--	2.05	3.58	0.93	0.67	--	2.50
21.14	Octanoic acid	124-07-2	--	--	--	--	--	1.31	--	--	15.38
22.07	Decanal	112-31-2	--	--	--	--	--	--	0.63	--	--
22.25	Dodecane	112-40-3	--	--	1.94	0.61	0.63	--	0.38	0.26	--
22.52	Allyl isovalerate	2835-39-4	--	--	--	--	--	1.73	--	--	103.57
23.05	Nonanoic acid	112-05-0	--	--	--	--	--	8.20	--	--	118.11
24.12	Tridecane	629-50-5	--	--	1.87	0.55	0.67	--	0.35	0.30	--
24.76	Decanoic acid	334-48-5	--	--	--	--	--	1.52	--	--	3.83
25.85	Tetradecane	629-59-4	--	--	--	0.47	0.56	--	0.38	0.25	--
26.08	Allyl heptanoate	142-19-8	--	--	--	--	--	--	--	--	41.36
27.08	Allyl octanoate	4230-97-1	--	--	--	--	--	--	--	--	20.40
28.52	Diethyl Phthalate	84-66-2	--	0.41	--	--	--	--	--	--	--
29.26	Allyl nonanoate	7493-72-3	--	--	--	--	--	--	--	--	3.36
31.30	n-Butylbenzenesulfonamide	3622-84-2	--	0.83	--	--	0.35	--	--	--	--
33.62	Hexadecanoic acid	57-10-3	--	3.94	4.54	--	--	1.48	2.02	1.13	--
36.03	Octadecanoic acid	57-11-4	1.85	--	--	--	--	--	1.01	--	--

-- = below the detection limits of the method used.

[1]Toluene-equivalent concentrations.

[2]A volume of 1L was used for blanks to facilitate the VOC quantification.

Day 4- Morning: MJO II Contamination Event using APU at 180ºC (Concentration results in units of parts per billion volume, ppbV)

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline APU 180ºC			MJO II APU 180ºC; 10ppmW		
			Shipping Blank 4[2]	Field Blank 4[2]	Trailer Sample 2	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	1.88	--	--	--	--	--	--
4.64	Acetone	67-64-1	1.36	1.16	8.98	0.96	0.95	1.87	0.58	--	3.90
4.82	Isopropyl alcohol	67-63-0	--	--	5.71	--	--	--	--	--	--
6.18	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	4.39
6.68	Butanal	123-72-8	--	--	--	--	--	--	--	--	4.63
6.82	Acetic acid	64-19-7	--	--	--	--	--	2.42	--	--	19.76
6.83	2-Butanone	78-93-3	--	--	1.68	--	--	--	--	--	6.37
7.88	Tetrahydrofuran	109-99-9	--	--	3.59	--	--	--	--	--	--
8.97	Benzene	71-43-2	1.03	0.74	--	0.43	0.38	--	0.36	0.42	--
9.65	Pentanal	110-62-3	--	--	--	--	--	--	--	--	8.08
12.16	Butanoic acid	107-92-6	--	--	--	--	--	0.63	--	0.39	3.84
12.24	4,4-Dimethyl-2-pentanone	590-50-1	--	--	--	--	--	0.98	--	--	--
12.35	2-Hexanone	591-78-6	--	--	--	--	--	--	--	--	2.12
12.51	Butynediol	110-65-6	--	--	--	--	--	--	--	--	30.01
12.63	Hexanal	66-25-1	--	--	--	--	--	--	--	--	14.49
13.20	Octane	111-65-9	--	--	--	0.54	0.51	--	--	--	--
14.43	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	--	--	--	102.77
15.05	Cyclohexanone	108-94-1	--	--	1.27	--	--	--	--	--	--
15.34	Heptanal	111-71-7	--	--	--	--	--	--	--	--	8.33
15.44	Pentanoic acid	109-52-4	--	--	--	--	--	7.92	0.88	1.09	355.95
15.81	Nonane	111-84-2	--	--	1.81	1.35	1.25	0.65	0.41	0.37	--
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	0.80	--	--	2.98
16.76	Benzaldehyde	100-52-7	--	--	--	--	--	0.76	0.27	--	--
17.14	Hexanoic acid	142-62-1	--	--	--	--	--	--	--	--	20.83
17.79	Octanal	124-13-0	--	--	--	--	--	--	--	--	2.67
17.94	Mesitylene	108-67-8	--	--	2.29	--	--	--	0.26	0.28	--
18.15	Decane	124-18-5	--	--	4.35	1.04	1.01	0.95	0.64	0.59	--
18.45	2-Ethylhexanol	104-76-7	0.23	0.21	--	--	--	--	--	--	--
18.37	2-Methylhexanoic acid	4536-23-6	--	--	--	--	--	--	--	--	6.23
19.22	p/m/o-Cresol	1319-77-3	--	--	--	--	--	--	--	--	20.73

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline APU 180°C			MJO II APU 180°C; 10ppmW		
			Shipping Blank 4[2]	Field Blank 4[2]	Trailer Sample 2	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
19.68	Heptanoic acid	111-14-8	--	--	--	--	--	3.37	1.08	1.81	519.88
20.02	Nonanal	124-19-6	--	--	--	--	0.22	--	--	0.19	4.00
20.29	Undecane	1120-21-4	--	--	4.41	0.55	0.55	0.99	0.59	0.53	--
20.68	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	0.45	--	--	3.28
20.75	3,5,5-Trimethylhexanoic acid	3302-10-1	--	--	--	--	--	0.90	--	--	15.52
21.01	Benzoic acid	65-85-0	--	--	--	0.51	0.63	--	0.44	0.55	--
21.38	Octanoic acid	124-07-2	--	--	--	--	--	--	0.25	0.48	140.10
21.59	3,5-Dimethyl-4-heptanone	19549-84-9	--	--	--	--	--	--	--	0.23	32.64
22.27	Dodecane	112-40-3	--	--	2.80	0.23	0.25	0.83	0.39	0.32	--
22.52	Allyl isovalerate	2835-39-4	--	--	--	--	--	--	--	--	43.96
22.83	2(3H)-Furanone, 5-butyldihydro-	104-50-7	--	--	--	--	--	--	--	--	1.24
23.04	Nonanoic acid	112-05-0	--	--	--	--	--	1.12	--	--	8.99
24.12	Tridecane	629-50-5	--	--	1.65	--	--	0.58	0.26	0.18	--
24.83	Decanoic acid	334-48-5	--	--	--	--	--	--	--	0.18	34.37
25.85	Tetradecane	629-59-4	--	--	1.00	--	--	0.29	0.15	--	--
26.06	Allyl heptanoate	142-19-8	--	--	--	--	--	--	--	--	49.41
27.74	Allyl octanoate	4230-97-1	--	--	--	--	--	--	--	--	11.01
30.74	Allyl decanoate	57856-81-2	--	--	--	--	--	--	--	--	2.56
33.62	Hexadecanoic acid	57-10-3	0.42	0.35	--	0.27	0.61	0.57	0.20	0.37	--
36.03	Octadecanoic acid	57-11-4	--	--	--	0.18	0.28	0.20	0.10	0.13	--
36.22	N-phenyl-1-naphthalenamine (PANA)	90-30-2	--	--	--	--	--	--	--	--	3.75

-- = below the detection limits of the method used.
[1]Toluene-equivalent concentrations.
[2]A volume of 1L was used for blanks to facilitate the VOC quantification.

Day 4- Morning: MJO II Contamination Event using APU at 180°C (Concentration results in units of micrograms per cubic meter, µg/m³)

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m³)[1]								
			Controls			Baseline APU 180°C			MJO II APU 180°C; 10ppmW		
			Shipping Blank 4[2]	Field Blank 4[2]	Trailer Sample 2	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	4.46	--	--	--	--	--	--
4.64	Acetone	67-64-1	3.24	2.75	21.31	2.27	2.25	4.44	1.38	--	9.25
4.82	Isopropyl alcohol	67-63-0	--	--	14.03	--	--	--	--	--	--
6.18	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	12.57
6.68	Butanal	123-72-8	--	--	--	--	--	--	--	--	13.64
6.82	Acetic acid	64-19-7	--	--	--	--	--	5.94	--	--	48.50
6.83	2-Butanone	78-93-3	--	--	4.94	--	--	--	--	--	18.77
7.88	Tetrahydrofuran	109-99-9	--	--	10.58	--	--	--	--	--	--
8.97	Benzene	71-43-2	3.29	2.35	--	1.37	1.21	--	1.15	1.33	--
9.65	Pentanal	110-62-3	--	--	--	--	--	--	--	--	28.44
12.16	Butanoic acid	107-92-6	--	--	--	--	--	2.27	--	1.42	13.83
12.24	4,4-Dimethyl-2-pentanone	590-50-1	--	--	--	--	--	4.55	--	--	--
12.35	2-Hexanone	591-78-6	--	--	--	--	--	--	--	--	8.69
12.51	Butynediol	110-65-6	--	--	--	--	--	--	--	--	105.61
12.63	Hexanal	66-25-1	--	--	--	--	--	--	--	--	59.33
13.20	Octane	111-65-9	--	--	--	2.52	2.37	--	--	--	--
14.43	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	--	--	--	429.03
15.05	Cyclohexanone	108-94-1	--	--	5.08	--	--	--	--	--	--
15.34	Heptanal	111-71-7	--	--	--	--	--	--	--	--	38.87
15.44	Pentanoic acid	109-52-4	--	--	--	--	--	33.08	3.69	4.54	1485.93
15.81	Nonane	111-84-2	--	--	9.48	7.10	6.56	3.41	2.16	1.92	--
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	3.29	--	--	12.19
16.76	Benzaldehyde	100-52-7	--	--	--	--	--	3.29	1.15	--	--
17.14	Hexanoic acid	142-62-1	--	--	--	--	--	--	--	--	98.88
17.79	Octanal	124-13-0	--	--	--	--	--	--	--	--	13.98
17.94	Mesitylene	108-67-8	--	--	11.25	--	--	--	1.28	1.37	--
18.15	Decane	124-18-5	--	--	25.29	6.06	5.89	5.52	3.73	3.46	--
18.45	2-Ethylhexanol	104-76-7	1.21	1.13	--	--	--	--	--	--	--
18.37	2-Methylhexanoic acid	4536-23-6	--	--	--	--	--	--	--	--	33.15
19.22	p/m/o-Cresol	1319-77-3	--	--	--	--	--	--	--	--	91.64

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m³)[1]								
			Controls			Baseline APU 180°C			MJO II APU 180°C; 10ppmW		
			Shipping Blank 4[2]	Field Blank 4[2]	Trailer Sample 2	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
19.68	Heptanoic acid	111-14-8	--	--	--	--	--	17.95	5.72	9.64	2766.27
20.02	Nonanal	124-19-6	--	--	--	--	1.30	--	--	1.10	23.26
20.29	Undecane	1120-21-4	--	--	28.19	3.49	3.50	6.32	3.80	3.37	--
20.68	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	2.37	--	--	17.16
20.75	3,5,5-Trimethylhexanoic acid	3302-10-1	--	--	--	--	--	5.81	--	--	100.35
21.01	Benzoic acid	65-85-0	--	--	--	2.56	3.13	--	2.21	2.74	--
21.38	Octanoic acid	124-07-2	--	--	--	--	--	--	1.46	2.84	825.76
21.59	3,5-Dimethyl-4-heptanone	19549-84-9	--	--	--	--	--	--	--	1.35	189.73
22.27	Dodecane	112-40-3	--	--	19.48	1.62	1.76	5.79	2.71	2.23	--
22.52	Allyl isovalerate	2835-39-4	--	--	--	--	--	--	--	--	255.45
22.83	2(3H)-Furanone, 5-butyldihydro-	104-50-7	--	--	--	--	--	--	--	--	7.22
23.04	Nonanoic acid	112-05-0	--	--	--	--	--	7.23	--	--	58.13
24.12	Tridecane	629-50-5	--	--	12.44	--	--	4.39	1.93	1.36	--
24.83	Decanoic acid	334-48-5	--	--	--	--	--	--	--	1.30	242.01
25.85	Tetradecane	629-59-4	--	--	8.10	--	--	2.39	1.19	--	--
26.06	Allyl heptanoate	142-19-8	--	--	--	--	--	--	--	--	343.78
27.74	Allyl octanoate	4230-97-1	--	--	--	--	--	--	--	--	82.91
30.74	Allyl decanoate	57856-81-2	--	--	--	--	--	--	--	--	22.18
33.62	Hexadecanoic acid	57-10-3	4.40	3.72	--	2.88	6.37	5.94	2.13	3.87	--
36.03	Octadecanoic acid	57-11-4	--	--	--	2.08	3.23	2.31	1.20	1.50	--
36.22	N-phenyl-1-naphthalenamine (PANA)	90-30-2	--	--	--	--	--	--	--	--	33.61

-- = below the detection limits of the method used.
[1]Toluene-equivalent concentrations.
[2]A volume of 1L was used for blanks to facilitate the VOC quantification.

Day 4- Afternoon: PE 5 Contamination Event using APU at 180^oC (Concentration results in units of parts per billion volume, ppbV)

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline APU 180^oC			PE 5 APU 180^oC; 5ppmW		
			Shipping Blank 4[2]	Field Blank 4[2]	Trailer Sample 2	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	1.88	--	--	--	--	--	--
3.80	Isobutylene[3]	115-11-7	--	--	--	--	--	--	--	--	65.91
3.85	cis-2-Butene[3]	624-64-6	--	--	--	--	--	--	--	--	16.01
4.08	trans-2-Butene[3]	590-18-1	--	--	--	--	--	--	--	--	15.62
4.69	Acetone	67-64-1	1.36	1.16	8.98	--	0.39	2.06	0.47	0.24	3.39
4.82	Isopropyl alcohol	67-63-0	--	--	5.71	--	--	--	--	--	--
6.19	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	1.35
6.67	Butanal	123-72-8	--	--	--	--	--	--	--	--	13.66
6.78	Acetic acid	64-19-7	--	--	--	--	--	--	0.38	0.20	4.70
6.83	2-Butanone	78-93-3	--	--	1.68	--	--	5.47	--	--	--
7.88	Tetrahydrofuran	109-99-9	--	--	3.59	--	--	--	--	--	--
8.84	1-Butanol	71-36-3	--	--	--	--	--	--	--	--	34.54
8.97	Benzene	71-43-2	1.03	0.74	--	0.38	0.41	--	0.74	0.43	--
9.65	Pentanal	110-62-3	--	--	--	--	--	1.10	--	--	--
12.16	Butanoic acid	107-92-6	--	--	--	--	--	1.64	--	--	--
12.58	Butynediol	110-65-6	--	--	--	--	--	1.67	--	--	--
12.63	Hexanal	66-25-1	--	--	--	--	--	1.27	--	--	--
14.01	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	9.89	--	--	5.77
14.78	Pentanoic acid	109-52-4	--	--	--	--	--	25.95	--	--	13.40
15.05	Cyclohexanone	108-94-1	--	--	1.27	--	--	--	--	--	--
15.34	Heptanal	111-71-7	--	--	--	--	--	--	--	--	--
15.81	Nonane	111-84-2	--	--	1.81	--	--	--	--	--	--
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	1.35	--	--	--
16.76	Benzaldehyde	100-52-7	--	--	--	--	0.25	--	0.36	--	--
17.10	Phenol	108-95-2	--	--	--	--	--	--	--	--	8.16
17.37	Hexanoic acid	142-62-1	--	--	--	--	--	1.74	--	--	--
17.94	Mesitylene	108-67-8	--	--	2.29	0.19	--	--	--	--	--
18.15	Decane	124-18-5	--	--	4.35	0.23	0.21	0.68	0.27	--	--
18.45	2-Ethylhexanol	104-76-7	0.23	0.21	--	--	--	--	--	--	7.70
19.18	Heptanoic acid	111-14-8	--	--	--	--	--	32.24	--	--	19.87

RT (min)	Compound Name	CAS#	Compound Concentration (ppbV)[1]								
			Controls			Baseline APU 180°C			PE 5 APU 180°C; 5ppmW		
			Shipping Blank 4[2]	Field Blank 4[2]	Trailer Sample 2	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
19.19	Acetophenone	98-86-2	--	--	--	--	0.22	--	0.27	--	--
20.02	Nonanal	124-19-6	--	--	--	--	--	--	0.25	--	--
20.29	Undecane	1120-21-4	--	--	4.41	0.30	0.30	0.87	0.33	--	--
20.73	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	1.47	--	--	--
21.01	Benzoic acid	65-85-0	--	--	--	0.76	0.92	1.16	1.12	--	--
21.35	Octanoic acid	124-07-2	--	--	--	--	--	8.95	--	--	6.72
21.63	3,5-Dimethyl-4-heptanone	19549-84-9	--	--	--	--	--	1.28	--	--	--
22.27	Dodecane	112-40-3	--	--	2.80	0.27	0.25	0.66	0.29	--	--
22.56	Allyl isovalerate	2835-39-4	--	--	--	--	--	1.69	--	--	--
23.10	Nonanoic acid	112-05-0	--	--	--	--	--	0.95	--	--	--
24.12	Tridecane	629-50-5	--	--	1.65	0.19	0.19	0.49	0.23	--	--
24.96	Decanoic acid	334-48-5	--	--	--	--	--	10.29	--	--	3.65
25.85	Tetradecane	629-59-4	--	--	1.00	0.15	0.13	--	0.17	--	--
26.12	Allyl heptanoate	142-19-8	--	--	--	--	--	1.54	--	--	--
27.01	2,6-Di-tert-butylbenzoquinone	719-22-2	--	--	--	--	--	--	--	--	3.38
27.25	Triisobutyl phosphate	126-71-6	--	--	--	--	--	--	0.28	0.15	58.52
27.63	Butylated Hydroxytoluene	128-37-0	--	--	--	--	--	--	--	--	6.30
27.74	Allyl octanoate	4230-97-1	--	--	--	--	--	0.40	--	--	--
28.09	Tributyl phosphate[4]	126-73-8	--	--	--	--	--	--	--	--	9.42
29.23	Tributyl phosphate[4]	126-73-8	--	--	--	--	--	--	1.99	1.36	197.13
30.53	2-Ethylhexyl benzoate	5444-75-7	--	--	--	--	--	--	--	--	7.43
30.74	Allyl decanoate	57856-81-2	--	--	--	--	--	0.56	--	--	--
32.39	3-Cyclopentylpropionic acid, 2-ethylhexyl ester[5]	1000293-47-0	--	--	--	--	--	--	--	--	13.21
32.62	3-Cyclopentylpropionic acid, 2-ethylhexyl ester[5]	1000293-47-0	--	--	--	--	--	--	--	--	8.68
33.62	Hexadecanoic acid	57-10-3	0.42	0.35	--	0.47	0.75	0.49	0.93	0.42	--
36.03	Octadecanoic acid	57-11-4	--	--	--	0.22	0.32	--	0.48	--	--

-- = below the detection limits of the method used.
[1]Toluene-equivalent concentrations.
[2]A volume of 1L was used for blanks to facilitate the VOC quantification.
[3] Closely related butene compounds.
[4] Closely related organophosphate compounds.
[5] Closely related 7-oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester compound.

Day 4- Afternoon: PE 5 Contamination Event using APU at 180°C (Concentration results in units of micrograms per cubic meter, µg/m³)

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m³)[1]								
			Controls			Baseline APU 180°C			PE 5 APU 180°C; 5ppmW		
			Shipping Blank 4[2]	Field Blank 4[2]	Trailer Sample 2	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
3.64	Isobutane	75-28-5	--	--	4.46	--	--	--	--	--	--
3.80	Isobutylene[3]	115-11-7	--	--	--	--	--	--	--	--	151.12
3.85	cis-2-Butene[3]	624-64-6	--	--	--	--	--	--	--	--	36.70
4.08	trans-2-Butene[3]	590-18-1	--	--	--	--	--	--	--	--	35.82
4.69	Acetone	67-64-1	3.24	2.75	21.31	--	0.93	4.89	1.11	0.57	8.05
4.82	Isopropyl alcohol	67-63-0	--	--	14.03	--	--	--	--	--	--
6.19	Methacrolein	78-85-3	--	--	--	--	--	--	--	--	3.86
6.67	Butanal	123-72-8	--	--	--	--	--	--	--	--	40.27
6.78	Acetic acid	64-19-7	--	--	--	--	--	--	0.94	0.50	11.54
6.83	2-Butanone	78-93-3	--	--	4.94	--	--	16.11	--	--	--
7.88	Tetrahydrofuran	109-99-9	--	--	10.58	--	--	--	--	--	--
8.84	1-Butanol	71-36-3	--	--	--	--	--	--	--	--	104.66
8.97	Benzene	71-43-2	3.29	2.35	--	1.20	1.32	--	2.35	1.38	--
9.65	Pentanal	110-62-3	--	--	--	--	--	3.86	--	--	--
12.16	Butanoic acid	107-92-6	--	--	--	--	--	5.90	--	--	--
12.58	Butynediol	110-65-6	--	--	--	--	--	5.86	--	--	--
12.63	Hexanal	66-25-1	--	--	--	--	--	5.22	--	--	--
14.01	2-Methylbutanoic acid	116-53-0	--	--	--	--	--	41.28	--	--	24.10
14.78	Pentanoic acid	109-52-4	--	--	--	--	--	108.33	--	--	55.93
15.05	Cyclohexanone	108-94-1	--	--	5.08	--	--	--	--	--	--
15.34	Heptanal	111-71-7	--	--	--	--	--	--	--	--	--
15.81	Nonane	111-84-2	--	--	9.48	--	--	--	--	--	--
16.03	2(3H)-Furanone, dihydro-5-methyl-	108-29-2	--	--	--	--	--	5.54	--	--	--
16.76	Benzaldehyde	100-52-7	--	--	--	--	1.08	--	1.57	--	--
17.10	Phenol	108-95-2	--	--	--	--	--	--	--	--	31.37
17.37	Hexanoic acid	142-62-1	--	--	--	--	--	8.24	--	--	--
17.94	Mesitylene	108-67-8	--	--	11.25	0.91	--	--	--	--	--
18.15	Decane	124-18-5	--	--	25.29	1.36	1.25	3.93	1.58	--	--
18.45	2-Ethylhexanol	104-76-7	1.21	1.13	--	--	--	--	--	--	40.99
19.18	Heptanoic acid	111-14-8	--	--	--	--	--	171.55	--	--	105.71

RT (min)	Compound Name	CAS#	Compound Concentration (µg/m³)[1]								
			Controls			Baseline APU 180°C			PE 5 APU 180°C; 5ppmW		
			Shipping Blank 4[2]	Field Blank 4[2]	Trailer Sample 2	Inlet 1	Inlet 2	Bleed	Inlet 1	Inlet 2	Bleed
19.19	Acetophenone	98-86-2	--	--	--	--	1.07	--	1.33	--	--
20.02	Nonanal	124-19-6	--	--	--	--	--	--	1.45	--	--
20.29	Undecane	1120-21-4	--	--	28.19	1.93	1.92	5.56	2.13	--	--
20.73	2(3H)-Furanone, dihydro-5-propyl-	105-21-5	--	--	--	--	--	7.72	--	--	--
21.01	Benzoic acid	65-85-0	--	--	--	3.82	4.60	5.77	5.60	--	--
21.35	Octanoic acid	124-07-2	--	--	--	--	--	52.74	--	--	39.63
21.63	3,5-Dimethyl-4-heptanone	19549-84-9	--	--	--	--	--	7.47	--	--	--
22.27	Dodecane	112-40-3	--	--	19.48	1.86	1.77	4.59	2.01	--	--
22.56	Allyl isovalerate	2835-39-4	--	--	--	--	--	9.83	--	--	--
23.10	Nonanoic acid	112-05-0	--	--	--	--	--	6.15	--	--	--
24.12	Tridecane	629-50-5	--	--	12.44	1.42	1.46	3.72	1.70	--	--
24.96	Decanoic acid	334-48-5	--	--	--	--	--	72.44	--	--	25.69
25.85	Tetradecane	629-59-4	--	--	8.10	1.22	1.06	--	1.37	--	--
26.12	Allyl heptanoate	142-19-8	--	--	--	--	--	10.72	--	--	--
27.01	2,6-Di-tert-butylbenzoquinone	719-22-2	--	--	--	--	--	--	--	--	30.45
27.25	Triisobutyl phosphate	126-71-6	--	--	--	--	--	--	3.04	1.66	637.09
27.63	Butylated Hydroxytoluene	128-37-0	--	--	--	--	--	--	--	--	56.75
27.74	Allyl octanoate	4230-97-1	--	--	--	--	--	3.00	--	--	--
28.09	Tributyl phosphate[4]	126-73-8	--	--	--	--	--	--	--	--	102.60
29.23	Tributyl phosphate[4]	126-73-8	--	--	--	--	--	--	21.68	14.79	2145.98
30.53	2-Ethylhexyl benzoate	5444-75-7	--	--	--	--	--	--	--	--	71.15
30.74	Allyl decanoate	57856-81-2	--	--	--	--	--	4.89	--	--	--
32.39	3-Cyclopentylpropionic acid, 2-ethylhexyl ester[5]	1000293-47-0	--	--	--	--	--	--	--	--	137.40
32.62	3-Cyclopentylpropionic acid, 2-ethylhexyl ester[5]	1000293-47-0	--	--	--	--	--	--	--	--	90.26
33.62	Hexadecanoic acid	57-10-3	4.40	3.72	--	4.94	7.82	5.15	9.70	4.43	--
36.03	Octadecanoic acid	57-11-4	--	--	--	2.59	3.67	--	5.58	--	--

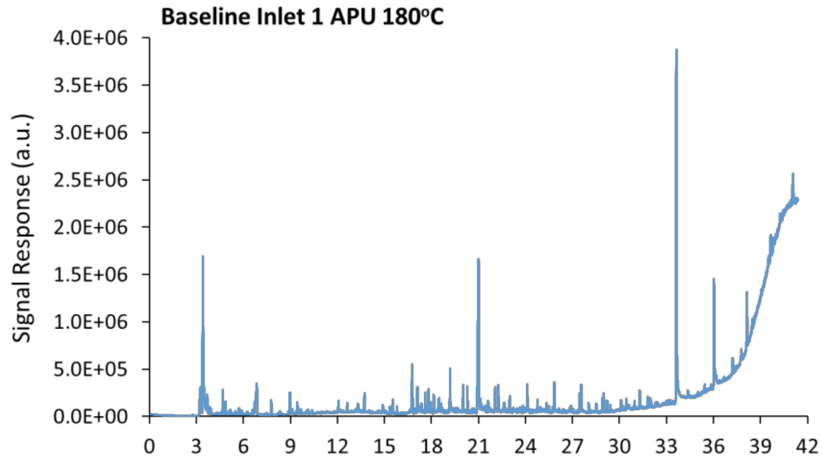
-- = below the detection limits of the method used.
[1]Toluene-equivalent concentrations.
[2]A volume of 1L was used for blanks to facilitate the VOC quantification.
[3] Closely related butene compounds.
[4] Closely related organophosphate compounds.
[5] Closely related 7-oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester compound.

