Controlled VOC Ozone Converter Testing

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PREFACE

The VOC ozone converter test used a controlled set of attributes common to one commercial aircraft type.

In the real world… operators encounter

- diverse aircraft types,
- different ozone converter designs,
- adapted maintenance protocols,
- and diverse operating conditions….

…which impact efforts to reduce smoke odor fume events.

TOPICS

- Video (14 min)
- Slide pack (45 mins)
- Q&A (15 min)

- Pre-Test Questions
- Testing
    - approach, location, supporting companies & instrumentation
    - set up & conditions
- Evaluated characteristics
    - Ultra-fine particles
    - Carboxylic Acids
    - Aldehydes
    - VOC by Gas Chromatography -Electron Ionization Time of Flight (EITOF)
    - Odor & Other Instruments
- Observations
- Limitation and Further Study
- Revisiting Research Questions

PRE-TEST QUESTIONS

1. Do VOC Ozone Converters reduce odors in aircraft bleed air directed into the cabin?
   - In the AeroParts test environment, the data indicates that a VOC converter creates less odor causing substances compared with a non-VOC converter.

2. Should owner/operators install/maintain VOC converters to reduce SOF events?
   - Properly maintained VOC converters along with efforts to minimize ingestion of contaminates and employment of effective ECS decontamination protocols should reduce ECS related SOF events.

Video and Photos

Controlled VOC Ozone Converter Testing

Approach, Set Up & Conditions, and Constituents Evaluated