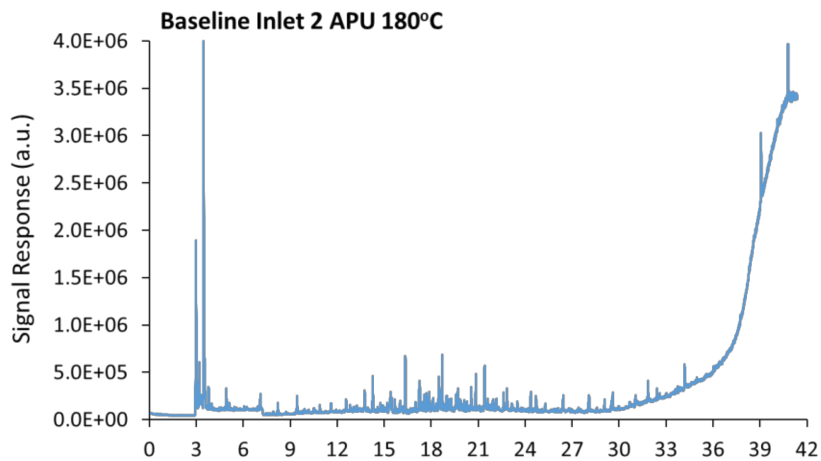
Appendix D: GCMS Total Ion Chromatograms (TICs)

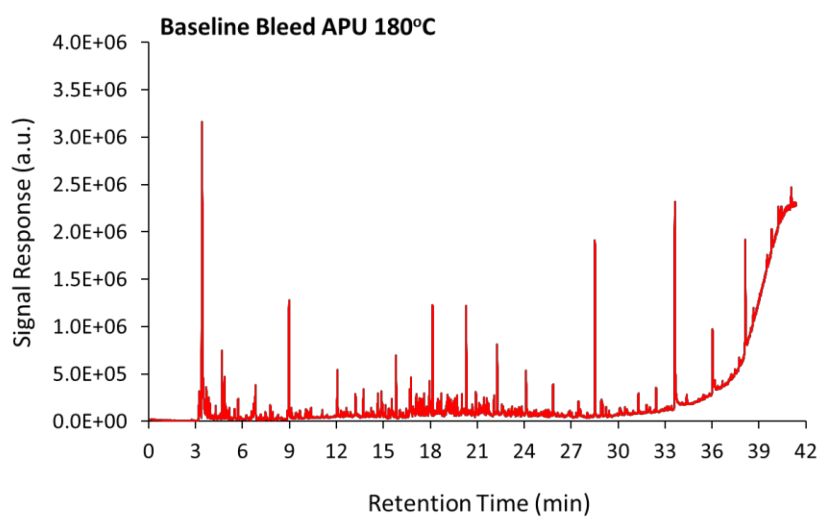
Note: *The distinctive peak observed at 3.2 minutes is an artifact of the method used.*

Day 1-Afternoon: MJO II Contamination Event using APU at 180°C

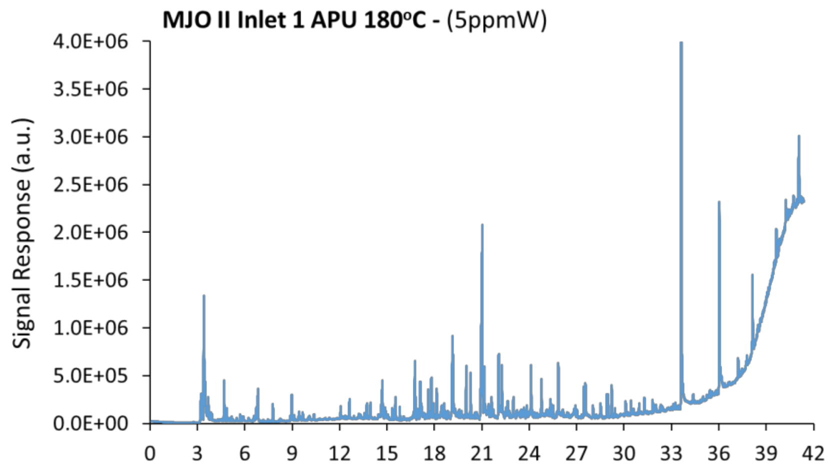
Samples Before Injection

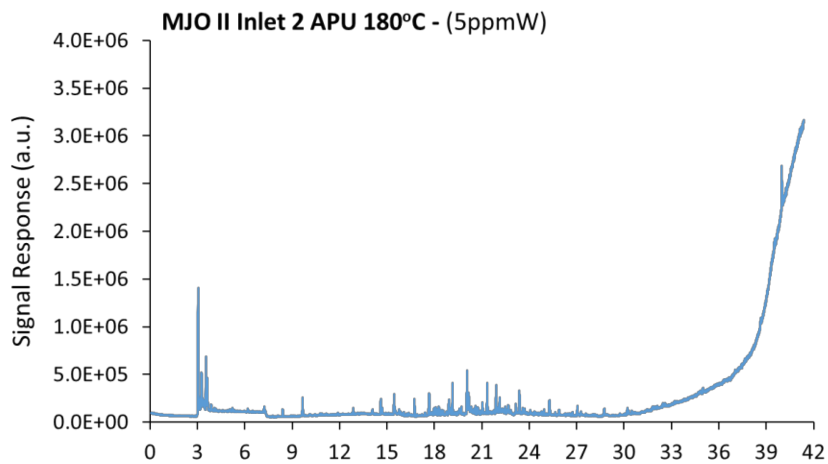


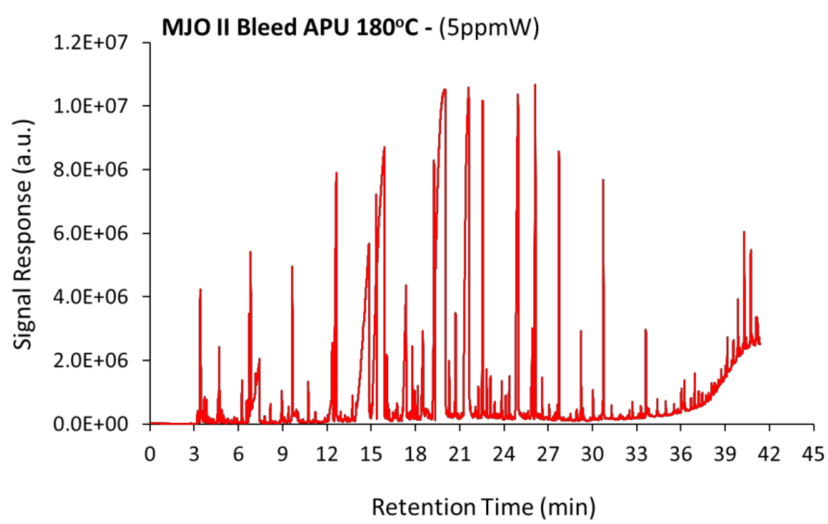




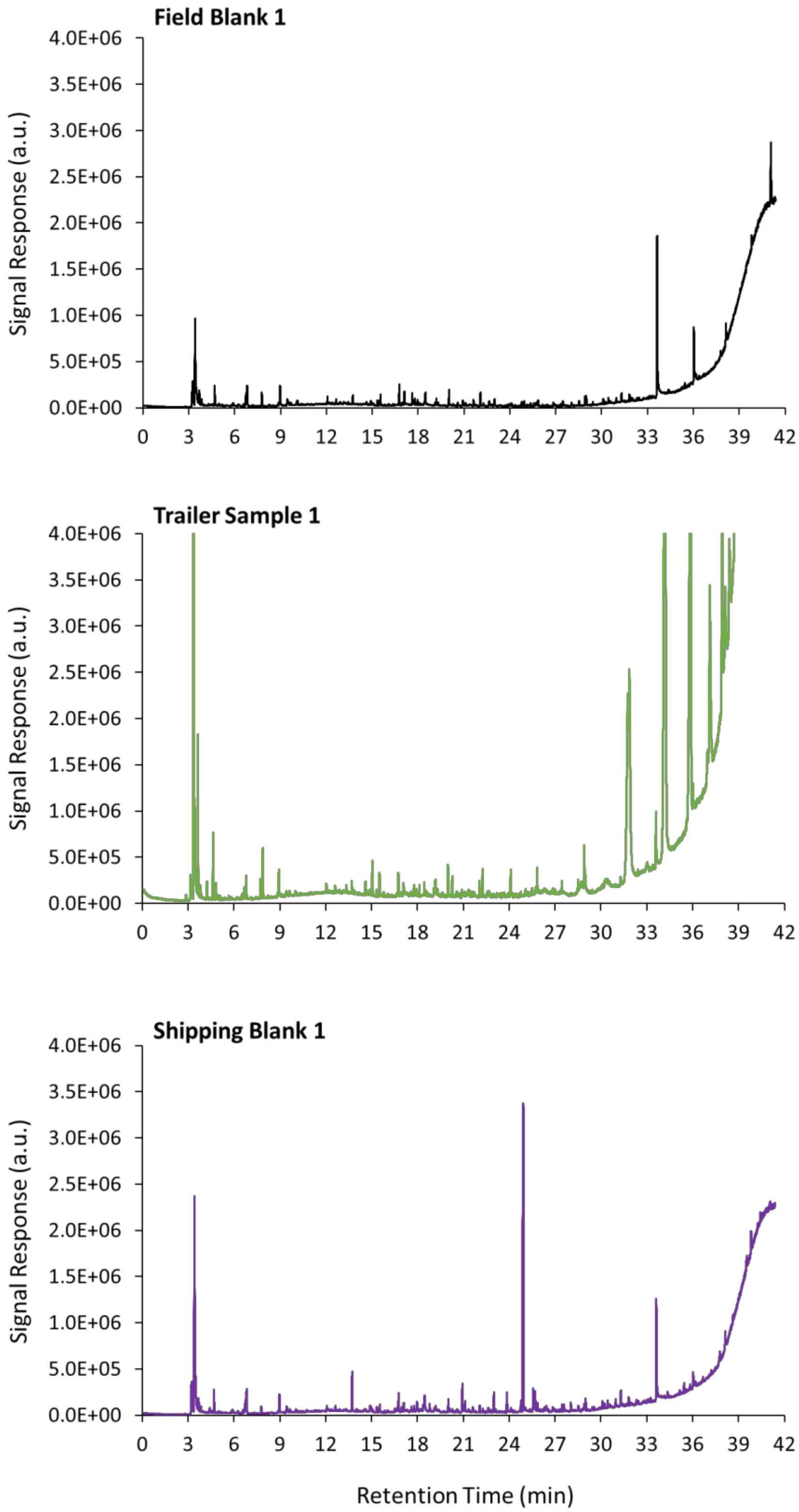
Samples During MJO II Injection





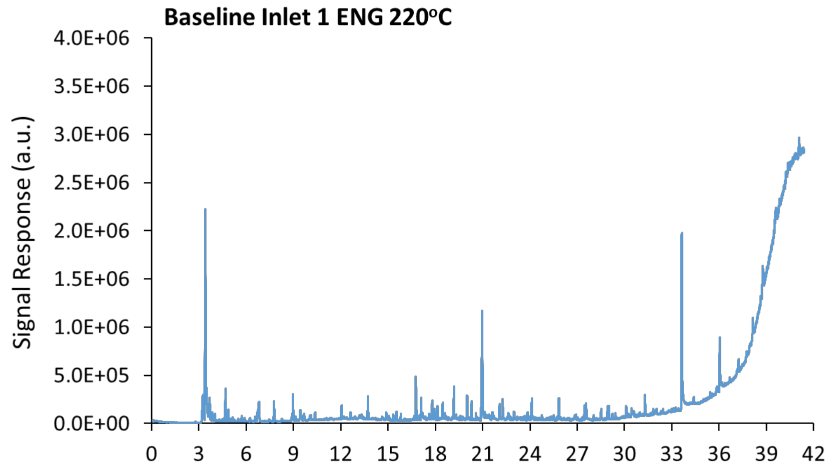


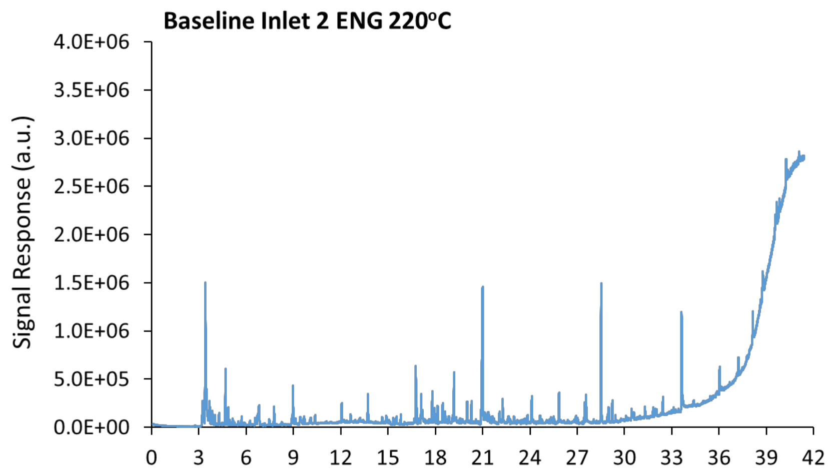
Control Samples

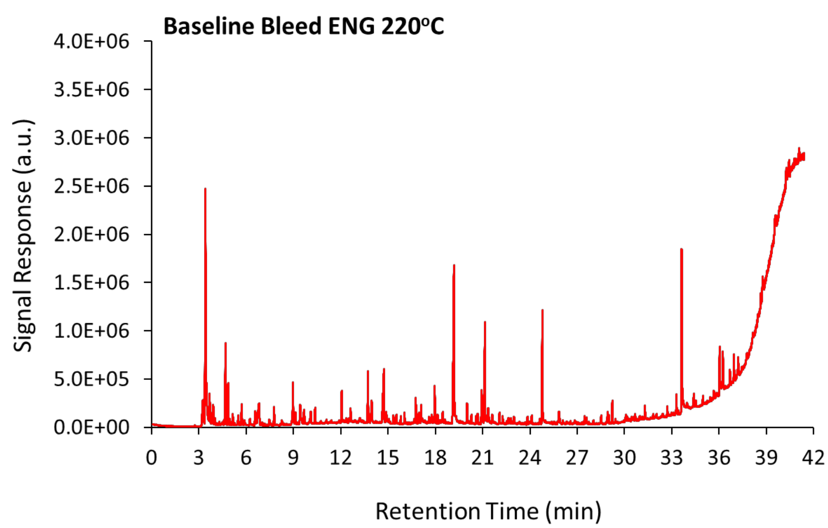


Day 2-Morning: MJO II Contamination Event using ENG at 220°C

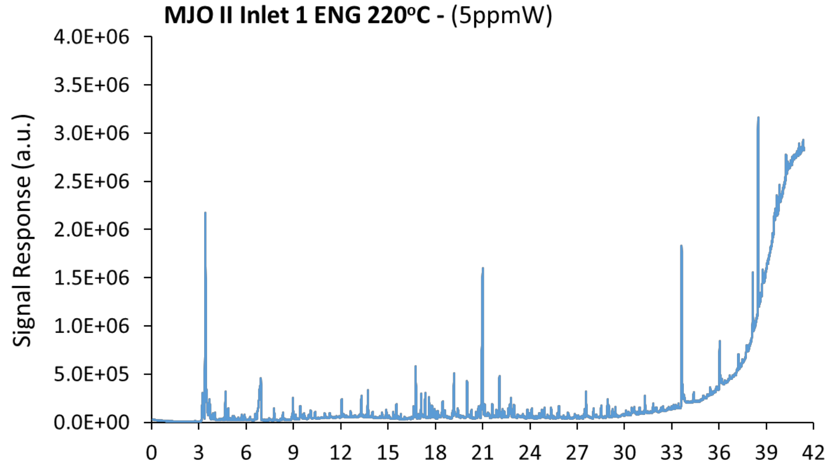
Samples Before Injection

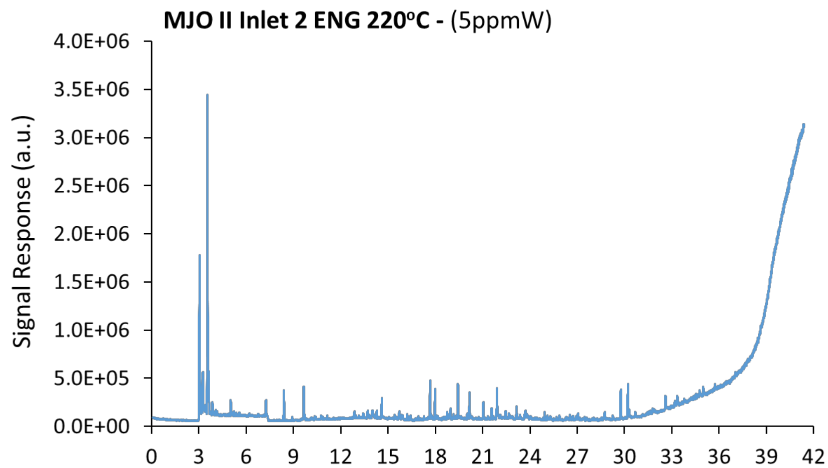


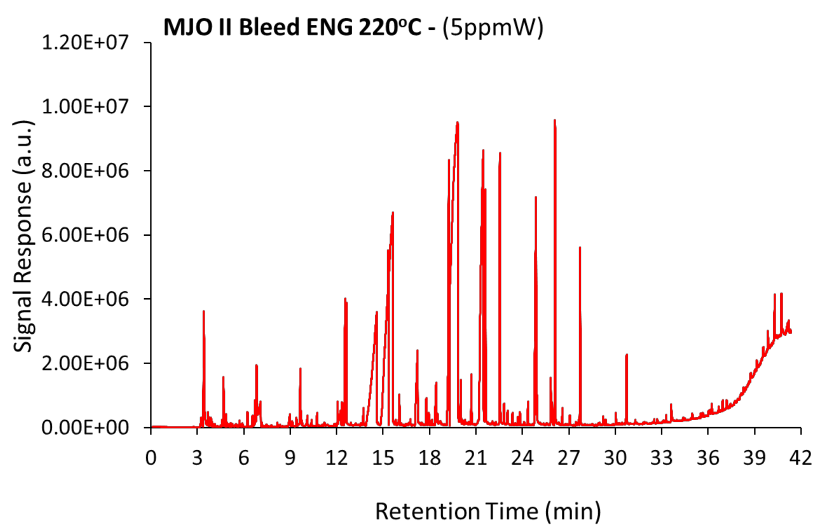




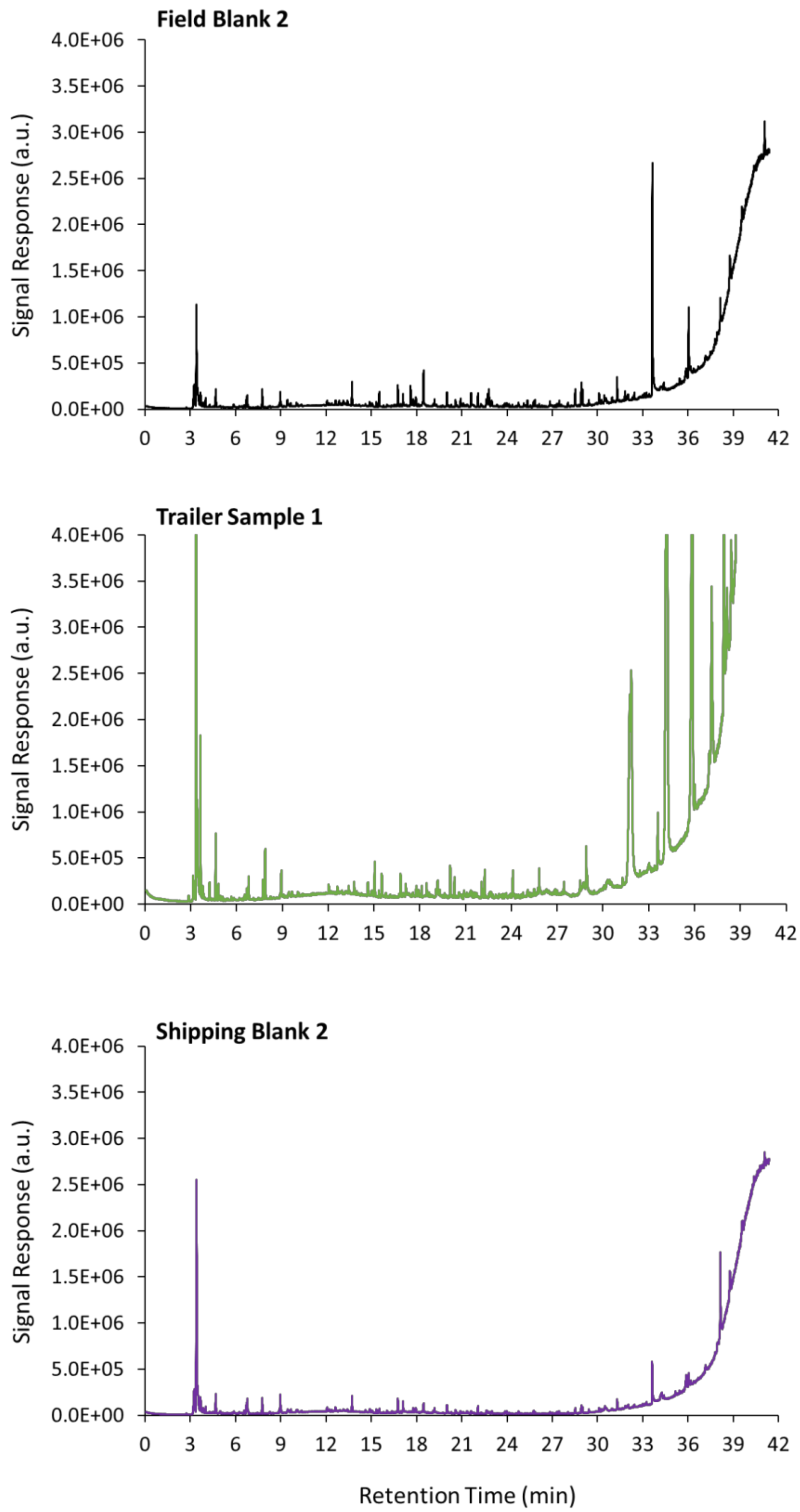
Samples During MJO II Injection





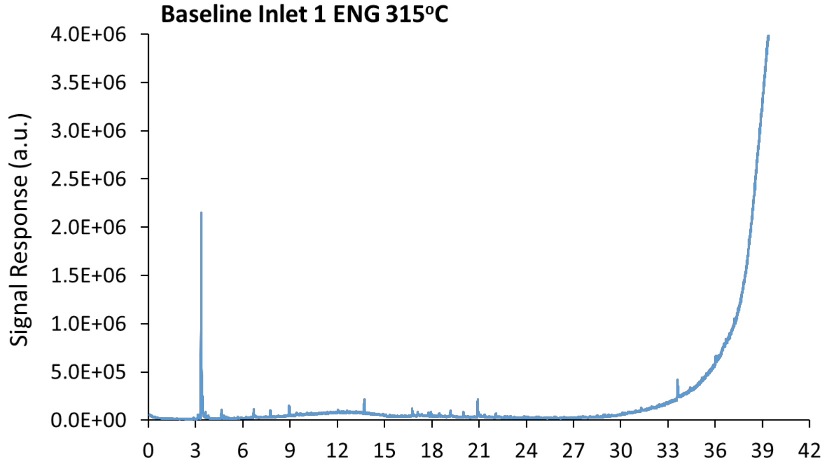


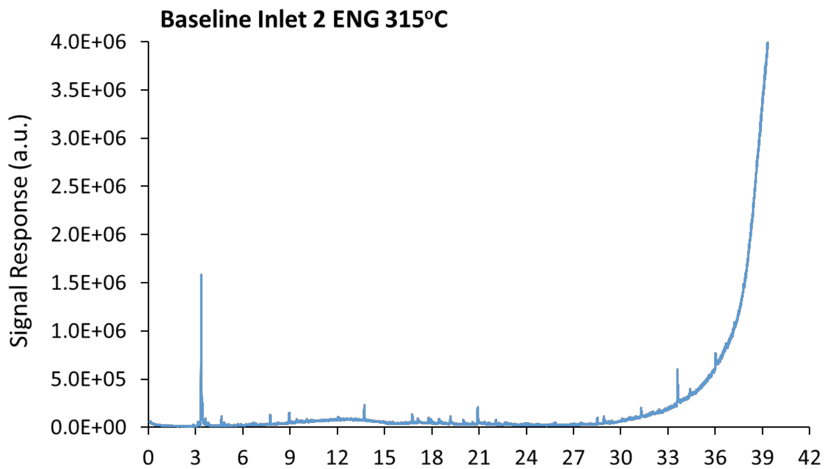
Control Samples

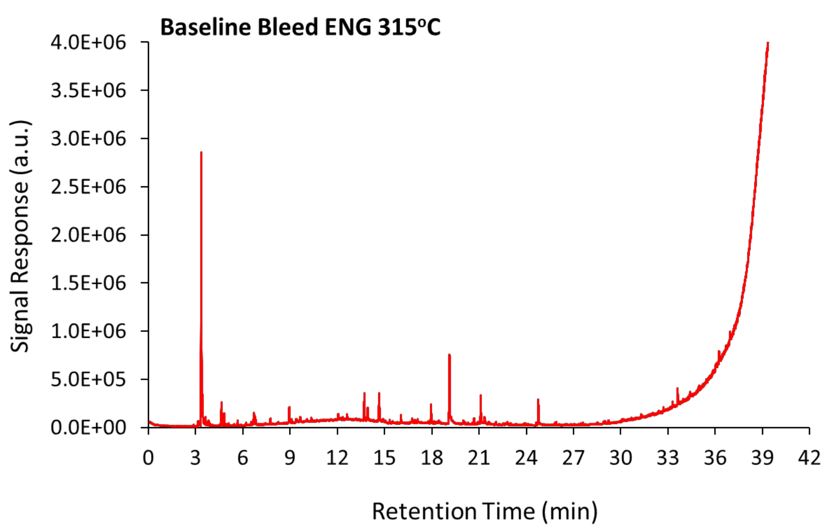


Day 2-Afternoon: MJO II Contamination Event using ENG at 315^{o}C

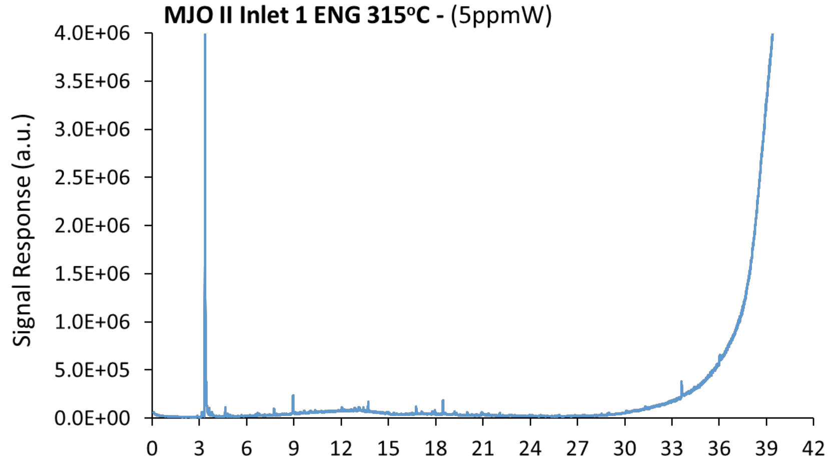
Samples Before Injection

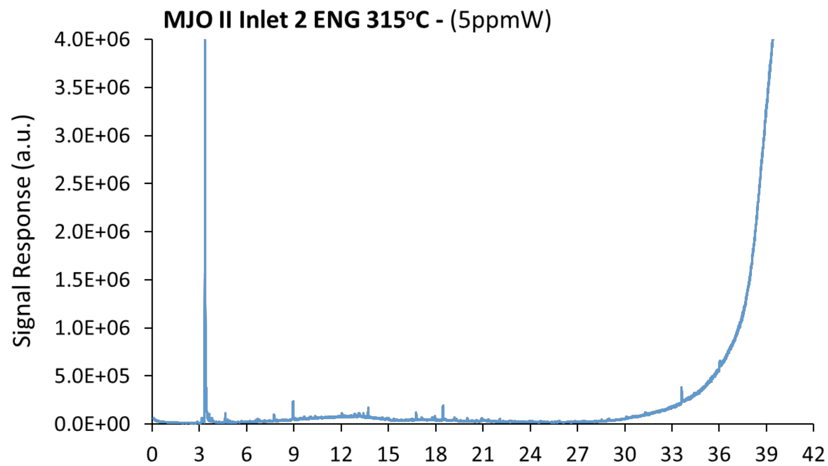


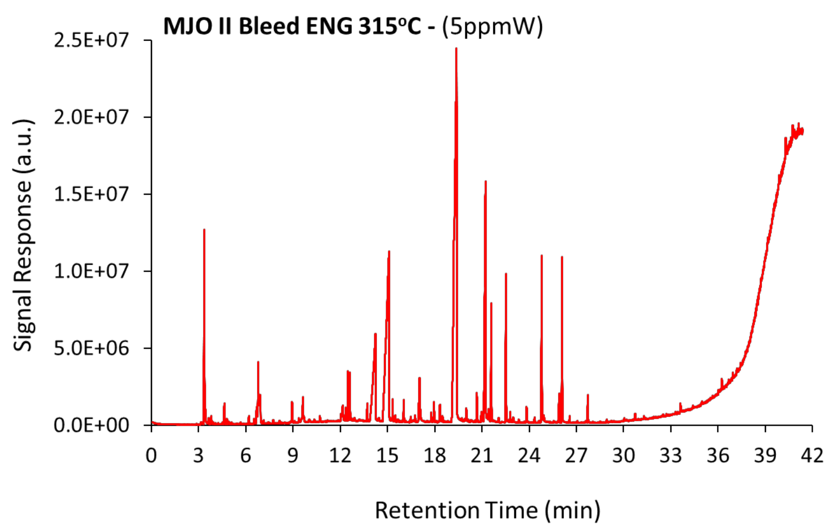




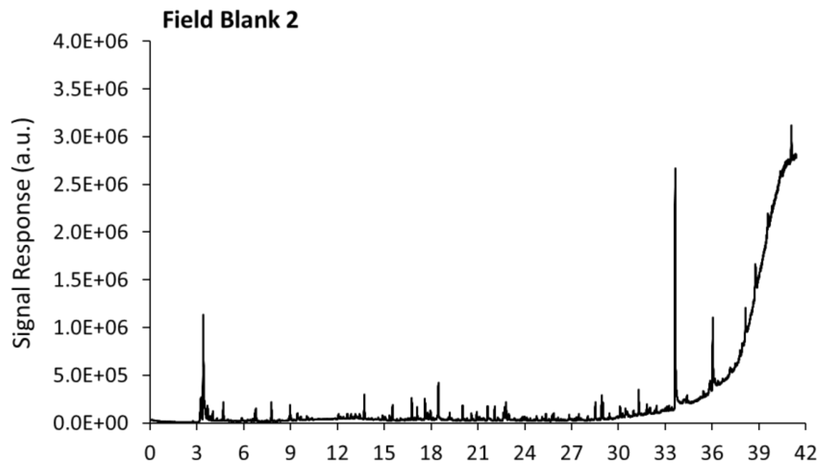
Samples During MJO II Injection

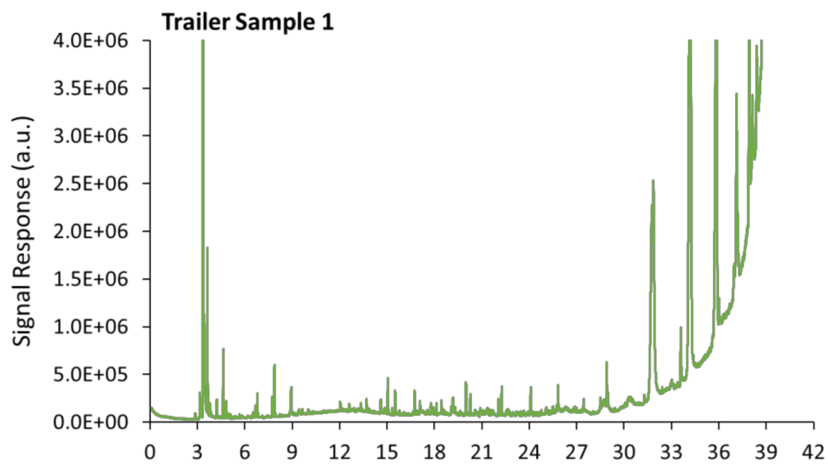


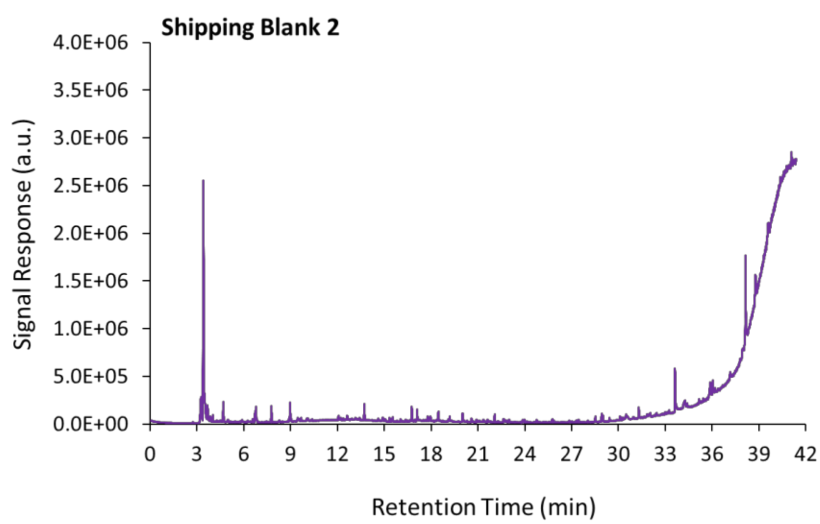




Control Samples

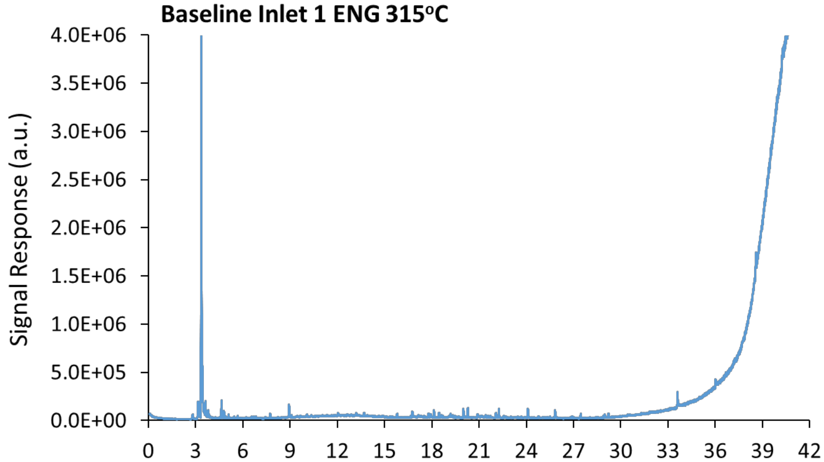


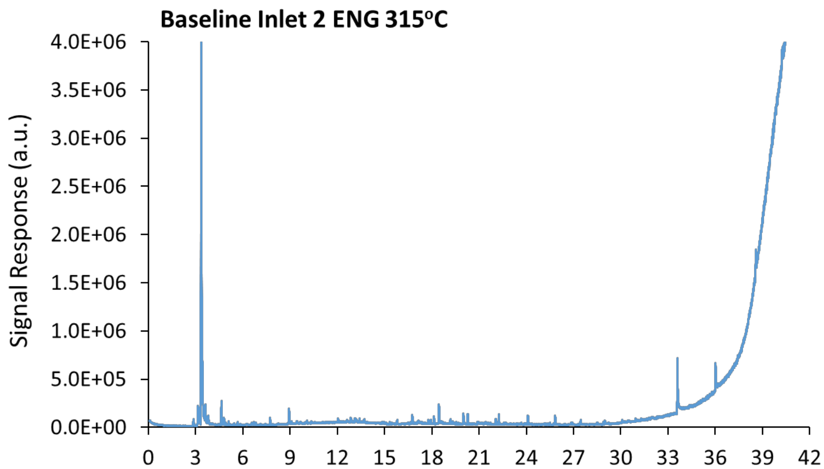


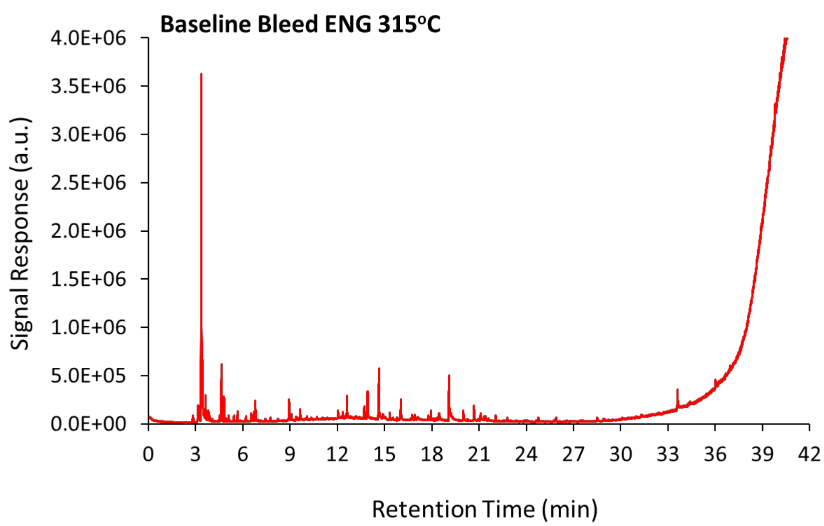


Day 3-Morning: ETO 2197 Contamination Event using ENG at 315°C

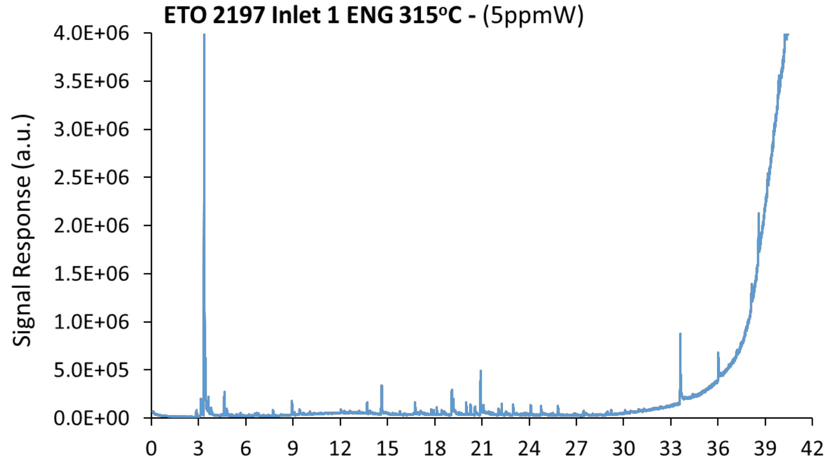
Samples Before Injection

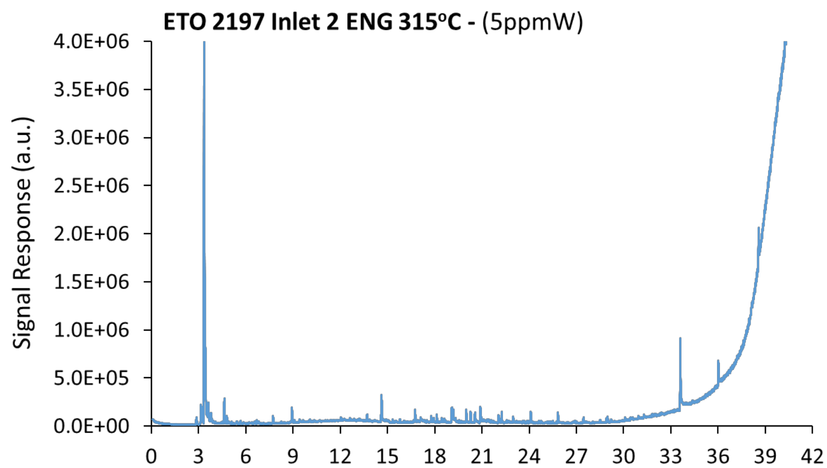


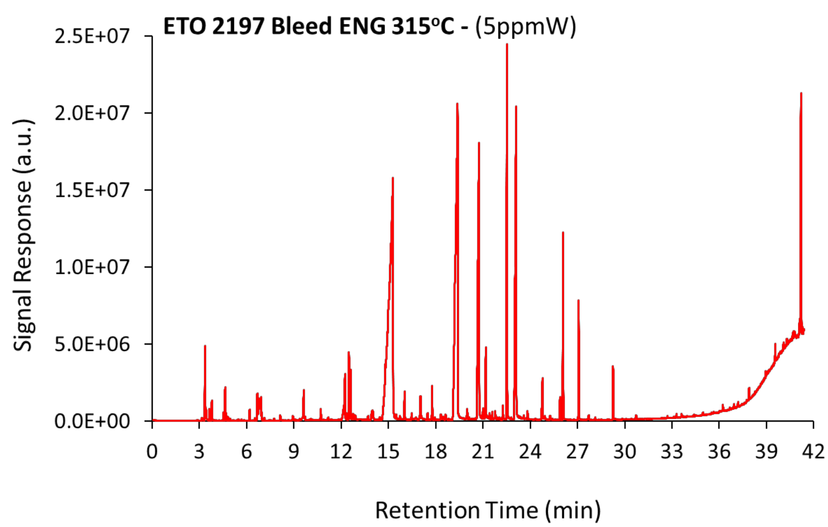




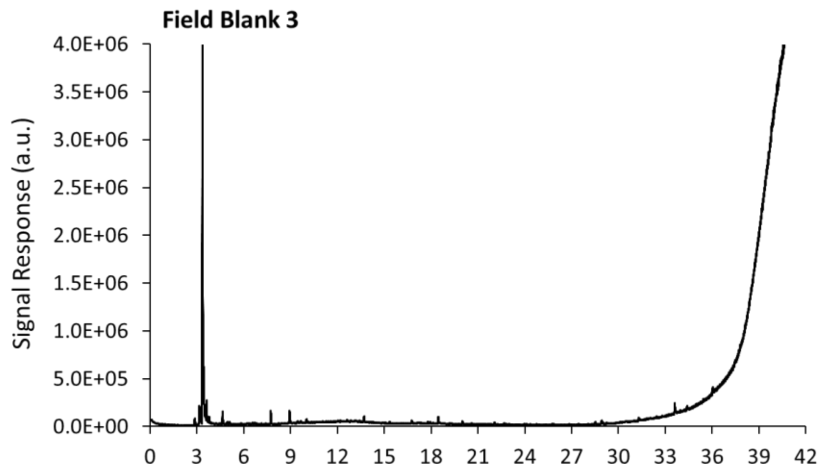
Samples During ETO 2197 Injection

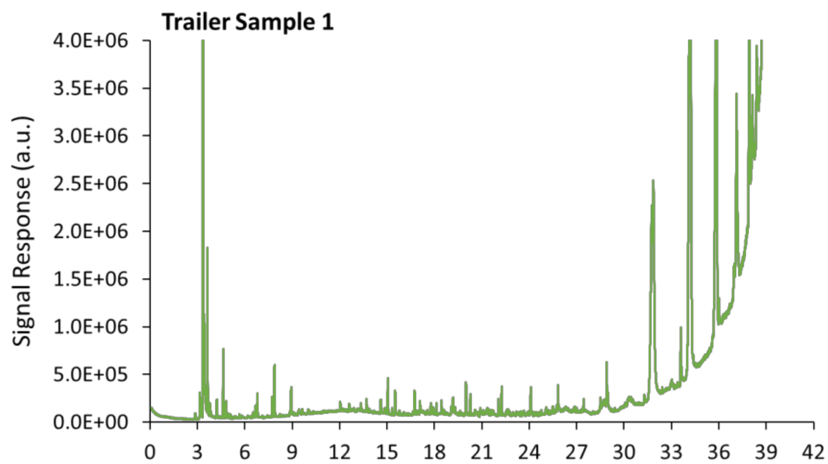


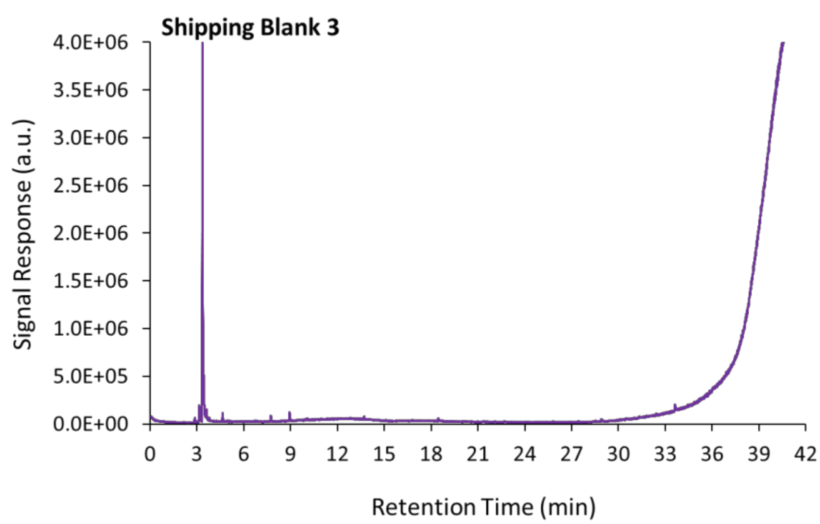




Control Samples

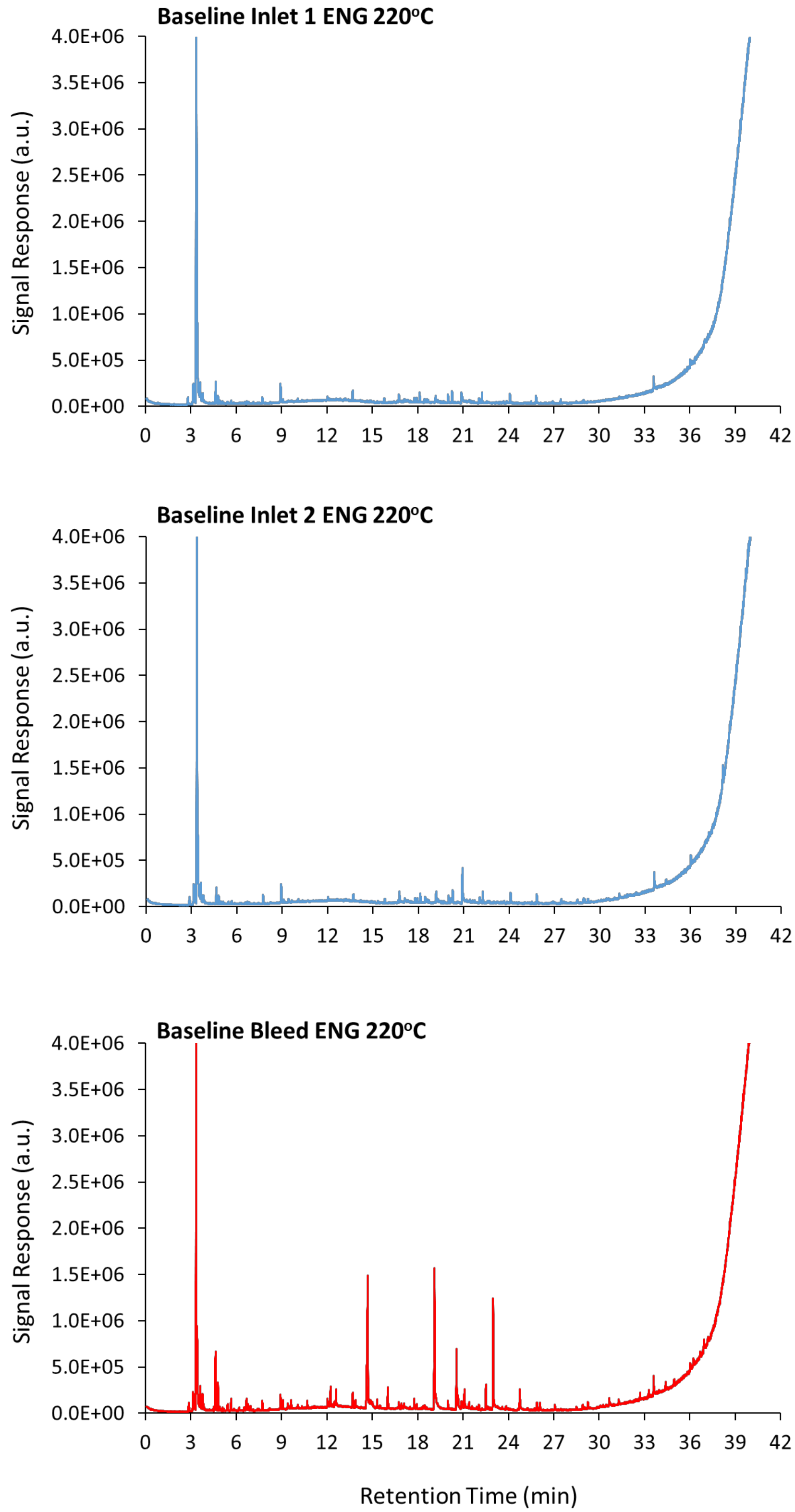




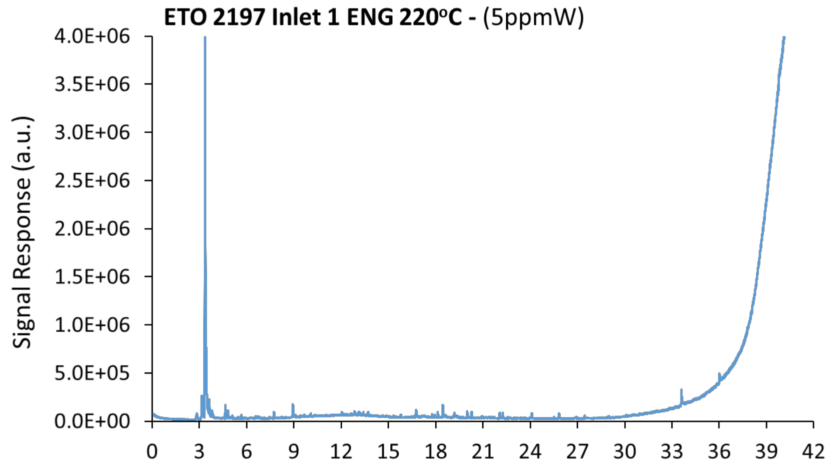


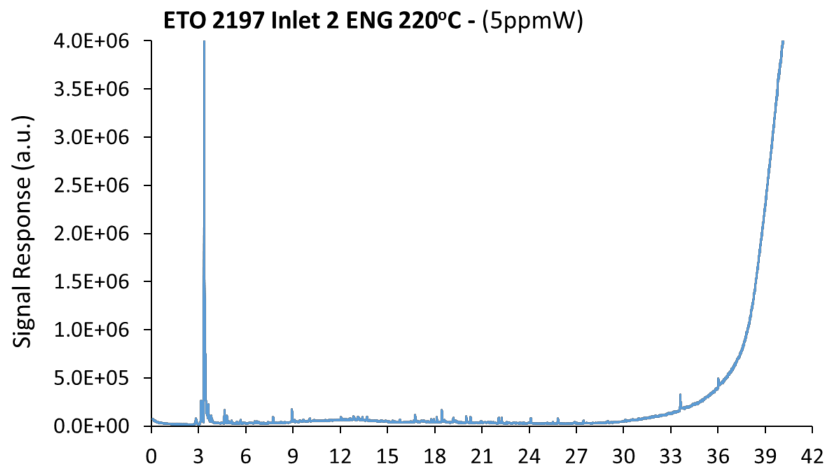
Day 3-Afternoon: ETO 2197 Contamination Event using ENG at 220°C

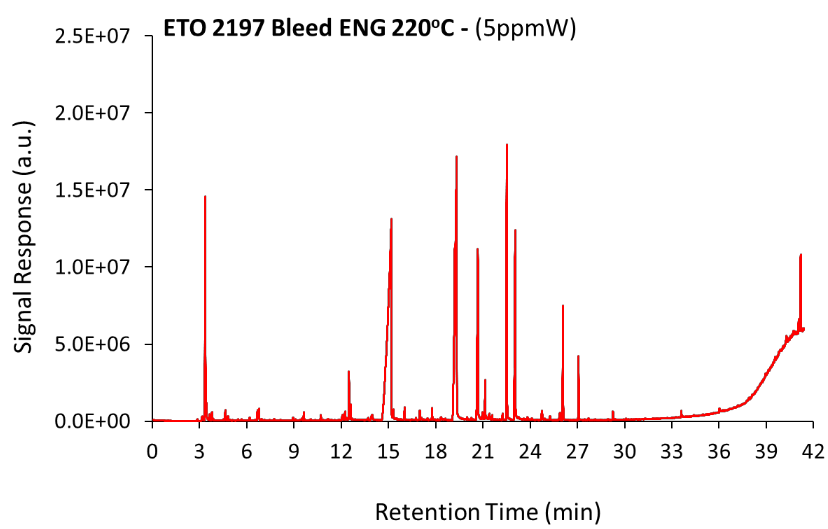
Samples Before Injection



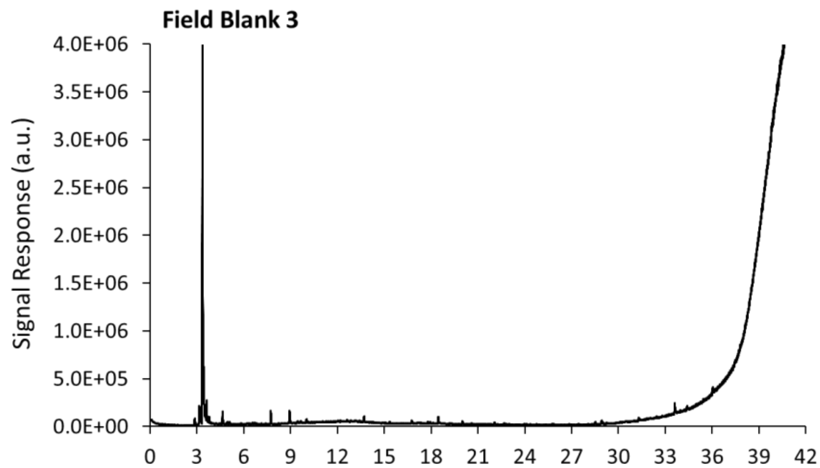
Samples During ETO 2197 Injection

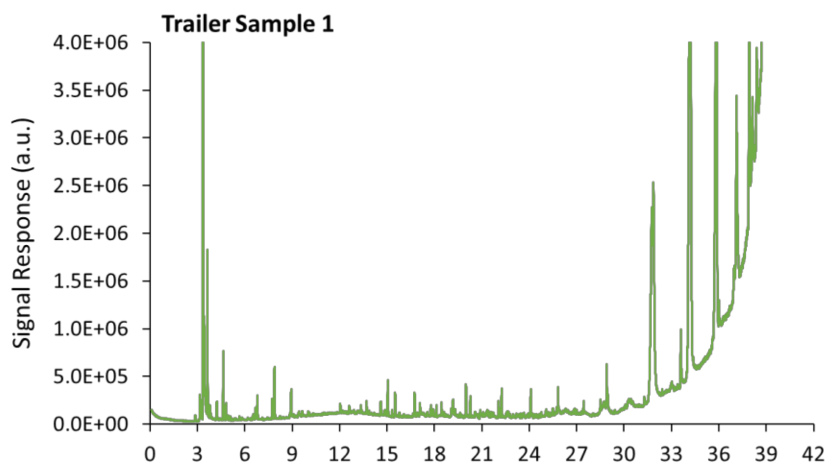


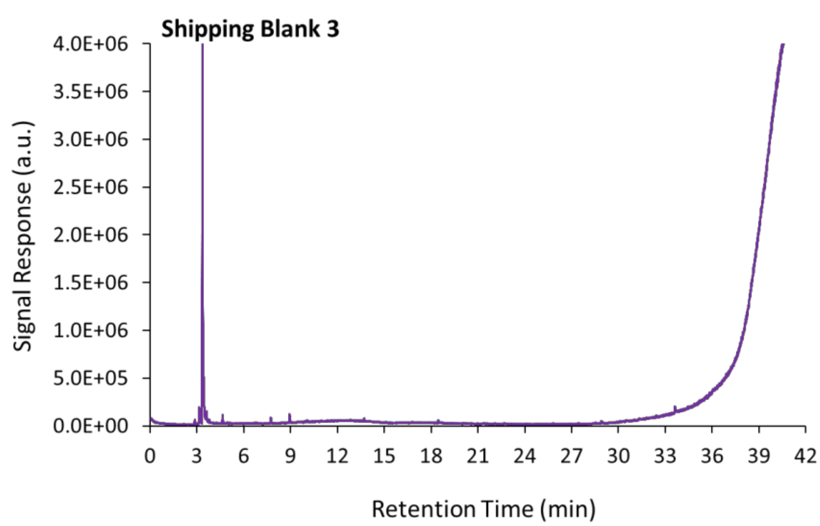




Control Samples

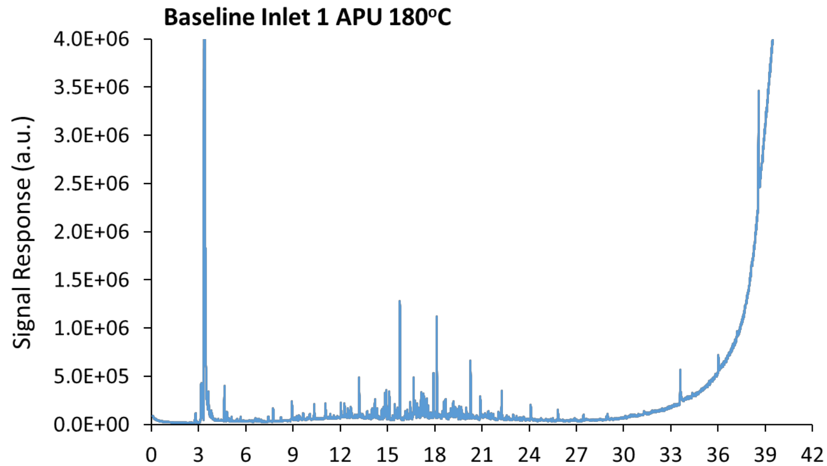


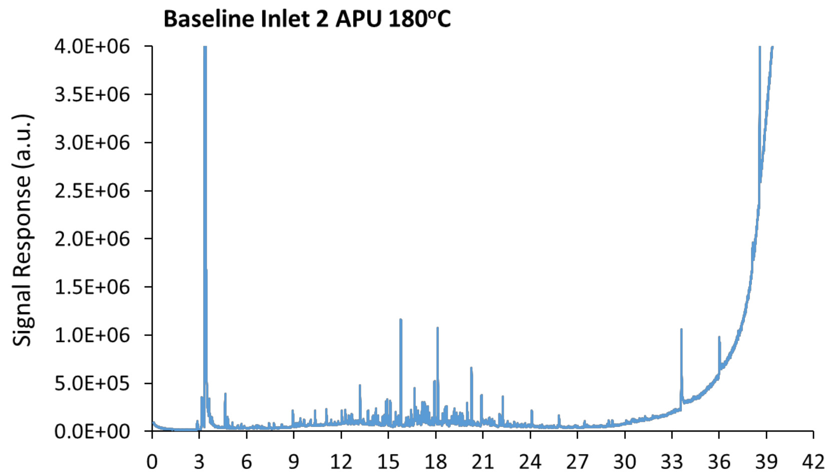


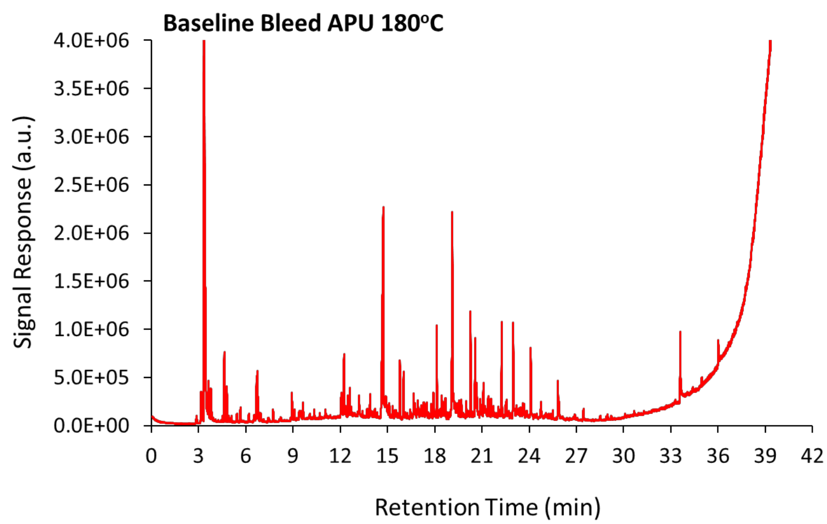


Day 4-Morning: MJO II Contamination Event using APU at 180°C

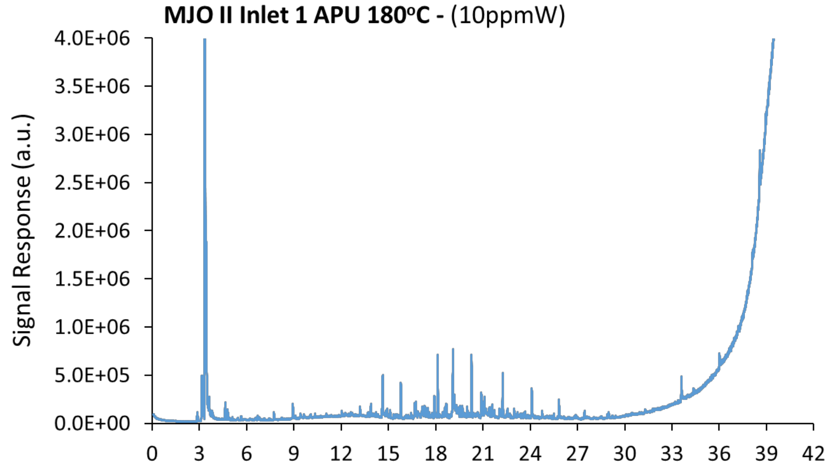
Samples Before Injection

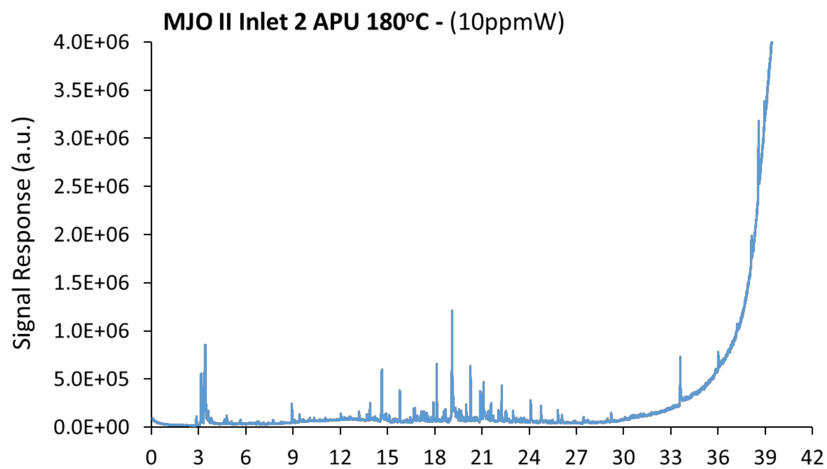


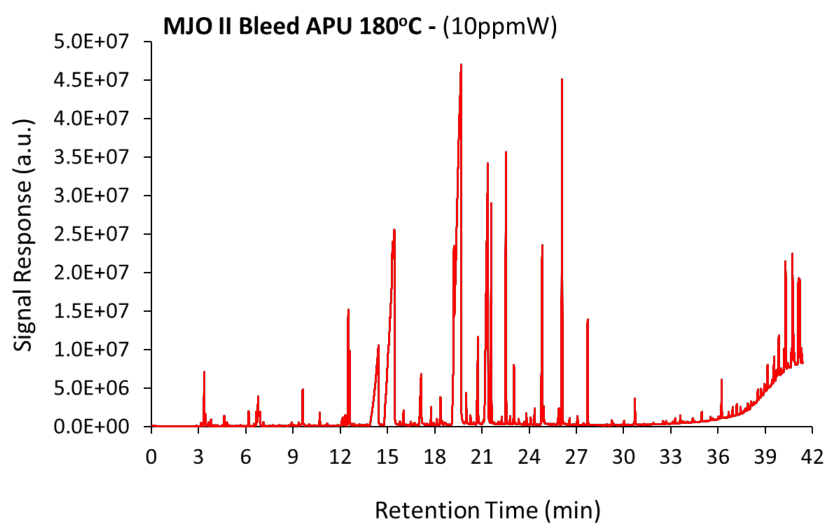




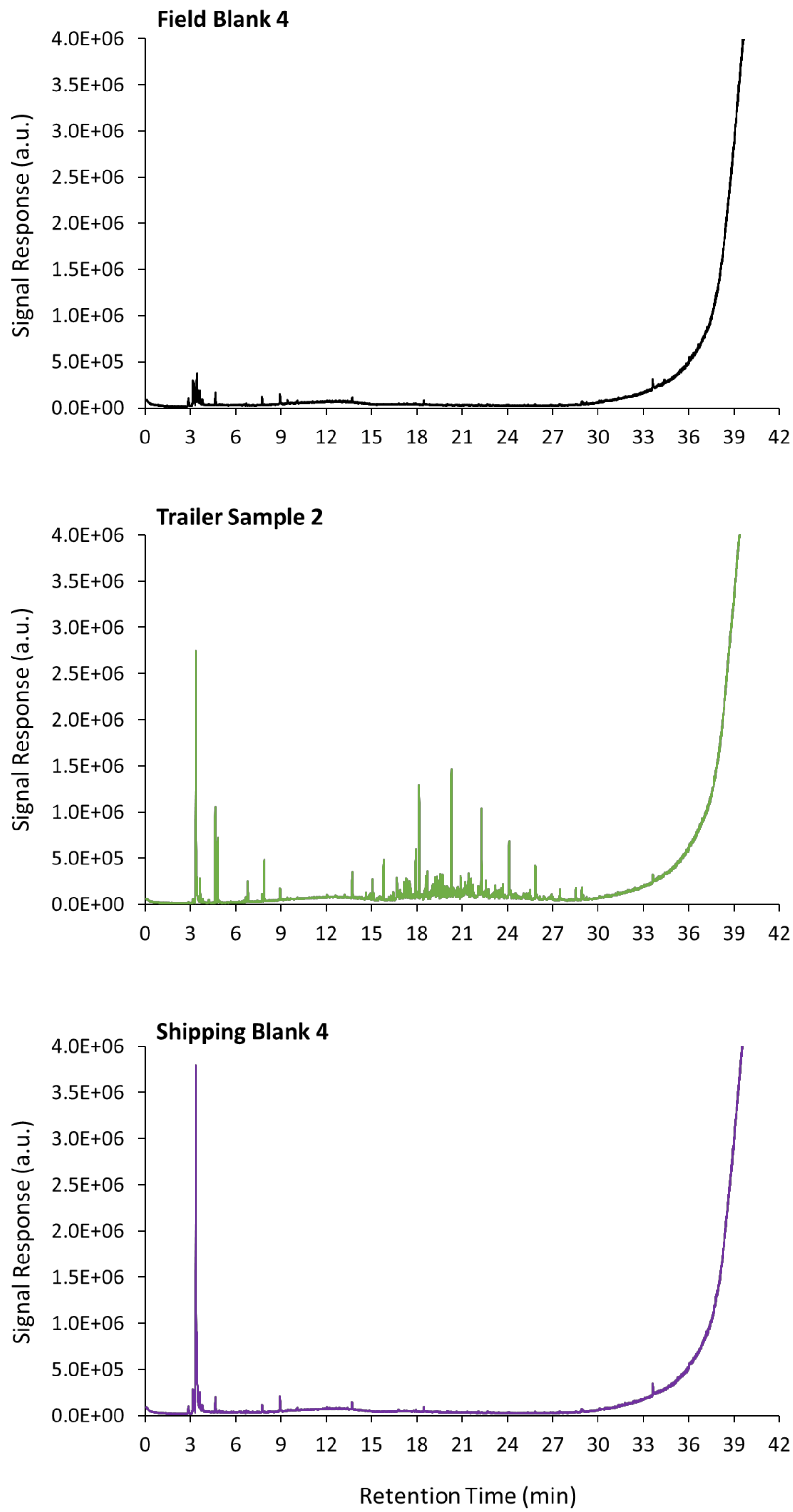
Samples During MJO II Injection





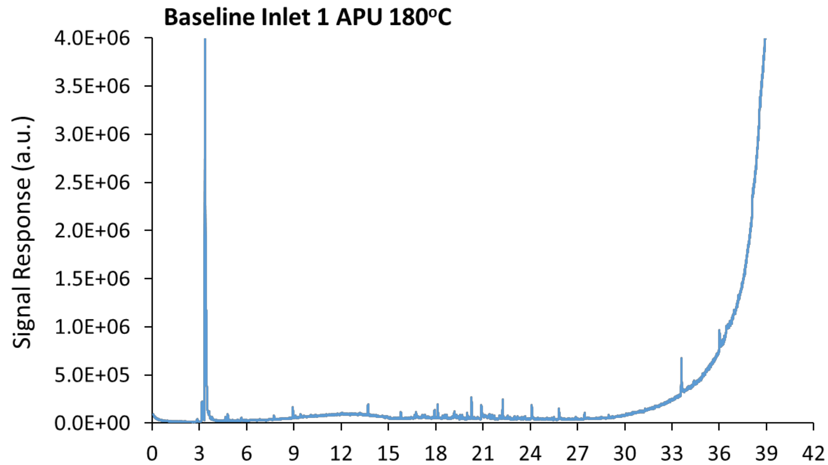


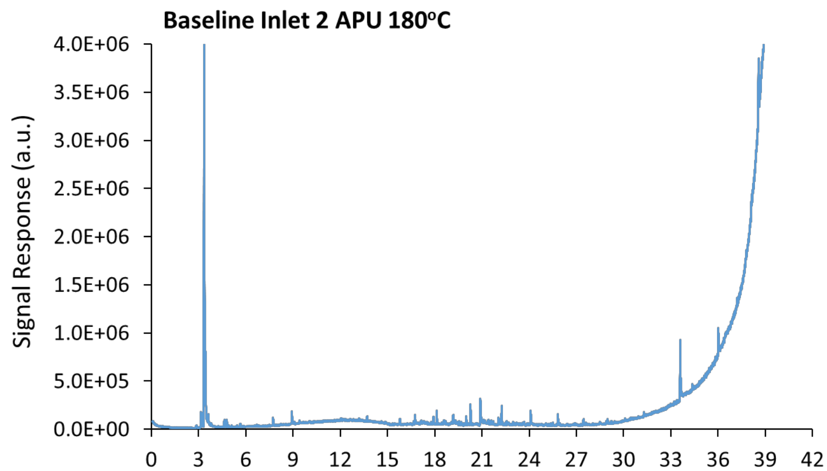
Control Samples

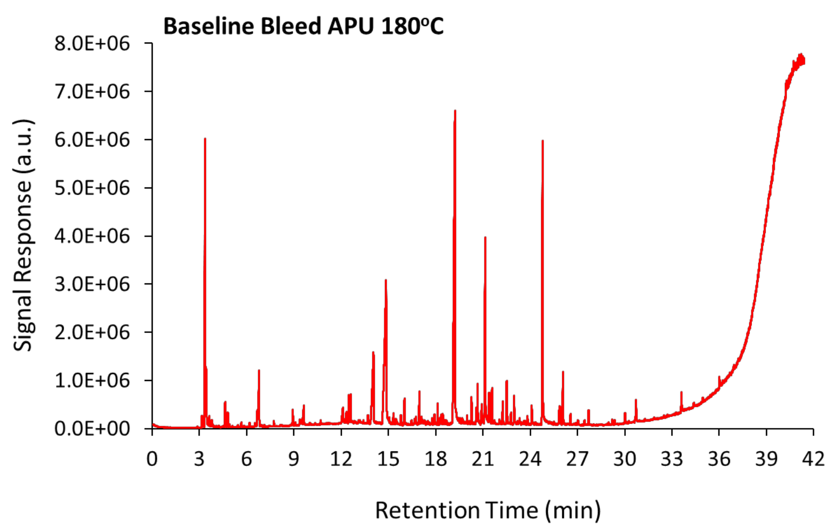


Day 4-Afternoon: PE 5 Contamination Event using APU at 180°C

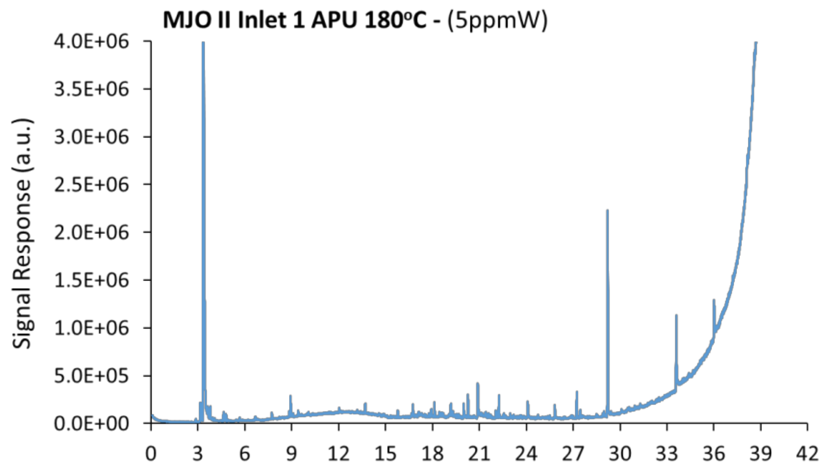
Samples Before Injection

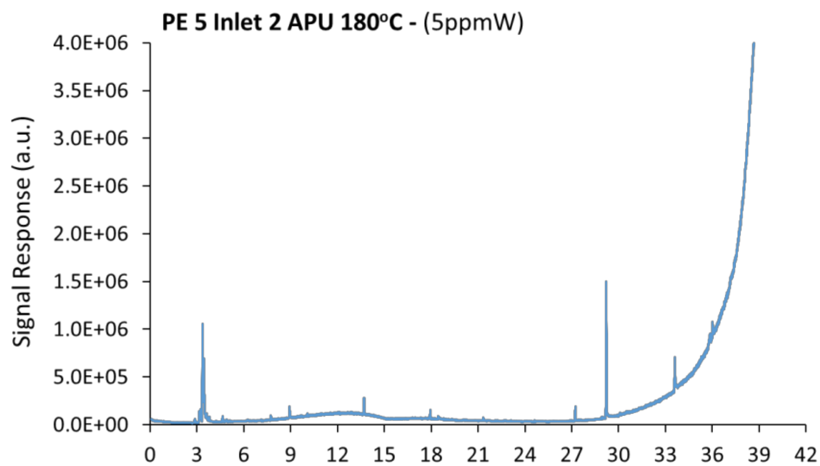


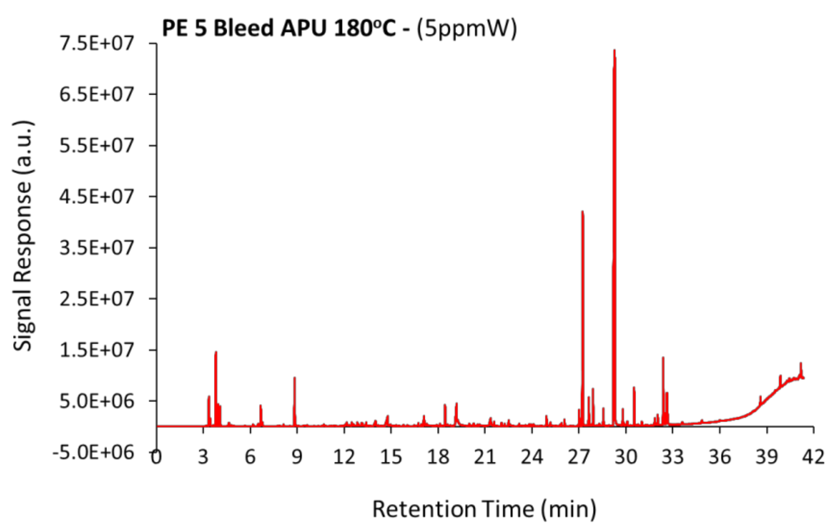




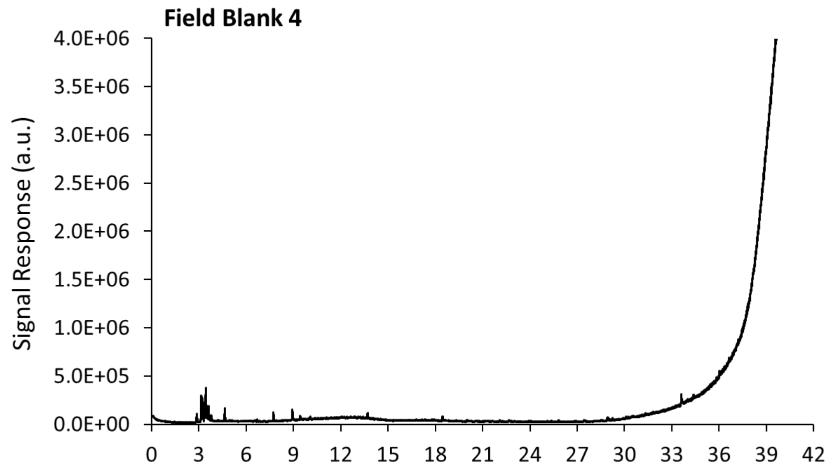
Samples During PE 5 Injection

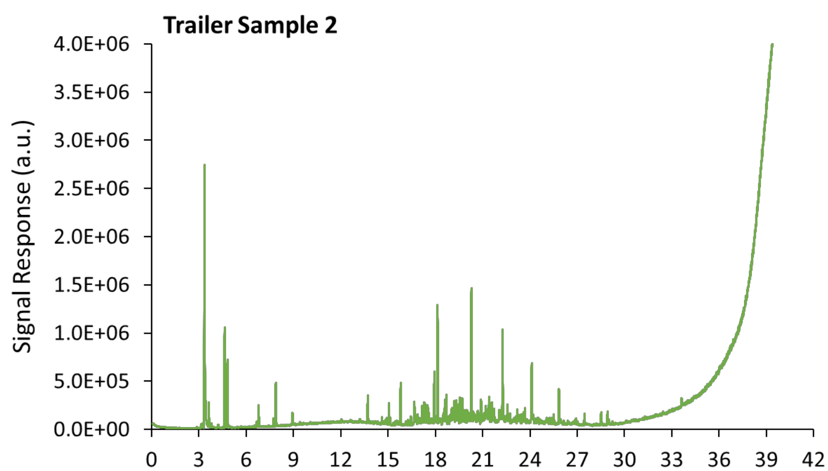


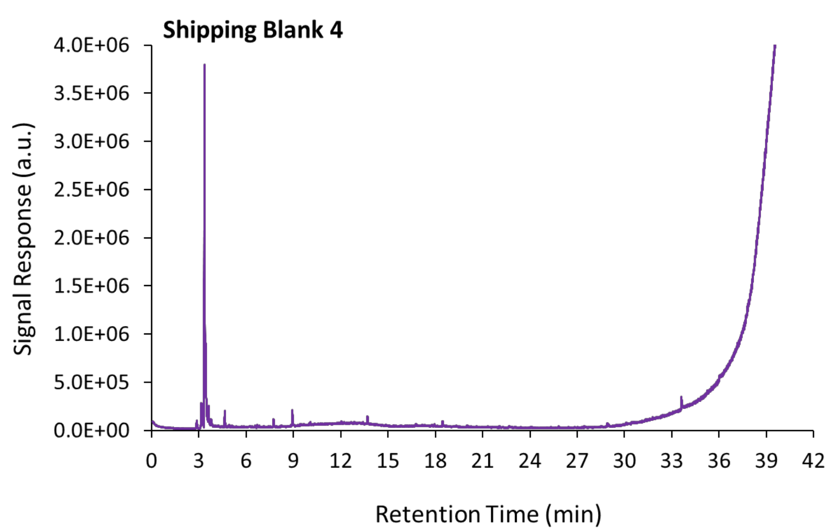




Control Samples

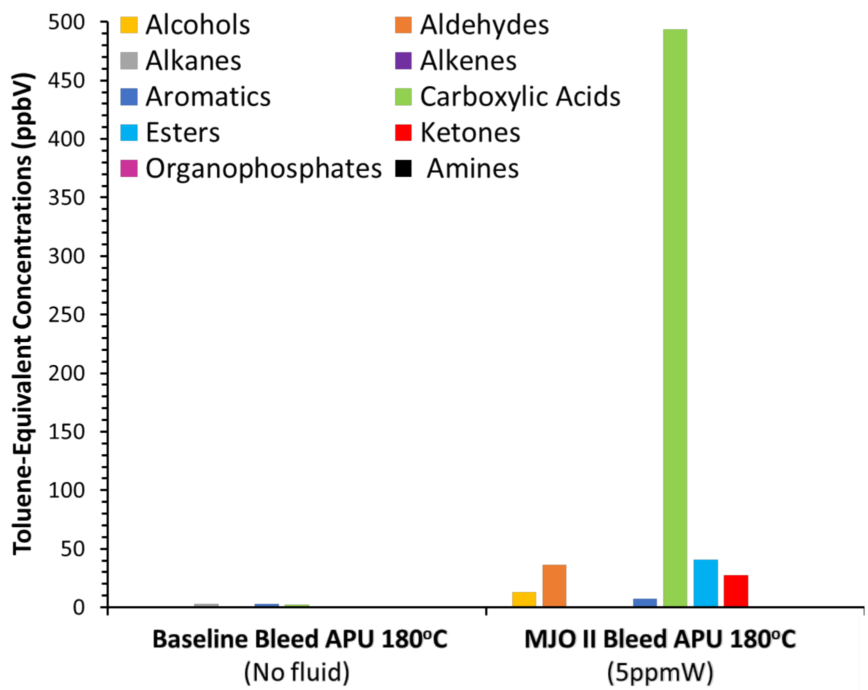




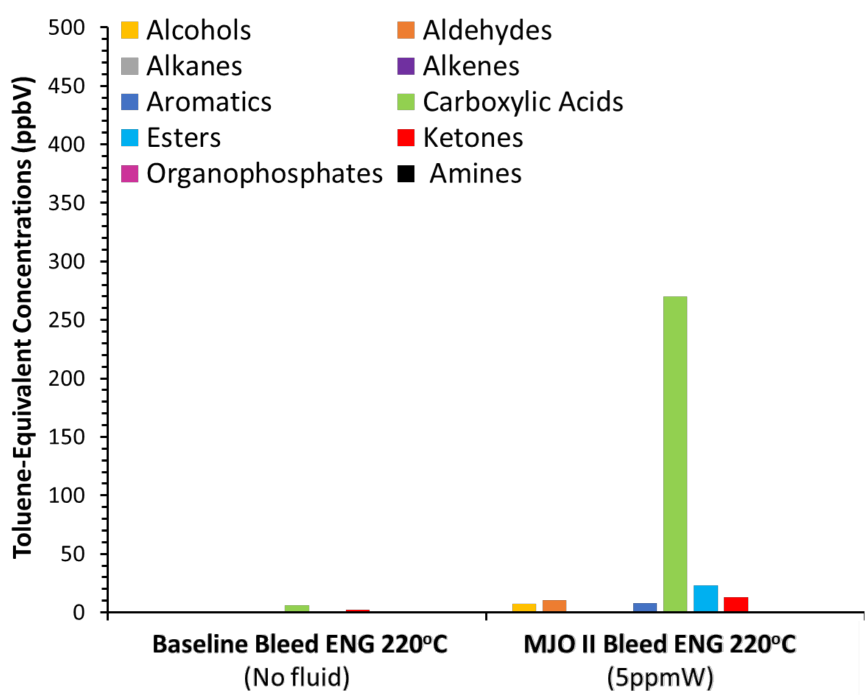


Appendix E: Major Classes of VOCs Identified in the Bleed Samples before Corrections

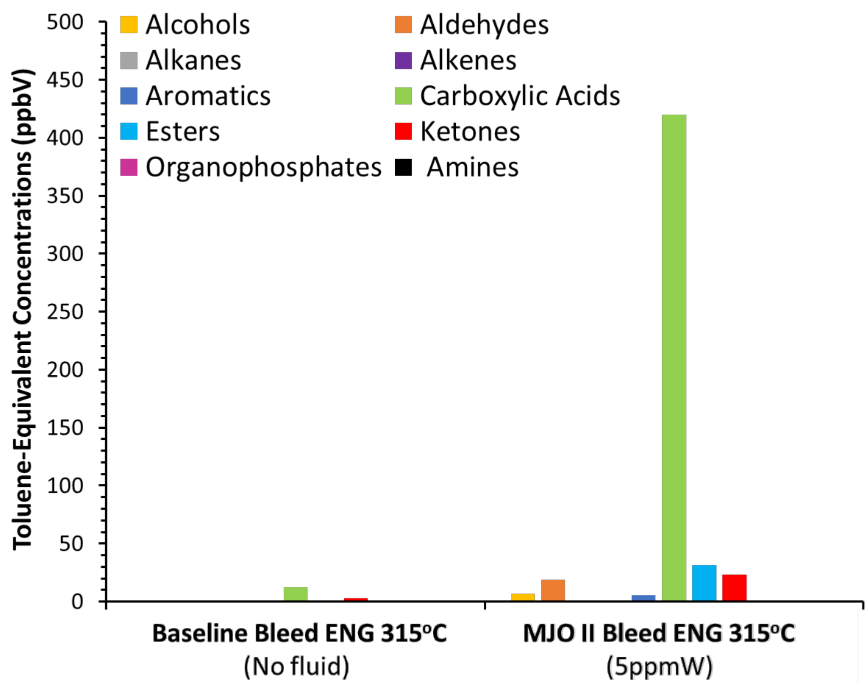
Day 1-Afternoon: MJO II Contamination Event using APU at 180°C



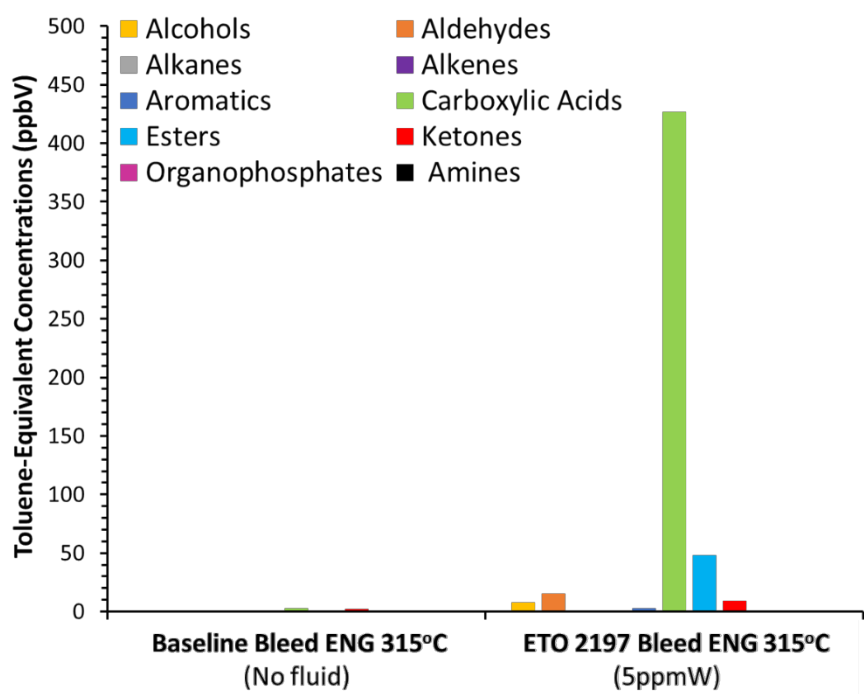
Day 2-Morning: MJO II Contamination Event using ENG at 220°C



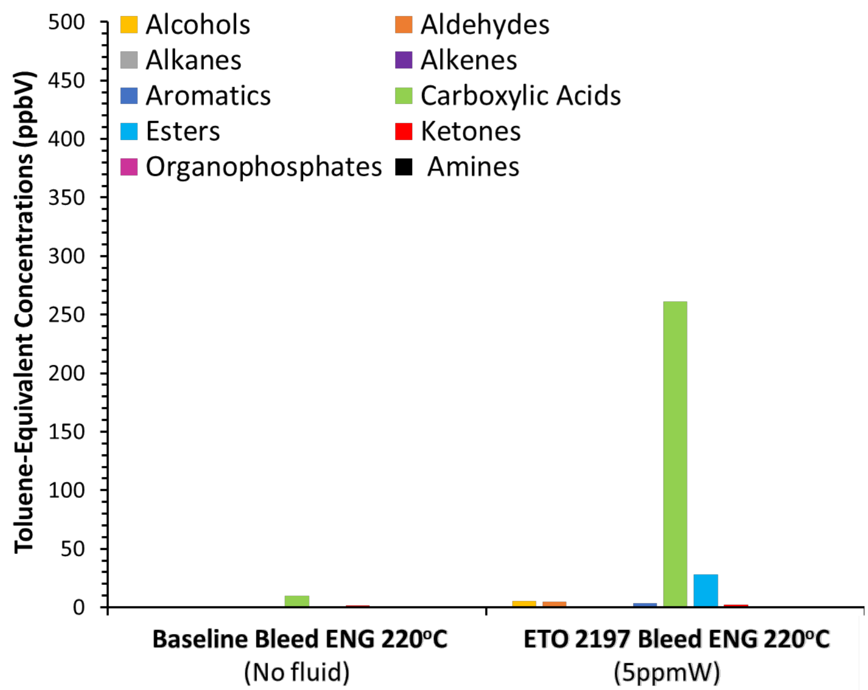
Day 2-Afternoon: MJO II Contamination Event using ENG at 315°C



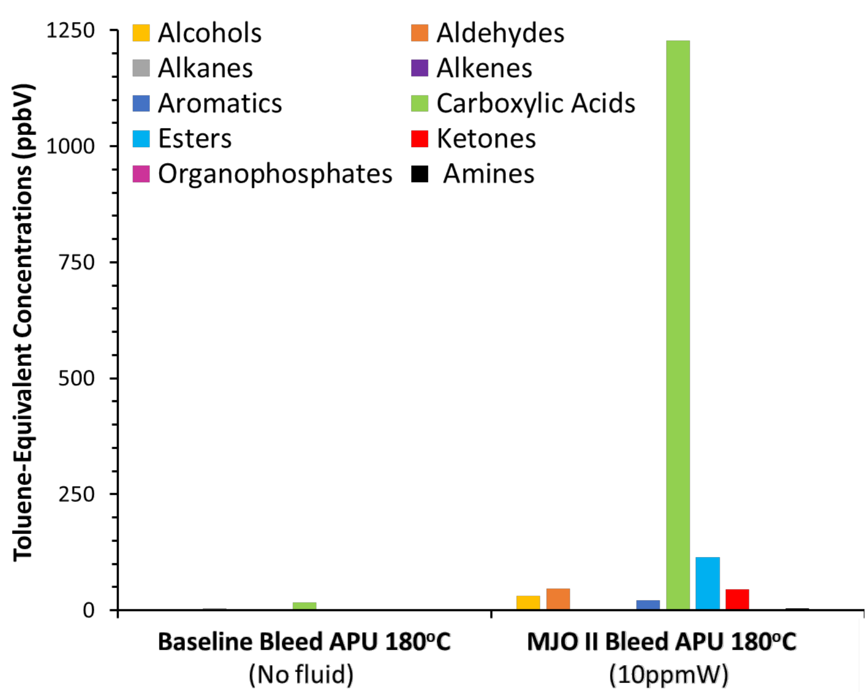
Day 3-Morning: ETO 2197 Contamination Event using ENG at 315°C



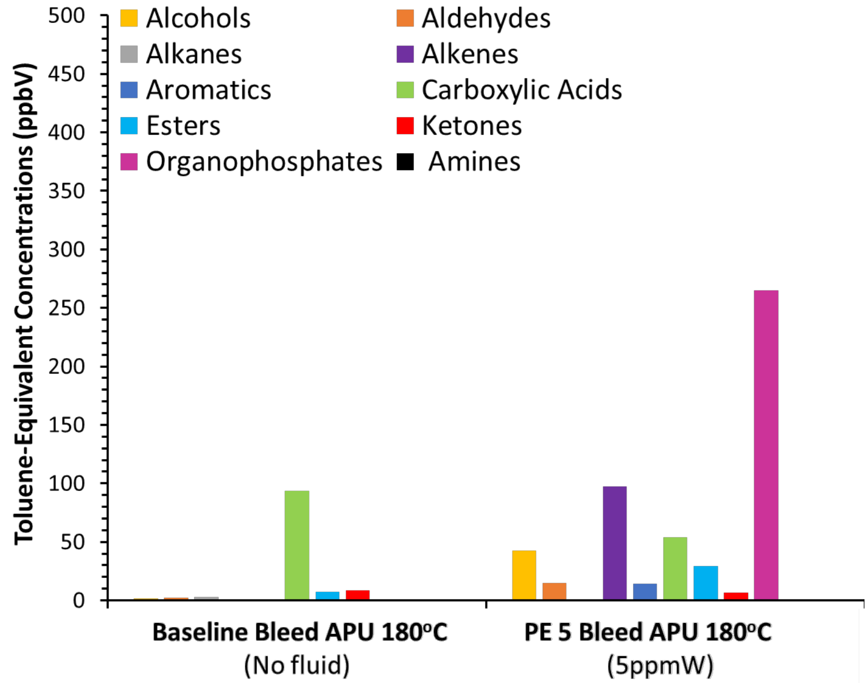
Day 3-Afternoon: ETO 2197 Contamination Event using ENG at 220°C



Day 4-Morning: MJO II Contamination Event using APU at 180°C



Day 4-Afternoon: PE 5 Contamination Event using APU at 180°C



Compound Name	Major Classes of VOCs										
	Alcohols	Aldehydes	Alkanes	Alkenes	Aromatics	Carboxylic acids	Esters	Ketones	Organophosphates	Amines	Phthalates
Isobutylene			x								
cis-2-Butene			x								
trans-2-Butene			x								
Acetone								x			
Isopropyl alcohol	x										
Methacrolein		x									
Butanal		x									
2-Butanone								x			
Acetic acid						x					
1-Butanol	x										
Benzene					x						
Pentanal		x									
Toluene					x						
Butanoic acid						x					
4,4-Dimethyl-2-pentanone								x			
2-Hexanone								x			
Butynediol	x										
Hexanal		x									
Octane			x								
2-Methylbutanoic acid						x					
Heptanal		x									
Nonane			x								
Pentanoic acid						x					
2(3H)-Furanone, dihydro-5-methyl-							x				
Benzaldehyde		x									
Hexanoic acid						x					
Phenol					x						
Octanal		x									
Mesitylene					x						
Decane			x								
2-Ethylhexanol	x										
2-Methylhexanoic acid						x					
Acetophenone								x			
p/m/o-Cresol					x						
Heptanoic acid						x					
Nonanal		x									

Compound Name	Major Classes of VOCs										
	Alcohols	Aldehydes	Alkanes	Alkenes	Aromatics	Carboxylic acids	Esters	Ketones	Organophosphates	Amines	Phthalates
Undecane			x								
3,5,5-Trimethylhexanoic acid						x					
2(3H)-Furanone, dihydro-5-propyl-							x				
Benzoic acid						x					
Octanoic acid						x					
Hexamethylacetone								x			
Decanal		x									
Dodecane			x								
Allyl isovalerate							x				
2(3H)-Furanone, 5-butyldihydro-							x				
Nonanoic acid						x					
1,3-Diisocyanato-2-methylbenzene					x						
2,4-Diisocyanato-1-methylbenzene					x						
Decanoic acid						x					
Allyl heptanoate							x				
2,6-Di-tert-butylbenzoquinone								x			
Triisobutyl phosphate									x		
Butylated Hydroxytoluene					x						
Allyl octanoate							x				
Diethyl Phthalate											x
Tributyl phosphate									x		
Allyl nonanoate							x				
2-Ethylhexyl benzoate							x				
n-Butylbenzenesulfonamide										x	
3-Cyclopentylpropionic acid, 2-ethylhexyl ester							x				
Hexadecanoic acid						x					
Octadecanoic acid						x					
N-phenyl-1-naphthalenamine										x	

Appendix F: Chain of Custody Record

Day 1-Afternoon: MJO II Contamination Event using APU at 180°C

Human Systems Engineering Department
Aeromedical Research and Integration Branch
Sampling Collection Chain of Custody Record
ARIC-2023-01

Project Name:	Aircraft test: MJOII injection (5ppmw) with APU
Project Location:	FAA Tech Center, NJ
Send Samples To (POC & Address):	N/A
Method of Transport:	hand-carried
Sampler (Print & Sign):	Krisiam Ortiz Martinez

Sample ID No.	Collection Date/Time	Sampling Location	TO-17 Tube No.	Sample Description	Total Sampling Time (min)	Flow Rate (mL/min)	Pump No.*	Back Pressure (in H_2O)
1	May15/15:13	Inlet-1	423491	Baseline APU	60	50	2	4.4
2	May15/15:13	Inlet-2	411217	Baseline APU	60	50	3	4.1
3	May15/15:13	Bleed-ClScr	424063	Baseline APU	60	50	1	1.7
4	May15/15:30	N/A	407339	Field Blnk	N/A	N/A	4	N/A
5	May15/17:00	Inlet-1	422615	MJOII APU 5ppm	60	50	2	6.5
6	May15/17:00	Inlet-2	423435	MJOII APU 5ppm	60	50	3	4.5
7	May15/17:00	Bleed-ClScr	402262	MJOII APU 5ppm	60	50	1	1.9
8	May15/18:45	N/A	423831	Shipping Blnk	N/A	N/A	N/A	N/A
9								
10								

Relinquished by (Signature):	Date:	Time:	Chain of Custody Seal (circle):	Received By (Signature):	Date:	Time:
Krisiam Ortiz	May15, 23	19:00	INTACT BROKEN ABSENT	K.O.M.	May 19, 23	14:15
Relinquished by (Signature):	Date:	Time:		Received By (Signature):	Date:	Time:

***Note:** *Pump 1 (S/N: 20180530022); Pump 2 (S/N: 20180330045); Pump 3 (S/N: 20180330046); Pump 4 (S/N: 20180330043); Pump 5 (S/N: 20180330038); Pump 6 (S/N: 20180230056); Pump 7 (S/N: 20180530063). Pumps were calibrated using a Sensidyne Go-Cal Air Flow Calibrator. 0.7% and 1.0% reading flow accuracy were obtained for 50mL/min and 100mL/min, respectively.*

NAVAIR

FOR OFFICIAL USE ONLY

Page 1 of 1

Day 2-Morning: MJO II Contamination Event using ENG at 220°C

Human Systems Engineering Department
Aeromedical Research and Integration Branch
Sampling Collection Chain of Custody Record
ARIC-2023-02

Project Name:	Aircraft test: MJOII injection (5ppm) with Engine 3 225°C
Project Location:	FAA Tech Center, NJ
Send Samples To (POC & Address):	N/A
Method of Transport:	hand-carried
Sampler (Print & Sign):	Krisiam Ortiz Martinez

Sample ID No.	Collection Date/Time	Sampling Location	TO-17 Tube No.	Sample Description	Total Sampling Time (min)	Flow Rate (mL/min)	Pump No.*	Back Pressure (in H_2O)
1	May16 10:11	Control room	424042	Trailer	60	50	4	4.1
2	May16 11:01	Bleed-Clscr	402229	Baseline ENG	60	50	1	1.5
3	May16 11:03	Inlet-1	423496	Baseline ENG225	60	50	2	4.1
4	May16 11:03	Inlet-2	424050	Baseline ENG225	60	50	3	4.8
5	May16 13:15	Inlet-1	423390	MJOII ENG 225	60	50	2	4.1
6	May16 13:15	Inlet-2	423826	MJOII ENG225	60	50	3	4.6
7	May16 13:15	Bleed-Clscr	423453	MJOII ENG 225	60	50	1	0.3
8								
9								
10								

Relinquished by (Signature):	Date:	Time:	Chain of Custody Seal (circle):	Received By (Signature):	Date:	Time:
Krisiam Ortiz	May16,23	14:40		KDM	May 19,23	14:15
Relinquished by (Signature):	Date:	Time:	INTACT BROKEN ABSENT	Received By (Signature):	Date:	Time:

***Note:** *Pump 1 (S/N: 20180530022); Pump 2 (S/N: 20180330045); Pump 3 (S/N: 20180330046); Pump 4 (S/N: 20180330043); Pump 5 (S/N: 20180330038); Pump 6 (S/N: 20180230056); Pump 7 (S/N: 20180530063). Pumps were calibrated using a Sensidyne Go-Cal Air Flow Calibrator. 0.9 % and 1.3% reading flow accuracy were obtained for 50mL/min and 100mL/min, respectively.*

NAVAIR

FOR OFFICIAL USE ONLY

Page 1 of 2

Day 2-Afternoon: MJO II Contamination Event using ENG at 315°C

Human Systems Engineering Department
Aeromedical Research and Integration Branch
Sampling Collection Chain of Custody Record
ARIC-2023-02

Project Name:	Aircraft test; MJOII injection (5ppm) with Engine 3 315°C
Project Location:	FAA Tech Center, NJ
Send Samples To (POC & Address):	N/A
Method of Transport:	hand-carried
Sampler (Print & Sign):	Krisiam Ortiz Martinez

Sample ID No.	Collection Date/Time	Sampling Location	TO-17 Tube No.	Sample Description	Total Sampling Time (min)	Flow Rate (mL/min)	Pump No.*	Back Pressure (in H_2O)
1	May16/15:25	Inlet-1	424189	Baseline ENG 315	61	50	2	3.9
2	May16/15:26	Inlet-2	412021	Baseline ENG 315	61	50	3	4.6
3	May16/15:26	Bleed-Clscr	424199	Baseline ENG 315	61	50	1	1.4
4	May16/15:	N/A	408343	Field Blnk	N/A	N/A	4	N/A
5	May16/17:30	Inlet-1	424054	MJOII ENG 315	60	50	2	3.9
6	May16/17:31	Inlet-2	424077	MJOII ENG315	60	50	3	3.7
7	May16/17:31	Bleed-Clscr	424090	MJOII ENG315	60	50	1	1.5
8	May16/18:41	N/A	423815	Shipping Blnk	N/A	N/A	N/A	N/A
9								
10								

Relinquished by (Signature):	Date:	Time:	Chain of Custody Seal (circle):	Received By (Signature):	Date:	Time:
Krisiam Ortiz	May 16, 23	19:20	INTACT BROKEN ABSENT	KEM.	May19,23	14:15
Relinquished by (Signature):	Date:	Time:		Received By (Signature):	Date:	Time:

****Note:** Pump 1 (S/N: 20180530022); Pump 2 (S/N: 20180330045); Pump 3 (S/N: 20180330046); Pump 4 (S/N: 20180330043); Pump 5 (S/N: 20180330038); Pump 6 (S/N: 20180230055); Pump 7 (S/N: 20180630063). Pumps were calibrated using a Sensidyne Go-Cal Air Flow Calibrator. 0.9% and 1.3% reading flow accuracy were obtained for 50mL/min and 100mL/min, respectively.*

NAVAIR FOR OFFICIAL USE ONLY Page 2 of 2

Day 3-Morning: ETO 2197 Contamination Event using ENG at 315°C

Human Systems Engineering Department
Aeromedical Research and Integration Branch
Sampling Collection Chain of Custody Record
ARIC-2023-03

Project Name:	Aircraft test; ETO2197 injection (8ppm) with Engine 3 315°C
Project Location:	FAA Tech Center, NJ
Send Samples To (POC & Address):	N/A
Method of Transport:	hand-carried
Sampler (Print & Sign):	Krisiam Ortiz Martinez

Sample ID No.	Collection Date/Time	Sampling Location	TO-17 Tube No.	Sample Description	Total Sampling Time (min)	Flow Rate (mL/min)	Pump No.*	Back Pressure (in H_2O)
1	May17/10:22	Inlet-1	422627	Baseline ENG 315	60	50	2	3.9
2	May17/10:23	Inlet-2	422611	Baseline ENG315	60	50	3	4.2
3	May17/10:23	Bleed-clscr	423016	Baseline ENG 315	60	50	1	0.2
4	May17/12:19	Inlet-1	423499	ETO2197 ENG315	61	50	2	4.2
5	May17/12:19	Inlet-2	423833	ETO2197 ENG315	61	50	3	4.1
6	May17/12:20	Bleed-clscr	433384	ETO2197 ENG315	60	50	1	1.6
7								
8								
9								
10								

Relinquished by (Signature):	Date:	Time:	Chain of Custody Seal (circle):	Received By (Signature):	Date:	Time:
Krisiam Ortiz	May17,23	13:38	INTACT BROKEN ABSENT	KCM	May 19,23	14:15
Relinquished by (Signature):	Date:	Time:		Received By (Signature):	Date:	Time:

***Note:** *Pump 1 (S/N: 20180530022); Pump 2 (S/N: 20180330045); Pump 3 (S/N: 20180330046); Pump 4 (S/N: 20180330043); Pump 5 (S/N: 20180330038); Pump 6 (S/N: 20180230056); Pump 7 (S/N: 20180630063). Pumps were calibrated using a Sensidyne Go-Cal Air Flow Calibrator. 0.7% and 1.0% reading flow accuracy were obtained for 50mL/min and 100mL/min, respectively.*

NAVAIR

FOR OFFICIAL USE ONLY

Page 1 of 2

Day 3-Afternoon: ETO 2197 Contamination Event using ENG at 220°C

Human Systems Engineering Department
Aeromedical Research and Integration Branch
Sampling Collection Chain of Custody Record
ARIC-2023-03

Project Name:	Aircraft test; ETO2197 injection (5ppm) with Engine 3 220°C
Project Location:	FAA Tech Center, NJ
Send Samples To (POC & Address):	N/A
Method of Transport:	hand-carried
Sampler (Print & Sign):	Krisiam Ortiz Martinez

Sample ID No.	Collection Date/Time	Sampling Location	TO-17 Tube No.	Sample Description	Total Sampling Time (min)	Flow Rate (mL/min)	Pump No.*	Back Pressure (in H_2O)
1	May17/14:29	Inlet-1	423823	Baseline ENG 220	60	50	2	3.7
2	May17/14:29	Inlet-2	422666	Baseline ENG220	60	50	3	4.6
3	May17/14:30	Bleed-Clscr	406798	Baseline ENG 220	60	50	1	1.5
4	May17/15:35	N/A	423811	Field Blnk	N/A	N/A	4	N/A
5	May17/16:41	Inlet-1	407383	ETO2197 ENG220	60	50	2	3.7
6	May17/16:41	Inlet-2	423805	ETO2197 ENG 220	60	50	3	3.7
7	May17/16:41	Bleed-Clscr	423830	ETO2197 ENG 220	60	50	1	1.4
8	May17/18:10	N/A	422613	Shipping Blnk	N/A	N/A	N/A	N/A
9								
10								

Relinquished by (Signature):	Date:	Time:	Chain of Custody Seal (circle):	Received By (Signature):	Date:	Time:
Krisiam Ortiz	May17,23	18:15	INTACT BROKEN ABSENT	KOM	May19,23	14:15
Relinquished by (Signature):	Date:	Time:		Received By (Signature):	Date:	Time:

**Note: Pump 1 (S/N: 20180530022); Pump 2 (S/N: 20180330045); Pump 3 (S/N: 20180330046); Pump 4 (S/N: 20180330043); Pump 5 (S/N: 20180330038); Pump 6 (S/N: 20180230056); Pump 7 (S/N: 20180530063). Pumps were calibrated using a Sensidyne Go-Cal Air Flow Calibrator 0.7 % and 1.0% reading flow accuracy were obtained for 50mL/min and 100mL/min, respectively.*

NAVAIR FOR OFFICIAL USE ONLY Page 2 of 2

Day 4-Morning: MJO II Contamination Event using APU at 180°C

Human Systems Engineering Department
Aeromedical Research and Integration Branch
Sampling Collection Chain of Custody Record
ARIC-2023-04

Project Name:	Aircraft test; MJOII injection (10ppm) with APU
Project Location:	FAA Tech Center, NJ
Send Samples To (POC & Address):	N/A
Method of Transport:	hand-carried
Sampler (Print & Sign):	Krisiam Ortiz Martinez

Sample ID No.	Collection Date/Time	Sampling Location	TO-17 Tube No.	Sample Description	Total Sampling Time (min)	Flow Rate (mL/min)	Pump No.*	Back Pressure (in H_2O)
1	May18/10:17	Inlet-1	423497	Baseline APU	61	50	2	4.4
2	May18/10:17	Inlet-2	414363	Baseline APU	61	50	3	4.6
3	May18/10:18	Bleed-Clscr	422678	Baseline APU	60	50	1	1.8
4	May18/11:14	Control room	407746	Trailer	60	50	4	3.5
5	May18/11:59	Inlet-1	422617	MJOII APU 10ppm	60	50	2	4.1
6	May18/11:59	Inlet-2	377694	MJOII APU 10ppm	60	50	3	4.0
7	May18/12:00	Bleed-Clscr	407332	MJOII APU 10ppm	60	50	1	1.0
8								
9								
10								

Relinquished by (Signature):	Date:	Time:	Chain of Custody Seal (circle):	Received By (Signature):	Date:	Time:
Krisiam Ortiz	May 18, 23	13:15		KOM	May 19, 23	14:15
Relinquished by (Signature):	Date:	Time:	INTACT BROKEN ABSENT	Received By (Signature):	Date:	Time:

***Note:** *Pump 1 (S/N: 20180530022); Pump 2 (S/N: 20180330045); Pump 3 (S/N: 20180330046); Pump 4 (S/N: 20180330043); Pump 5 (S/N: 20180330038); Pump 6 (S/N: 20180230056); Pump 7 (S/N: 20180530063). Pumps were calibrated using a Sensidyne Go-Cal Air Flow Calibrator. 0.4% and 1.5% reading flow accuracy were obtained for 50mL/min and 100mL/min, respectively.*

NAVAIR FOR OFFICIAL USE ONLY Page 1 of 2

Day 4-Afternoon: PE 5 Contamination Event using APU at 180°C

Human Systems Engineering Department
Aeromedical Research and Integration Branch
Sampling Collection Chain of Custody Record
ARIC-2023-04

Project Name:	Aircraft test: PE5 injection (5ppm) with APU
Project Location:	FAA Tech Center, NJ
Send Samples To (POC & Address):	N/A
Method of Transport:	hand-carried
Sampler (Print & Sign):	Krsiam Ortiz Martinez

Sample ID No.	Collection Date/Time	Sampling Location	TO-17 Tube No.	Sample Description	Total Sampling Time (min)	Flow Rate (mL/min)	Pump No.*	Back Pressure (in H_2O)
1	May 18 | 15:00	Inlet-1	422759	Baseline APU	60	50	2	3.9
2	May 18 | 15:00	Inlet-2	422629	Baseline APU	60	50	3	4.1
3	May 18 | 15:01	Bleed-Clscr	424008	Baseline APU	60	50	1	1.5
4	May 18 | 15:05	N/A	378525	Field Blnk	N/A	N/A	4	N/A
5	May 18 | 17:00	Inlet-1	395842	PE5 APU	60	50	2	4.1
6	May 18 | 17:00	Inlet-2	424057	PE5 APU	60	50	3	4.2
7	May 18 | 17:00	Bleed-Clscr	422682	PE5 APU	60	50	1	1.7
8	May 18 | 18:13	N/A	424066	Shipping Blnk	N/A	N/A	N/A	N/A
9								
10								

Relinquished by (Signature):	Date:	Time:	Chain of Custody Seal (circle):	Received By (Signature):	Date:	Time:
Krsiam Ortiz	May 18, 23	18:15	INTACT BROKEN ABSENT	KDM	May 19, 23	14:15
Relinquished by (Signature):	Date:	Time:		Received By (Signature):	Date:	Time:

***Note:** *Pump 1 (S/N: 20180530022); Pump 2 (S/N: 20180330045); Pump 3 (S/N: 20180330046); Pump 4 (S/N: 20180330043); Pump 5 (S/N: 20180330038); Pump 6 (S/N: 20180230056); Pump 7 (S/N: 20180630063). Pumps were calibrated using a Sensidyne Go-Cal Air Flow Calibrator. 0.4% and 1.5% reading flow accuracy were obtained for 50mL/min and 100mL/min, respectively.*

NAVAIR

FOR OFFICIAL USE ONLY

Page 2 of 2

Appendix G: Safety Data Sheets (SDS) of the Selected Aircraft Fluids

SDS – Exxon Mobile MJO II

SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: **MOBIL JET OIL II**
Product Description: Synthetic Esters and Additives
Product Code: 201550101020, 430207-85
Intended Use: Aviation lubricating oil, Turbine oil

COMPANY IDENTIFICATION

Supplier: **Aviall Australia Pty. Limited**
20-22 Lindaway Place
Tullamarine
Victoria 3043 Australia

Product Technical Information	(8:00am to 4:30pm Mon to Fri)	1300 919 904
Supplier General Contact	(03) 9339 3000	

Supplier: **AMPOL AUSTRALIA PTY LTD**
ABN 17 000 032 128
2 Market Street
Sydney
New South Wales 2000 Australia

24 Hour Emergency Telephone	1800 033 111
Product Technical Information	
Supplier General Contact	1300364169
	+612 9250-5000

SECTION 2 HAZARDS IDENTIFICATION

This material is not hazardous according to regulatory guidelines (see (M)SDS Section 15).

Contains: N-PHENYL-1-NAPHTHYLAMINE May produce an allergic reaction.

Other hazard information:

Physical / Chemical Hazards:
No significant hazards.

Health Hazards:
High-pressure injection under skin may cause serious damage. This product is not expected to produce adverse health effects under normal conditions of use and with appropriate personal hygiene practices.

Product may decompose at elevated temperatures or under fire conditions and give off irritating and/or harmful (carbon monoxide) gases/vapours/fumes. Symptoms from acute exposure to these decomposition products in confined spaces may include headache, nausea, eye, nose, and throat irritation.

Environmental Hazards:
No significant hazards.

NOTE: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

This material is defined as a mixture.

Hazardous Substance(s) or Complex Substance(s) required for disclosure

Name	CAS#	Concentration*	GHS Hazard Codes
N-PHENYL-1-NAPHTHYLAMINE	90-30-2	1%	H302, H317, H373, H400(M factor 1), H410(M factor 1)
9,10-ANTHRACENEDIONE, 1,4-DIHYDROXY-	81-64-1	< 0.1%	H400(M factor 10), H410(M factor 10)
TRICRESYL PHOSPHATE	1330-78-5	1 - < 3%	H361(F), H400(M factor 1), H410(M factor 1)

* All concentrations are percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume. Other ingredients determined not to be hazardous up to 100%.

SECTION 4 FIRST AID MEASURES

INHALATION
Immediately remove from further exposure. Get immediate medical assistance. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. Give supplemental oxygen, if available. If breathing has stopped, assist ventilation with a mechanical device.

SKIN CONTACT
Wash contact areas with soap and water. Remove contaminated clothing. Launder contaminated clothing before reuse. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT
Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION
Seek immediate medical attention. If medical attention will be delayed, contact a Regional Poison Centre or emergency medical professional regarding the induction of vomiting or use of activated charcoal/syrup of ipecac. Do not induce vomiting or give anything by mouth to a groggy or unconscious person.

NOTE TO PHYSICIAN

None

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO_2) to extinguish flames.

Inappropriate Extinguishing Media: Straight streams of water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent run-off from fire control or dilution from entering streams, sewers or drinking water supply. Fire-fighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Unusual Fire Hazards: May generate irritating and harmful gases/vapours/fumes when burning.

Hazardous Combustion Products: Aldehydes, Incomplete combustion products, Oxides of carbon, Phosphorus oxides, Smoke, Fume

FLAMMABILITY PROPERTIES

Flash Point [Method]: >246°C (475°F) [ASTM D-92]
Flammable Limits (Approximate volume % in air): LEL: N/D UEL: N/D
Autoignition Temperature: N/D

SECTION 6 ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations.

PROTECTIVE MEASURES

Avoid contact with spilled material. See Section 5 for fire fighting information. See the Hazard Identification Section for Significant Hazards. See Section 4 for First Aid Advice. See Section 8 for advice on the minimum requirements for personal protective equipment. Additional protective measures may be necessary, depending on the specific circumstances and/or the expert judgment of the emergency responders.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do so without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do so without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dyke far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7 HANDLING AND STORAGE

HANDLING

Avoid all personal contact. Prevent small spills and leakage to avoid slip hazard. Material can accumulate static charges which may cause an electrical spark (ignition source). When the material is handled in bulk, an electrical spark could ignite any flammable vapors from liquids or residues that may be present (e.g., during switch-loading operations). Use proper bonding and/or earthing procedures. However, bonding and earthing may not eliminate the hazard from static accumulation. Consult local applicable standards for guidance. Additional references include American Petroleum Institute 2003 (Protection Against Ignitions Arising out of Static, Lightning and Stray Currents) or National Fire Protection Agency 77 (Recommended Practice on Static Electricity) or CENELEC CLC/TR 50404 (Electrostatics - Code of practice for the avoidance of hazards due to static electricity).

Static Accumulator: This material is a static accumulator.

STORAGE

The type of container used to store the material may affect static accumulation and dissipation. Store in a cool, dry place with adequate ventilation. Keep away from incompatible materials, open flames and high temperatures. Do not store in open or unlabelled containers.

Material is defined under the National Standard [NOHSC:1015] Storage and Handling of Workplace Dangerous Goods.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

Biological limits

No biological limits allocated.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

Particulate
No protection is ordinarily required under normal conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapour warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Glove suitability and breakthrough time will differ depending on the specific use conditions. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. Inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

Nitrile
Chemical resistant gloves are recommended. If contact with forearms is likely wear gauntlet style gloves.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

Chemical/oil resistant clothing is recommended.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practise good housekeeping.

ENVIRONMENTAL CONTROLS

Comply with applicable environmental regulations limiting discharge to air, water and soil. Protect the environment by applying appropriate control measures to prevent or limit emissions.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Note: Physical and chemical properties are provided for safety, health and environmental considerations only and may not fully represent product specifications. Contact the Supplier for additional information.

GENERAL INFORMATION

Physical State: Liquid
Colour: Amber
Odour: Characteristic
Odour Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 °C): 1
Flammability (Solid, Gas): N/A
Flash Point [Method]: >246°C (475°F) [ASTM D-92]
Flammable Limits (Approximate volume % in air): LEL: N/D UEL: N/D
Autoignition Temperature: N/D

Boiling Point / Range: N/D
Decomposition Temperature: N/D
Vapour Density (Air = 1): N/D
Vapour Pressure: [N/D at 20ºC]
Evaporation Rate (n-butyl acetate = 1): N/D
pH: N/A
Log Pow (n-Octanol/Water Partition Coefficient): N/D
Solubility in Water: Negligible
Viscosity: 27.6 cSt (27.6 mm2/sec) at 40 ºC | 5.1 cSt (5.1 mm2/sec) at 100°C
Oxidizing Properties: See Hazards Identification Section.

OTHER INFORMATION
Freezing Point: N/D
Melting Point: N/A
Pour Point: -59°C (-74°F)

SECTION 10 STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat.

INCOMPATIBLE MATERIALS: Strong oxidisers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

POSSIBILITY OF HAZARDOUS REACTIONS: Hazardous polymerization will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

INFORMATION ON TOXICOLOGICAL EFFECTS

Hazard Class	Conclusion / Remarks
Inhalation	
Acute Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Irritation: No end point data for material.	Negligible hazard at ambient/normal handling temperatures.
Ingestion	
Acute Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Skin	
Acute Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Skin Corrosion/Irritation: No end point data for material.	Negligible irritation to skin at ambient temperatures. Based on assessment of the components.
Eye	
Serious Eye Damage/Irritation: No end point data for material.	May cause mild, short-lasting discomfort to eyes. Based on assessment of the components.
Sensitisation	
Respiratory Sensitization: No end point data for material.	Not expected to be a respiratory sensitizer.

Skin Sensitization: No end point data for material.	Not expected to be a skin sensitizer. Based on assessment of the components.
Aspiration: Data available.	Not expected to be an aspiration hazard. Based on physico-chemical properties of the material.
Germ Cell Mutagenicity: No end point data for material.	Not expected to be a germ cell mutagen. Based on assessment of the components.
Carcinogenicity: No end point data for material.	Not expected to cause cancer. Based on assessment of the components.
Reproductive Toxicity: No end point data for material.	Contains a substance that may be a reproductive toxicant. Based on assessment of the components.
Lactation: No end point data for material.	Not expected to cause harm to breast-fed children.
Specific Target Organ Toxicity (STOT)	
Single Exposure: No end point data for material.	Not expected to cause organ damage from a single exposure.
Repeated Exposure: No end point data for material.	Contains a substance that may cause damage to organs from prolonged or repeated exposure. Based on assessment of the components.

TOXICITY FOR SUBSTANCES

NAME	ACUTE TOXICITY
N-PHENYL-1-NAPHTHYLAMINE	Oral Lethality: LD 50 1625 mg/kg (Rat)

OTHER INFORMATION

For the product itself:

Target Organs Repeated Exposure: Blood, Kidney

Component concentrations in this formulation would not be expected to cause skin sensitization, based on tests of the components, this formulation, or similar formulations.
A literature report of a generic jet engine oil containing tri-cresyl phosphate (TCP) with concentrations of ortho-phenol isomers well in excess of those found in this ExxonMobil product noted delayed peripheral nerve system damage in test animals. A current study of an ExxonMobil Jet Oil formulated with a relatively low ortho-phenol isomer content produced no peripheral nerve system damage in test animals. Oral exposure of male rats to a generic jet engine oil containing 3% of a commercial aryl phosphate product had no effect on male reproductive end points (organ weights, histology, sperm morphology or motility).
Contains:
N-phenyl-1-naphthylamine (PAN): A single oral overexposure may result in clinical signs/symptoms of cyanosis, headache, shallow respiration, dizziness, confusion, low blood pressure, convulsions, coma, or jaundice. Hematuria may occur due to bladder and kidney irritation, and anemia may develop later. Repeated exposure in laboratory animals caused liver and kidney damage and depressed bone marrow activity. Undiluted PAN is a skin sensitiser. Human testing of lubricants containing 1.0% PAN resulted in no reactions indicative of sensitisation. Tricresyl phosphate (TCP): TCP (<9% ortho isomer) administered to rats by oral gavage in a one-generation reproduction/developmental toxicology study adversely affected both males and females. TCP-treated male rats had decreased sperm concentration and motility, abnormal sperm morphology and adverse histologic changes in the testes and epididymides. Adverse histologic changes were also observed in the ovaries of TCP-treated female rats. The percent of sperm-positive females littering was significantly reduced in the TCP-treatment groups with only one of twenty females in the high dose group delivering young . Developmental parameters were unaffected by TCP exposure. Impaired fertility and decreased sperm motility following TCP treatment have also been reported in a reproduction toxicity study in mice.

IARC Classification:

The following ingredients are cited on the lists below: None.

--REGULATORY LISTS SEARCHED--

1 = IARC 1 2 = IARC 2A 3 = IARC 2B

SECTION 12 ECOLOGICAL INFORMATION

The information given is based on data for the material, components of the material, or for similar materials, through the application of bridging principals.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.
Material -- Not expected to demonstrate chronic toxicity to aquatic organisms.

ECOLOGICAL DATA

Ecotoxicity

Test	Duration	Organism Type	Test Results
Aquatic - Chronic Toxicity	21 day(s)	Daphnia magna	NOELR 1 mg/l

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Dispose of waste at an appropriate treatment and disposal facility in accordance with applicable laws and regulations, and product characteristics at time of disposal. Protect the environment. Dispose of used oil at designated sites. Minimize skin contact. Do not mix used oils with solvents, brake fluids or coolants. Product is suitable for burning in an enclosed, controlled burner for fuel value or disposal by supervised incineration.

Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

SECTION 14 TRANSPORT INFORMATION

LAND (ADG) : Not Regulated for Land Transport

SEA (IMDG): Not Regulated for Sea Transport according to IMDG-Code

Marine Pollutant: No

AIR (IATA): Not Regulated for Air Transport

SECTION 15 REGULATORY INFORMATION

This material is not considered hazardous according to Australia Model Work Health and Safety Regulations.

Product is not regulated according to Australian Dangerous Goods Code.

No Poison Schedule number allocated by the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) established under the Therapeutic Goods Act.

AS1940 COMBUSTIBLE CLASS: C2

REGULATORY STATUS AND APPLICABLE LAWS AND REGULATIONS

Listed or exempt from listing/notification on the following chemical inventories : AIIC, DSL, IECSC, KECI, TCSI, TSCA

Special Cases:

Inventory	Status
PICCS	Restrictions Apply

SECTION 16 OTHER INFORMATION

KEY TO ABBREVIATIONS AND ACRONYMS:

N/D = Not determined, N/A = Not applicable, STEL = Short-Term Exposure Limit, TWA = Time-Weighted Average

KEY TO THE H-CODES CONTAINED IN SECTION 3 OF THIS DOCUMENT (for information only):
H302: Harmful if swallowed; Acute Tox Oral, Cat 4
H317: May cause allergic skin reaction; Skin Sensitisation, Cat 1
H361(F): Suspected of damaging fertility; Repro Tox, Cat 2 (Fertility)
H373: May cause damage to organs through prolonged or repeated exposure; Target Organ, Repeated, Cat 2
H400: Very toxic to aquatic life; Acute Env Tox, Cat 1
H410: Very toxic to aquatic life with long lasting effects; Chronic Env Tox, Cat 1

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:
AMPOL AUSTRALIA PTY LTD: Section 01: Supplier Mailing Address information was added.
Perkal Pty Ltd Trading as Statewide Oil (South Australia): Section 01: Supplier Mailing Address information was deleted.
Perkal Pty Ltd Trading as Statewide Oil (Western Australia): Section 01: Supplier Mailing Address information was deleted.
Section 01: Company Contact Methods information was modified.
Section 01: Company Mailing Address information was deleted.
Section 01: Company Mailing Address information was modified.
Section 04: First Aid Inhalation information was modified.
Section 16: HCode Key information was modified.
Southern Cross Lubes (Victoria and Tasmania, New South Wales and Australian Capital Territory): Section 01:

Supplier Mailing Address information was deleted.

The information and recommendations contained herein are, to the best of ExxonMobil's knowledge and belief, accurate and reliable as of the date issued. You can contact ExxonMobil to insure that this document is the most current available from ExxonMobil. The information and recommendations are offered for the user's consideration and examination. It is the user's responsibility to satisfy itself that the product is suitable for the intended use. If buyer repackages this product, it is the user's responsibility to insure proper health, safety and other necessary information is included with and/or on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, re-publication or retransmission of this document, in whole or in part, is not permitted. The term, "ExxonMobil" is used for convenience, and may include any one or more of ExxonMobil Chemical Company, Exxon Mobil Corporation, or any affiliates in which they directly of indirectly hold any interest.

DGN: 2003056DAU (552669)

Prepared by: Exxon Mobil Corporation
EMBSI, Clinton NJ USA
Contact Point: See Section 1 for Local Contact number

End of (M)SDS

SDS – Eastman ETO 2197

Eastman(TM) Turbo Oil 2197

Version	Revision Date:	SDS Number:	Date of last issue: 07/02/2020
1.5	01/12/2023	150000097791	Date of first issue: 09/06/2016
PRD		SDSUS / Z8 / 0001	

SECTION 1. IDENTIFICATION

Product name : Eastman(TM) Turbo Oil 2197

Product code : 34358-00, P3435809, E3435801, P3435800, P3435802, P3435803, P3435804, P3435805, P3435806, P3435808

Manufacturer or supplier's details

Company name of supplier : Eastman Chemical Company

Address : 200 South Wilcox Drive
Kingsport TN 37660-5280

Telephone : (423) 229-2000

Emergency telephone : CHEMTREC: +1-800-424-9300, +1-703-527-3887 CCN7321

Recommended use of the chemical and restrictions on use

Recommended use : Lubricant

Restrictions on use : None known.

SECTION 2. HAZARDS IDENTIFICATION

GHS classification in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200)

Not a hazardous substance or mixture.

GHS label elements

Not a hazardous substance or mixture.

Other hazards

None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Components

Chemical name	CAS-No.	Concentration (% w/w)
Tricresyl phosphate	1330-78-5	>= 1 - < 5

Eastman is committed to the safety, health and environment of our employees, our customers, and the communities we operate within. As part of this commitment, Eastman's Safety Data Sheets (SDS) are prepared in accordance with all applicable national and local regulations. The compositions of our documents reflect these requirements which include, but are not limited to, requirements under the Globally Harmonized System of Classification and Labeling (GHS). These compositions commonly involve the use of ranges versus specific analytical values. If you require a composition that is more specific , please refer to the Certificate of Analysis, sales specification, or contact your Customer Service Representative.

SECTION 4. FIRST AID MEASURES

If inhaled	:	Move to fresh air. If breathing is difficult, give oxygen. Consult a physician if necessary.
In case of skin contact	:	Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Wash contaminated clothing before reuse. If symptoms persist, call a physician.
In case of eye contact	:	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if symptoms occur.
If swallowed	:	Rinse mouth. Call a physician or poison control center immediately. Do NOT induce vomiting. Never give anything by mouth to an unconscious person.
Most important symptoms and effects, both acute and delayed	:	Prolonged skin contact may defat the skin and produce dermatitis. Contact with hot product will cause thermal burns. Inhalation of thermal decomposition products may lead to adverse effects including pulmonary edema.
Notes to physician	:	Treat symptomatically.

SECTION 5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	:	Water spray Foam Dry powder Carbon dioxide (CO_2)
Unsuitable extinguishing media	:	Do not use a solid water stream as it may scatter and spread fire.
Hazardous combustion products	:	Carbon monoxide Carbon dioxide (CO_2) Oxides of phosphorus
Further information	:	In case of fire and/or explosion do not breathe fumes. Use water spray to cool unopened containers. Prevent fire extinguishing water from contaminating surface water or the ground water system.
Special protective equipment	:	Wear an approved positive pressure self-contained breathing

for fire-fighters		apparatus in addition to standard fire fighting gear.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	Ventilate the area. Material can create slippery conditions. Use personal protective equipment. Local authorities should be advised if significant spillages cannot be contained.
Environmental precautions	:	Avoid release to the environment.
Methods and materials for containment and cleaning up	:	Contain spillage, soak up with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and transfer to a container for disposal according to local / national regulations (see section 13).

SECTION 7. HANDLING AND STORAGE

Advice on safe handling	:	Handle in accordance with good industrial hygiene and safety practice. Do not get in eyes. Do not get on skin or clothing. Wash thoroughly after handling. Do not breathe vapors or spray mist. Use only in area provided with appropriate exhaust ventilation. Drain or remove substance from equipment prior to break-in or maintenance. Wear appropriate personal protective equipment.
Conditions for safe storage	:	Keep containers tightly closed in a cool, well-ventilated place.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Ingredients with workplace control parameters

Contains no substances with occupational exposure limit values.

Engineering measures	:	Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal protective equipment

Respiratory protection	:	Use respiratory protection unless adequate local exhaust ventilation is provided or exposure assessment demonstrates that exposures are within recommended exposure guidelines.

Hand protection

Material	:	Recommended gloves:
Material	:	Nitrile rubber
Remarks	:	Wear suitable gloves. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions.
Eye protection	:	Wear safety glasses with side shields (or goggles).
Protective measures	:	Ensure that eye flushing systems and safety showers are located close to the working place.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	liquid
Color	:	amber
Odor	:	No data available
Odor Threshold	:	not determined
pH	:	not determined
Melting point/freezing point	:	-65 °F / -54 °C
Boiling point/boiling range	:	not determined
Flash point	:	475 °F / 246 °C
		Method: Cleveland open cup
Evaporation rate	:	not determined
Flammability (solid, gas)	:	Not applicable
Upper explosion limit / Upper flammability limit	:	not determined
Lower explosion limit / Lower flammability limit	:	not determined
Vapor pressure	:	not determined
Relative vapor density	:	not determined

Relative density : 0.997

Solubility(ies)
Water solubility : insoluble

Partition coefficient: n-octanol/water :

No data available

Autoignition temperature : not determined

Decomposition temperature : not determined

Viscosity
Viscosity, dynamic : not determined

Viscosity, kinematic : 26 mm2/s (104 °F / 40 °C)

5.19 mm2/s (212 °F / 100 °C)

Explosive properties : No data available

Oxidizing properties : No data available

SECTION 10. STABILITY AND REACTIVITY

Reactivity : None reasonably foreseeable.

Chemical stability : Stable under normal conditions.

Conditions to avoid : Keep away from sources of ignition - No smoking.

Incompatible materials : Strong oxidizing agents

Hazardous decomposition products : Emits acrid smoke and fumes when heated to decomposition.

SECTION 11. TOXICOLOGICAL INFORMATION

Acute toxicity

Not classified based on available information.

Product:

Acute oral toxicity : Acute toxicity estimate (Rat): > 5,000 mg/kg
Assessment: Not classified
Remarks: Read-across from a similar material

Acute inhalation toxicity : Acute toxicity estimate (Expert judgment): Exposure time: 4 h
Assessment: Not classified
Remarks: Read-across from a similar material

Acute dermal toxicity : Acute toxicity estimate (Expert judgment): Assessment: Not

classified
Remarks: Read-across from a similar material

Components:

Tricresyl phosphate:

Acute oral toxicity	:	LD50 Oral (Rat): > 5,000 mg/kg
Acute inhalation toxicity	:	LC50 (Rat): > 5.2 mg/l Exposure time: 4 h
Acute dermal toxicity	:	LD50 Dermal (Rabbit): > 10,000 mg/kg

Skin corrosion/irritation

Not classified based on available information.

Product:

Species	:	Rabbit
Assessment	:	Not classified as hazardous.
Result	:	slight

Components:

Tricresyl phosphate:

Species	:	Rabbit
Exposure time	:	24 h
Assessment	:	Not classified as hazardous.
Result	:	Non-irritating to the skin.

Serious eye damage/eye irritation

Not classified based on available information.

Product:

Species	:	Rabbit
Result	:	slight
Assessment	:	Not classified
Remarks	:	Read-across from a similar material

Components:

Tricresyl phosphate:

Species	:	Rabbit
Assessment	:	Not classified

Respiratory or skin sensitization

Skin sensitization

Not classified based on available information.

Respiratory sensitization

Not classified based on available information.

Product:

Test Type	:	Skin Sensitization
Species	:	Humans
Assessment	:	Not classified
Method	:	Human Repeat Insult Patch Test
Result	:	non-sensitizing
Remarks	:	Read-across from a similar material

Components:

Tricresyl phosphate:

Test Type	:	Skin Sensitization
Assessment	:	Not classified

Germ cell mutagenicity

Not classified based on available information.

Product:

Genotoxicity in vitro	:	Test Type: various Metabolic activation: Read-across from a similar material Result: Based on available data, the classification criteria are not met.
Genotoxicity in vivo	:	Test Type: Mutagenicity Result: Based on available data, the classification criteria are not met. Remarks: Read-across from a similar material

Components:

Tricresyl phosphate:

Genotoxicity in vitro	:	Test Type: various Result: Based on available data, the classification criteria are not met. Remarks: Not classified
Genotoxicity in vivo	:	Test Type: various Result: Based on available data, the classification criteria are not met.

Carcinogenicity

Not classified based on available information.

Reproductive toxicity

Not classified based on available information.

Product:

Effects on fertility	:	Remarks: No data available
Reproductive toxicity - Assessment	:	No toxicity to reproduction

Components:

Tricresyl phosphate:

Reproductive toxicity - Assessment : May damage the unborn child. Suspected of damaging fertility.

STOT-single exposure

Not classified based on available information.

Product:

Assessment : Based on available data, the classification criteria are not met.

Components:

Tricresyl phosphate:

Assessment : Based on available data, the classification criteria are not met.

STOT-repeated exposure

Not classified based on available information.

Product:

Assessment : Based on available data, the classification criteria are not met.

Components:

Tricresyl phosphate:

Assessment : Based on available data, the classification criteria are not met.

Repeated dose toxicity

Product:

Remarks : No known significant effects or critical hazards.

Components:

Tricresyl phosphate:

Species : Rat
: 300 mg/l

Aspiration toxicity

Not classified based on available information.

Product:

Not classified

Components:

Tricresyl phosphate:

Not classified

Experience with human exposure

Product:

Inhalation	:	Remarks: None known.
Skin contact	:	Remarks: No data available
Eye contact	:	Remarks: No data available
Ingestion	:	Remarks: None known.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Product:

Toxicity to fish	:	LC50 (Fish): Exposure time: 96 h Remarks: Not classified as hazardous. (limit of solubility in fresh water) Read-across from a similar material
Toxicity to daphnia and other aquatic invertebrates	:	EC50 (Daphnia magna (Water flea)): Exposure time: 48 h Remarks: Not classified as hazardous. (limit of solubility in fresh water) Read-across from a similar material
Toxicity to algae/aquatic plants	:	NOEC (Pseudokirchneriella subcapitata (algae)): Exposure time: 72 h Remarks: Not classified as hazardous. (limit of solubility in fresh water) Read-across from a similar material
Toxicity to fish (Chronic toxicity)	:	NOEC (Fish): Remarks: Not classified as hazardous. (limit of solubility in fresh water) Read-across from a similar material
Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)	:	NOEC: Remarks: Not classified as hazardous. (limit of solubility in fresh water) Read-across from a similar material

Components:

Tricresyl phosphate:

Toxicity to fish	:	LC50 (Oncorhynchus mykiss (rainbow trout)): 0.6 mg/l Exposure time: 96 h
Toxicity to daphnia and other aquatic invertebrates	:	EC50 (Daphnia magna (Water flea)): 0.146 mg/l Exposure time: 48 h

M-Factor (Acute aquatic toxicity) : 1

Persistence and degradability

Product:

Biodegradability : Result: Readily biodegradable.
Biodegradation: 92.36 %
Exposure time: 28 d

Biochemical Oxygen Demand (BOD) : Remarks: No data available

Chemical Oxygen Demand (COD) : Remarks: No data available

BOD/COD : Remarks: No data available

Bioaccumulative potential

Product:

Bioaccumulation : Remarks: Mixture
Not applicable

Components:

Tricresyl phosphate:

Bioaccumulation : Bioconcentration factor (BCF): 2,000

Partition coefficient: n-octanol/water : Pow: 860,000
log Pow: 5.93

Mobility in soil

Components:

Tricresyl phosphate:

Distribution among environmental compartments : log Koc: 4.31

Other adverse effects

No data available

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues : Dispose of in accordance with local regulations.

SECTION 14. TRANSPORT INFORMATION

International Regulations

IATA-DGR
Not regulated as a dangerous good

IMDG-Code
Not regulated as a dangerous good

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
Not applicable for product as supplied.

Domestic regulation

49 CFR
Not regulated as a dangerous good

Special precautions for user
Not applicable

SECTION 15. REGULATORY INFORMATION

CERCLA Reportable Quantity
This material does not contain any components with a CERCLA RQ.

SARA 304 Extremely Hazardous Substances Reportable Quantity
This material does not contain any components with a section 304 EHS RQ.

SARA 302 Extremely Hazardous Substances Threshold Planning Quantity

Components	CAS-No.	Component TPQ (lbs)

SARA 311/312 Hazards : No SARA Hazards

SARA 313 : This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

California Prop. 65
This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive defects.

The ingredients of this product are reported in the following inventories:

TCSI : On the inventory, or in compliance with the inventory

TSCA : All substances listed as active on the TSCA inventory

AIIC : On the inventory, or in compliance with the inventory

DSL : This product contains one or several components listed in the Canadian NDSL.

ENCS : On the inventory, or in compliance with the inventory

NZIoC : On the inventory, or in compliance with the inventory

KECI : On the inventory, or in compliance with the inventory

IECSC : On the inventory, or in compliance with the inventory

TSCA list

No substances are subject to TSCA 12(b) export notification requirements.

The following substance(s) is/are subject to a Significant New Use Rule:

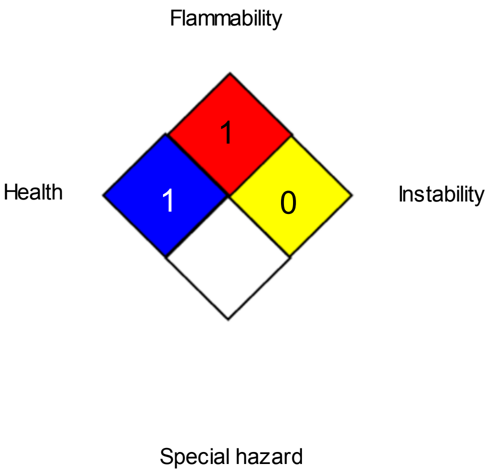
Amines, bis(C11-14-branched and linear alkyl)	900169-60-0

No substances are subject to TSCA 12(b) export notification requirements.

SECTION 16. OTHER INFORMATION

Further information

NFPA 704:



HMIS® IV:

HEALTH	/	1
FLAMMABILITY		1
PHYSICAL HAZARD		0

HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. The "*" represents a chronic hazard, while the "/" represents the absence of a chronic hazard.

Full text of other abbreviations

AIIC - Australian Inventory of Industrial Chemicals; ASTM - American Society for the Testing of Materials; bw - Body weight; CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act; CMR - Carcinogen, Mutagen or Reproductive Toxicant; DIN - Standard of the German Institute for Standardisation; DOT - Department of Transportation; DSL - Domestic Substances List (Canada); ECx - Concentration associated with x% response; EHS - Extremely Hazardous Substance; ELx - Loading rate associated with x% response; EmS - Emergency Schedule; ENCS - Existing and New Chemical Substances (Japan); ErCx - Concentration associated with x% growth rate response; ERG - Emergency Response Guide; GHS - Globally Harmonized System; GLP - Good Laboratory Practice; HMIS - Hazardous Materials Identification System; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; IBC - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk; IC50 - Half maximal inhibitory concentration; ICAO - International Civil Aviation Organization; IECSC - Inventory of Existing Chemical Substances in China; IMDG - International Maritime Dangerous Goods; IMO - International Maritime Organization; ISHL - Industrial Safety and Health Law (Japan); ISO - International Organisation for Standardization; KECI - Korea Existing Chemicals Inventory; LC50 - Lethal Concentration to 50 % of a test population; LD50 - Lethal Dose to 50% of a test population (Median Lethal Dose); MARPOL - International Convention for the Prevention of Pollution from Ships; MSHA - Mine Safety and Health Administration; n.o.s. - Not Otherwise Specified; NFPA - National Fire Protection Association; NO(A)EC - No Observed (Adverse) Effect Concentration; NO(A)EL - No Observed (Adverse) Effect Level; NOELR - No Observable Effect Loading Rate; NTP - National Toxicology Program; NZIoC - New Zealand Inventory of Chemicals; OECD - Organization for Economic Co-operation and Development; OPPTS - Office of Chemical Safety and Pollution Prevention; PBT - Persistent, Bioaccumulative and Toxic substance; PICCS - Philippines Inventory of Chemicals and Chemical Substances; (Q)SAR - (Quantitative) Structure Activity Relationship; RCRA - Resource Conservation and Recovery Act; REACH - Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals; RQ - Reportable Quantity; SADT - Self-Accelerating Decomposition Temperature; SARA - Superfund Amendments and Reauthorization Act; SDS - Safety Data Sheet; TCSI - Taiwan Chemical Substance Inventory; TECI - Thailand Existing Chemicals Inventory; TSCA - Toxic Substances Control Act (United States); UN - United Nations; UNRTDG - United Nations Recommendations on the Transport of Dangerous Goods; vPvB - Very Persistent and Very Bioaccumulative

Sources of key data used to compile the Material Safety Data Sheet : www.EastmanAviationSolutions.com

Revision Date : 01/12/2023

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

US / Z8

SDS – Skydrol PE 5

SECTION 1. IDENTIFICATION

Product name : Skydrol® PE-5

Product code : 34103-00, P3410305, P3410304, P3410302, P3410301, P3410306, P3410313, P3410312, P3410303, P3410311, P3410309, E3410301

Manufacturer or supplier's details

Company name of supplier : Eastman Chemical Company

Address : 200 South Wilcox Drive
Kingsport TN 37660-5280

Telephone : (423) 229-2000

Emergency telephone : CHEMTREC: +1-800-424-9300, +1-703-527-3887 CCN7321

Recommended use of the chemical and restrictions on use

Recommended use : Hydraulic fluids

Restrictions on use : The Environmental Protection Agency prohibits processing and distribution of this chemical/product for any use other than: (1) In hydraulic fluids either for the aviation industry or to meet military specifications for safety and performance where no alternative chemical is available that meets U.S. Department of Defense specification requirements, (2) lubricants and greases, (3) new or replacement parts for motor and aerospace vehicles, (4) as an intermediate in the manufacture of cyanoacrylate glue, (5) in specialised engine air filters for locomotive and marine applications, and (6) in adhesives and sealants before January 6, 2025, after which use in adhesives and sealants is prohibited. In addition, all persons are prohibited from releasing PIP (3:1) to water during manufacturing, processing and distribution in commerce, and must follow all existing regulations and best practices to prevent the release of PIP (3:1) to water during the commercial use of PIP (3:1).

SECTION 2. HAZARDS IDENTIFICATION

GHS classification in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200)

Acute toxicity (Oral) : Category 4

Skin irritation : Category 2

Carcinogenicity : Category 2

Reproductive toxicity (Oral) : Category 2

Specific target organ toxicity - repeated exposure : Category 2 (Adrenal gland)

GHS label elements

Hazard pictograms :

Signal Word : Warning

Hazard Statements :
H302 Harmful if swallowed.
H315 Causes skin irritation.
H351 Suspected of causing cancer.
H361 Suspected of damaging fertility or the unborn child if swallowed.
H373 May cause damage to organs (Adrenal gland) through prolonged or repeated exposure.

Precautionary Statements :

Prevention:

P201 Obtain special instructions before use.
P202 Do not handle until all safety precautions have been read and understood.
P260 Do not breathe dust/ fume/ gas/ mist/ vapors/ spray.
P264 Wash skin thoroughly after handling.
P270 Do not eat, drink or smoke when using this product.
P280 Wear protective gloves/ protective clothing/ eye protection/ face protection.

Response:

P301 + P312 + P330 IF SWALLOWED: Call a POISON CENTER/ doctor if you feel unwell. Rinse mouth.
P302 + P352 IF ON SKIN: Wash with plenty of soap and water.
P308 + P313 IF exposed or concerned: Get medical advice/ attention.
P332 + P313 If skin irritation occurs: Get medical advice/ attention.
P362 Take off contaminated clothing and wash before reuse.

Storage:

P405 Store locked up.

Disposal:

P501 Dispose of contents/ container to an approved waste disposal plant.

Other hazards

None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Components

Chemical name	CAS-No.	Concentration (% w/w)
Tributyl phosphate	126-73-8	58 - 68
Triisobutyl phosphate	126-71-6	8 - 10
Phenol, isopropylated, phosphate (3:1)	68937-41-7	5 - < 10
triphenylphosphate	115-86-6	1.3 - 1.9
7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester	62256-00-2	5.5 - 6.5
butylated hydroxytoluene	128-37-0	0.1 - 1

SECTION 4. FIRST AID MEASURES

If inhaled : Move to fresh air.
Call a physician or poison control center immediately.

In case of skin contact : Wash off with soap and plenty of water.
Wash contaminated clothing before re-use.
Get medical attention.
Thoroughly clean shoes before reuse.

In case of eye contact : In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

If swallowed : Seek medical advice.

Most important symptoms and effects, both acute and delayed : Harmful if swallowed.
Causes skin irritation.
Suspected of causing cancer.
Suspected of damaging fertility or the unborn child if swallowed.
May cause damage to organs through prolonged or repeated exposure.

Notes to physician : Treat symptomatically.

SECTION 5. FIRE-FIGHTING MEASURES

Suitable extinguishing media : Carbon dioxide (CO2)
Dry chemical
Water spray

Unsuitable extinguishing media : Do not use a solid water stream as it may scatter and spread fire.

Hazardous combustion products : Carbon monoxide
Carbon dioxide (CO2)
oxides of phosphorus

Further information : None known.

Special protective equipment for fire-fighters : Wear an approved positive pressure self-contained breathing apparatus in addition to standard fire fighting gear.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures : Wear appropriate personal protective equipment.
Avoid breathing mist or vapors.
Local authorities should be advised if significant spillages cannot be contained.

Environmental precautions : Prevent further leakage or spillage if safe to do so.
Clear up spills immediately and dispose of waste safely.
Avoid release to the environment.

Methods and materials for containment and cleaning up : Prevent runoff from entering drains, sewers, or streams.
Contain spillage, soak up with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and transfer to a container for disposal according to local / national regulations (see section 13).

SECTION 7. HANDLING AND STORAGE

Advice on protection against fire and explosion : None known.

Advice on safe handling : Avoid inhalation of vapor or mist.
Do not get on skin or clothing.
Avoid contact with skin, eyes and clothing.
Do not swallow.
Ensure adequate ventilation.
Wash thoroughly after handling.

Conditions for safe storage : Keep tightly closed.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Ingredients with workplace control parameters

Components	CAS-No.	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
Tributyl phosphate	126-73-8	TWA (Inhalable fraction and vapor)	5 mg/m3	ACGIH
		TWA	0.2 ppm 2.5 mg/m3	NIOSH REL
		TWA	5 mg/m3	OSHA Z-1
		TWA	0.2 ppm 2.5 mg/m3	OSHA P0
triphenylphosphate	115-86-6	TWA	3 mg/m3	ACGIH

		TWA	3 mg/m3	NIOSH REL
		TWA	3 mg/m3	OSHA Z-1
		TWA	3 mg/m3	OSHA P0

Engineering measures : Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal protective equipment

Respiratory protection : Use respiratory protection unless adequate local exhaust ventilation is provided or exposure assessment demonstrates that exposures are within recommended exposure guidelines.

Use a properly fitted, particulate filter respirator complying with an approved standard if a risk assessment indicates this is necessary.
Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable.
If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn.

Hand protection

Remarks : Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. After contamination with product change the gloves immediately and dispose of them according to relevant national and local regulations.

Eye protection : Wear safety glasses with side shields (or goggles).

Skin and body protection : Wear suitable protective clothing.

Protective measures : Remove respiratory and skin/eye protection only after vapors have been cleared from the area.
Ensure that eye flushing systems and safety showers are located close to the working place.
Use personal protective equipment as required.

Hygiene measures : Handle in accordance with good industrial hygiene and safety practice.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance : oily

Color	:	purple
Odor	:	odorless
Odor Threshold	:	not determined
pH	:	not determined
Melting point/range	:	< -80 °F / -62 °C
Boiling point/boiling range	:	not determined
Flash point	:	340 °F / 171 °C Method: Cleveland open cup
Evaporation rate	:	not determined
Flammability (solid, gas)	:	Not applicable
Upper explosion limit / Upper flammability limit	:	not determined
Lower explosion limit / Lower flammability limit	:	not determined
Vapor pressure	:	0.4 hPa (77 °F / 25 °C)
Relative vapor density	:	not determined
Relative density	:	0.9956 (77 °F / 25 °C)
Density	:	995 kg/m3 (77 °F / 25 °C)
Autoignition temperature	:	795 °F / 424 °C Method: ASTM D2155
Decomposition temperature	:	not determined
Viscosity		
Viscosity, dynamic	:	not determined
Viscosity, kinematic	:	9.02 - 10.02 mm2/s (100 °F / 38 °C)
Explosive properties	:	Not classified
Oxidizing properties	:	Not classified

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	None reasonably foreseeable.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	Stable
Conditions to avoid	:	None known.
Incompatible materials	:	Strong oxidizing agents
Hazardous decomposition products	:	Carbon dioxide (CO_2) Carbon monoxide

SECTION 11. TOXICOLOGICAL INFORMATION

Acute toxicity

Harmful if swallowed.

Product:

Acute oral toxicity	:	Remarks: Harmful if swallowed.
Acute inhalation toxicity	:	Remarks: No significant adverse effects were reported
Acute dermal toxicity	:	Remarks: No significant adverse effects were reported

Components:

Tributyl phosphate:

Acute oral toxicity	:	LD50 Oral (Rat, male and female): 1,553 mg/kg Assessment: Harmful if swallowed. LD50 Oral (Rat, male and female): 1,400 mg/kg
Acute inhalation toxicity	:	LC50 (Rat, male and female): > 4.242 mg/l Exposure time: 4 h Test atmosphere: dust/mist Assessment: The substance or mixture has no acute inhalation toxicity
Acute dermal toxicity	:	LD50 Dermal (Rabbit, male and female): > 3,100 mg/kg Assessment: The substance or mixture has no acute dermal toxicity

Triisobutyl phosphate:

Acute inhalation toxicity	:	LC50 (Rat): > 5.14 mg/l Exposure time: 4 h Test atmosphere: dust/mist Assessment: The substance or mixture has no acute inhalation toxicity
Acute dermal toxicity	:	LD50 Dermal (Rabbit): > 5,000 mg/kg

		Assessment: The substance or mixture has no acute dermal toxicity

Phenol, isopropylated, phosphate (3:1):

Acute oral toxicity	:	LD50 Oral (Rat): > 5,000 mg/kg Assessment: The substance or mixture has no acute oral toxicity
Acute inhalation toxicity	:	LC50 (Rat): > 200 mg/m3 Exposure time: 1 h Assessment: The substance or mixture has no acute inhalation toxicity
Acute dermal toxicity	:	LD50 Dermal (Rabbit): > 10,000 mg/kg Assessment: The substance or mixture has no acute dermal toxicity

triphenylphosphate:

Acute oral toxicity	:	LD50 Oral (Rat, male): > 6,400 mg/kg
Acute dermal toxicity	:	LD50 Dermal (Guinea pig, male): > 5,000 mg/kg

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:

Acute oral toxicity	:	LD50 Oral (Rat, male and female): 4,470 mg/kg
Acute dermal toxicity	:	LD50 Dermal (Rabbit, male and female): > 7,940 mg/kg

butylated hydroxytoluene:

Acute oral toxicity	:	LD50 Oral (Rat): > 6,000 mg/kg
Acute dermal toxicity	:	LD50 Dermal (Guinea pig): > 20,000 mg/kg

Skin corrosion/irritation

Causes skin irritation.

Product:

Remarks	:	Causes skin irritation.

Components:

Tributyl phosphate:

Species	:	Rabbit
Exposure time	:	4 h
Assessment	:	Causes skin irritation.
Result	:	irritating

Triisobutyl phosphate:

Species	:	Rabbit
Exposure time	:	4 h

Result : Mild skin irritation

Phenol, isopropylated, phosphate (3:1):

Species : Rabbit
Assessment : Not classified

triphenylphosphate:

Species : Guinea pig
Remarks : Non-irritating to the skin.

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:

Species : Rabbit
Exposure time : 24 h
Assessment : Not classified as hazardous.
Result : slight to moderate irritation

butylated hydroxytoluene:

Species : Rabbit
Exposure time : 24 h
Result : very slight

Serious eye damage/eye irritation

Not classified based on available information.

Components:

Tributyl phosphate:

Species : Rabbit
Result : slight irritation
Exposure time : 24 h
Assessment : Not classified

Triisobutyl phosphate:

Species : Rabbit
Result : slight
Assessment : Not classified

Phenol, isopropylated, phosphate (3:1):

Species : Rabbit
Result : none
Assessment : Not classified

triphenylphosphate:

Species : Rabbit
Result : slight

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:

Species : Rabbit

Result	:	slight irritation
Exposure time	:	24 h
Assessment	:	Not classified

butylated hydroxytoluene:

Species	:	Rabbit
Result	:	none

Respiratory or skin sensitization

Skin sensitization

Not classified based on available information.

Respiratory sensitization

Not classified based on available information.

Product:

Test Type	:	OECD 429: LLNA
Species	:	Mouse
Result	:	Not a skin sensitizer.

Components:

Tributyl phosphate:

Test Type	:	Skin Sensitization
Species	:	Guinea pig
Assessment	:	Not classified
Result	:	Does not cause skin sensitization.

Test Type	:	Skin Sensitization
Species	:	Humans
Assessment	:	Not classified
Result	:	Does not cause skin sensitization.

Triisobutyl phosphate:

Test Type	:	OECD 406: Guinea pig sensitization
Species	:	Guinea pig
Method	:	OECD 406: Guinea pig sensitization
Result	:	May cause sensitization by skin contact.

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:

Test Type	:	Skin Sensitization
Species	:	Guinea pig
Result	:	May cause sensitization by skin contact.

butylated hydroxytoluene:

Test Type	:	Skin sensitization
Species	:	Guinea pig
Result	:	non-sensitizing

Germ cell mutagenicity

Not classified based on available information.

Components:

Tributyl phosphate:

Genotoxicity in vitro	:	Test Type: Mutagenicity - Bacterial Metabolic activation: +/- activation Method: Bacterial Reverse Mutation Assay Result: negative Test Type: Mutagenicity - Mammalian Metabolic activation: +/- activation Method: In vitro Mammalian Chromosome Aberration Test Result: equivocal
Genotoxicity in vivo	:	Species: Rat (male and female) Application Route: oral: gavage Method: Mammalian Bone Marrow Chromosome Aberration Test Result: negative

Triisobutyl phosphate:

Genotoxicity in vitro	:	Test Type: Salmonella typhimurium assay (Ames test) Metabolic activation: +/- activation Method: Bacterial Reverse Mutation Assay Result: negative
Genotoxicity in vivo	:	Result: negative

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:

Genotoxicity in vitro	:	Test Type: Salmonella typhimurium assay (Ames test) Metabolic activation: +/- activation Method: Bacterial Reverse Mutation Assay Result: negative Test Type: Mutagenicity - Mammalian Metabolic activation: +/- activation Method: In vitro Mammalian Chromosome Aberration Test Result: equivocal Test Type: Mutagenicity - Mammalian Metabolic activation: +/- activation Method: In vitro Mammalian Cell Gene Mutation Test Result: negative
Genotoxicity in vivo	:	Species: Rat (male and female) Application Route: intraperitoneal injection Method: Mammalian Bone Marrow Chromosome Aberration Test Result: equivocal

Carcinogenicity

Suspected of causing cancer.

Components:

Tributyl phosphate:

Species	:	Rat, male and female
Application Route	:	Ingestion
Method	:	EPA OTS 798.3300
Remarks	:	Limited evidence of a carcinogenic effect. May cause cancer.

IARC	No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA	No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.
NTP	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Reproductive toxicity

Suspected of damaging fertility or the unborn child if swallowed.

Components:

Phenol, isopropylated, phosphate (3:1):

Effects on fertility	:	Species: Rat, male and female Application Route: Oral General Toxicity Parent: NOAEL: 25 milligram per kilogram Remarks: Suspected of damaging fertility or the unborn child.

triphenylphosphate:

Reproductive toxicity - Assessment	:	Based on available data, the classification criteria are not met.

STOT-single exposure

Not classified based on available information.

Components:

Tributyl phosphate:

Assessment	:	Based on available data, the classification criteria are not met.

Triisobutyl phosphate:

Assessment	:	Not classified

Phenol, isopropylated, phosphate (3:1):

Remarks	:	Not classified due to data which are conclusive although insufficient for classification.

STOT-repeated exposure

May cause damage to organs (Adrenal gland) through prolonged or repeated exposure.

Components:

Tributyl phosphate:

Assessment : Based on available data, the classification criteria are not met.

Triisobutyl phosphate:

Assessment : Not classified

Phenol, isopropylated, phosphate (3:1):

Assessment : May cause damage to organs through prolonged or repeated exposure.

Repeated dose toxicity

Components:

Tributyl phosphate:

Species	:	Mouse, male and female
	:	75 mg/kg
Application Route	:	in feed
Exposure time	:	90 days

Triisobutyl phosphate:

Species	:	Rat, male
	:	68.4 mg/kg
Application Route	:	Oral Study
Exposure time	:	90 days

Aspiration toxicity

Not classified based on available information.

Product:

No aspiration toxicity classification

Components:

Triisobutyl phosphate:

Not classified

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:

Not applicable

Routes of exposure

Product:

Inhalation : Remarks: May cause damage to organs through prolonged or

		repeated exposure.
Skin contact	:	Remarks: Causes skin irritation.
Eye contact	:	Remarks: None known.
Ingestion	:	Remarks: Harmful if swallowed.

Further information

Product:

Remarks	:	None known.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Components:

Tributyl phosphate:

Toxicity to fish	:	LC50 (Oncorhynchus mykiss (rainbow trout)): 4.2 mg/l Exposure time: 96 h
Toxicity to daphnia and other aquatic invertebrates	:	EC50 (Daphnia magna (Water flea)): 1.8 mg/l Exposure time: 48 h
Toxicity to algae/aquatic plants	:	EC50 (Desmodesmus subspicatus (green algae)): 1.1 mg/l Exposure time: 72 h
Toxicity to fish (Chronic toxicity)	:	NOEC (Oncorhynchus mykiss (rainbow trout)): 0.82 mg/l Exposure time: 95 d 1.7 mg/l
Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)	:	NOEC (Daphnia magna (Water flea)): 1.3 mg/l Exposure time: 21 d

Triisobutyl phosphate:

Toxicity to fish	:	EC50 (Danio rerio (zebra fish)): > 12.6 mg/l Exposure time: 96 h
Toxicity to daphnia and other aquatic invertebrates	:	EC50 (Daphnia magna (Water flea)): 24 mg/l Exposure time: 48 h
Toxicity to algae/aquatic plants	:	ErC50 (Pseudokirchneriella subcapitata (algae)): 14.3 mg/l Exposure time: 72 h EC10 (Pseudokirchneriella subcapitata (algae)): 10.4 mg/l Exposure time: 72 h

Phenol, isopropylated, phosphate (3:1):

Toxicity to fish : LC50 (Oncorhynchus mykiss (rainbow trout)): 0.36 mg/l
Exposure time: 96 h

LC50 (Cyprinodon variegatus (sheepshead minnow)): > 1.3 mg/l
Exposure time: 96 h

Toxicity to daphnia and other aquatic invertebrates : LC50 (Daphnia magna (Water flea)): 1 mg/l
Exposure time: 48 h

LC50 (Mysidopsis bahia (opossum shrimp)): > 1 mg/l

Toxicity to algae/aquatic plants : NOEC (Desmodesmus subspicatus (green algae)): 0.25 - 2.5 mg/l
Exposure time: 72 h
Test Type: Alga, Growth Inhibition Test

M-Factor (Acute aquatic toxicity) : 1

M-Factor (Chronic aquatic toxicity) : 1

triphenylphosphate:

Toxicity to fish : LC50 (Oncorhynchus mykiss (rainbow trout)): 0.4 mg/l
Exposure time: 96 h

Toxicity to daphnia and other aquatic invertebrates : LC50 (Americamysis): > 0.18 - < 0.32 mg/l
Exposure time: 96 h

Toxicity to algae/aquatic plants : NOEC (Pseudokirchneriella subcapitata (algae)): 0.25 mg/l
Exposure time: 72 h

Toxicity to fish (Chronic toxicity) : EC10 (Oncorhynchus mykiss (rainbow trout)): 0.037 mg/l
Exposure time: 30 d

Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity) : NOEC (Daphnia magna (Water flea)): 0.254 mg/l
Exposure time: 21 d

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:

Toxicity to fish : LC50 (Oncorhynchus mykiss (rainbow trout)): 2.9 mg/l
Exposure time: 96 h

Toxicity to daphnia and other aquatic invertebrates : EC50 (Daphnia magna (Water flea)): 6.5 mg/l
Exposure time: 48 h

Toxicity to algae/aquatic plants : ErC50 (Pseudokirchneriella subcapitata (algae)): 2.6 mg/l
Exposure time: 72 h

NOEC (Pseudokirchneriella subcapitata (algae)): 0.11 mg/l
Exposure time: 72 h

Toxicity to microorganisms : EC50: 2.6 mg/l
Exposure time: 72 h

butylated hydroxytoluene:

Toxicity to fish : LC50 (Danio rerio (zebra fish)): > 0.57 mg/l
Exposure time: 96 h

Toxicity to daphnia and other aquatic invertebrates : EC50 (Daphnia magna (Water flea)): 0.48 mg/l
Exposure time: 48 h

Toxicity to algae/aquatic plants : EC50 (Pseudokirchneriella subcapitata (algae)): > 0.24 mg/l
Exposure time: 72 h

NOEC (Pseudokirchneriella subcapitata (algae)): 0.24 mg/l
Exposure time: 72 h

Toxicity to fish (Chronic toxicity) : NOEC (Oryzias latipes (Orange-red killifish)): 0.053 mg/l
Exposure time: 30 d

Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity) : NOEC (Daphnia magna (Water flea)): 0.069 mg/l
Exposure time: 21 d

Persistence and degradability

<u>Components:</u>

Tributyl phosphate:

Biodegradability : Result: Readily biodegradable.

Triisobutyl phosphate:

Biodegradability : Result: Readily biodegradable.
Biodegradation: 70 - 80 %
Exposure time: 28 d
Method: Ready Biodegradability: CO2 Evolution Test

Phenol, isopropylated, phosphate (3:1):

Biodegradability : Remarks: Not readily biodegradable.

triphenylphosphate:

Biodegradability : Result: Readily biodegradable.

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:

Biodegradability : Concentration: 100 mg/l
Method: Ready Biodegradability: Modified MITI Test (I)
Remarks: Readily biodegradable

Bioaccumulative potential

Components:

Tributyl phosphate:

Bioaccumulation : Species: Cyprinus carpio (Carp)
Bioconcentration factor (BCF): 20
Exposure time: 56 d
Method: OECD Test Guideline 305

Bioconcentration factor (BCF): 35
Exposure time: 38 d

Partition coefficient: n-octanol/water : Pow: 10,100

Triisobutyl phosphate:

Bioaccumulation : Remarks: Bioaccumulation is unlikely.

Partition coefficient: n-octanol/water : log Pow: 3.72

Phenol, isopropylated, phosphate (3:1):

Bioaccumulation : Remarks: Potential bioaccumulation

triphenylphosphate:

Partition coefficient: n-octanol/water : log Pow: 4.63

Mobility in soil

Components:

Phenol, isopropylated, phosphate (3:1):

Distribution among environmental compartments : log Koc: 3.43 - 3.93

Other adverse effects

No data available

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues : This product meets the criteria for a synthetic used oil under the U.S. EPA Standards for the Management of Used Oil (40 CFR 279). Those standards govern recycling and disposal in lieu of 40 CFR 260 -272 of the Federal hazardous waste program in states that have adopted these used oil regulations. Consult your attorney or appropriate regulatory official to be sure these standards have been adopted in your state. Recycle or burn in accordance with the applicable

standards.
Dispose of in accordance with local regulations.

SECTION 14. TRANSPORT INFORMATION

International Regulations

IATA-DGR

UN/ID No.	:	UN 3082
Proper shipping name	:	Environmentally hazardous substance, liquid, n.o.s. (triphenyl phosphate)
Class	:	9
Packing group	:	III
Labels	:	Miscellaneous
Packing instruction (cargo aircraft)	:	964
Packing instruction (passenger aircraft)	:	964
Remarks	:	Shipping in package sizes of less than 5 L (liquids) or 5 KG (solids) may lead to a non-regulated classification.

IMDG-Code

UN number	:	UN 3082
Proper shipping name	:	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (triphenyl phosphate)
Class	:	9
Packing group	:	III
Labels	:	9
EmS Code	:	F-A, S-F
Marine pollutant	:	yes
Remarks	:	Shipping in package sizes of less than 5 L (liquids) or 5 KG (solids) may lead to a non-regulated classification.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not applicable for product as supplied.

Domestic regulation

49 CFR

UN/ID/NA number	:	UN 3082
Proper shipping name	:	Environmentally hazardous substance, liquid, n.o.s. (triphenyl phosphate)
Class	:	9
Packing group	:	III
Labels	:	CLASS 9
ERG Code	:	171
Marine pollutant	:	yes(triphenyl phosphate)
Remarks	:	Above applies only to containers over 119 gallons or 450 liters. Not regulated if shipped in packages less than or equal to 119 gallons (450 liters).

Special precautions for user

The transport classification(s) provided herein are for informational purposes only, and solely based upon the properties of the unpackaged material as it is described within this Safety Data Sheet. Transportation classifications may vary by mode of transportation, package sizes, and variations in regional or country regulations.

SECTION 15. REGULATORY INFORMATION

CERCLA Reportable Quantity

This material does not contain any components with a CERCLA RQ.

SARA 304 Extremely Hazardous Substances Reportable Quantity

This material does not contain any components with a section 304 EHS RQ.

SARA 302 Extremely Hazardous Substances Threshold Planning Quantity

This material does not contain any components with a section 302 EHS TPQ.

SARA 311/312 Hazards : Skin corrosion or irritation
Carcinogenicity
Reproductive toxicity
Specific target organ toxicity (single or repeated exposure)
Acute toxicity (any route of exposure)

SARA 313 : This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

California Prop. 65

This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive defects.

The ingredients of this product are reported in the following inventories:

DSL	:	All components of this product are on the Canadian DSL
AIIC	:	On the inventory, or in compliance with the inventory
ENCS	:	On the inventory, or in compliance with the inventory
IECSC	:	On the inventory, or in compliance with the inventory
TCSI	:	On the inventory, or in compliance with the inventory
TSCA	:	All substances listed as active on the TSCA inventory

TSCA list

The following substance(s) is/are subject to a Significant New Use Rule:

Potassium decafluoro(pentafluoroethyl)cyclohexanesulphonate	67584-42-3

The following substance(s) is/are subject to TSCA 12(b) export notification requirements:

Phenol, isopropylated, phosphate (3:1)	68937-41-7

The following substance(s) is/are subject to TSCA - 6 Risk Management Rules List of Chemicals:

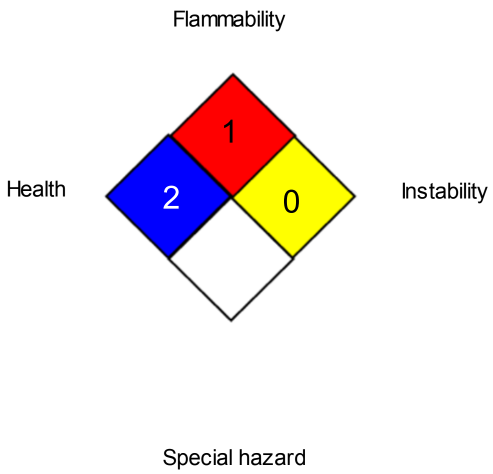
Phenol, isopropylated, phosphate (3:1) 68937-41-7

The Environmental Protection Agency prohibits processing and distribution of this chemical/product for any use other than: (1) In hydraulic fluids either for the aviation industry or to meet military specifications for safety and performance where no alternative chemical is available that meets U.S. Department of Defense specification requirements, (2) lubricants and greases, (3) new or replacement parts for motor and aerospace vehicles, (4) as an intermediate in the manufacture of cyanoacrylate glue, (5) in specialised engine air filters for locomotive and marine applications, and (6) in adhesives and sealants before January 6, 2025, after which use in adhesives and sealants is prohibited. In addition, all persons are prohibited from releasing PIP (3:1) to water during manufacturing, processing and distribution in commerce, and must follow all existing regulations and best practices to prevent the release of PIP (3:1) to water during the commercial use of PIP (3:1).

SECTION 16. OTHER INFORMATION

Further information

NFPA 704:



HMIS® IV:

HEALTH	*	2
FLAMMABILITY		1
PHYSICAL HAZARD		0

HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. The "*" represents a chronic hazard, while the "/" represents the absence of a chronic hazard.

Full text of other abbreviations

ACGIH	:	USA. ACGIH Threshold Limit Values (TLV)
NIOSH REL	:	USA. NIOSH Recommended Exposure Limits
OSHA P0	:	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
OSHA Z-1	:	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
ACGIH / TWA	:	8-hour, time-weighted average
NIOSH REL / TWA	:	Time-weighted average concentration for up to a 10-hour workday during a 40-hour workweek
OSHA P0 / TWA	:	8-hour time weighted average
OSHA Z-1 / TWA	:	8-hour time weighted average

AIIC - Australian Inventory of Industrial Chemicals; ASTM - American Society for the Testing of Materials; bw - Body weight; CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act; CMR - Carcinogen, Mutagen or Reproductive Toxicant; DIN - Standard of the German Institute for Standardisation; DOT - Department of Transportation; DSL - Domestic Substances List (Canada); ECx - Concentration associated with x% response; EHS - Extremely Hazardous Substance; ELx - Loading rate associated with x% response; EmS - Emergency Schedule; ENCS - Existing and New Chemical Substances (Japan); ErCx - Concentration associated with x% growth rate response; ERG - Emergency Response Guide; GHS - Globally Harmonized System; GLP - Good Laboratory Practice; HMIS - Hazardous Materials Identification System; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; IBC - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk; IC50 - Half maximal inhibitory concentration; ICAO - International Civil Aviation Organization; IECSC - Inventory of Existing Chemical Substances in China; IMDG - International Maritime Dangerous Goods; IMO - International Maritime Organization; ISHL - Industrial Safety and Health Law (Japan); ISO - International Organisation for Standardization; KECI - Korea Existing Chemicals Inventory; LC50 - Lethal Concentration to 50 % of a test population; LD50 - Lethal Dose to 50% of a test population (Median Lethal Dose); MARPOL - International Convention for the Prevention of Pollution from Ships; MSHA - Mine Safety and Health Administration; n.o.s. - Not Otherwise Specified; NFPA - National Fire Protection Association; NO(A)EC - No Observed (Adverse) Effect Concentration; NO(A)EL - No Observed (Adverse) Effect Level; NOELR - No Observable Effect Loading Rate; NTP - National Toxicology Program; NZIoC - New Zealand Inventory of Chemicals; OECD - Organization for Economic Co-operation and Development; OPPTS - Office of Chemical Safety and Pollution Prevention; PBT - Persistent, Bioaccumulative and Toxic substance; PICCS - Philippines Inventory of Chemicals and Chemical Substances; (Q)SAR - (Quantitative) Structure Activity Relationship; RCRA - Resource Conservation and Recovery Act; REACH - Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals; RQ - Reportable Quantity; SADT - Self-Accelerating Decomposition Temperature; SARA - Superfund Amendments and Reauthorization Act; SDS - Safety Data Sheet; TCSI - Taiwan Chemical Substance Inventory; TSCA - Toxic Substances Control Act (United States); UN - United Nations; UNRTDG - United Nations Recommendations on the Transport of Dangerous Goods; vPvB - Very Persistent and Very Bioaccumulative

Revision Date : 07/02/2021

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

US / Z8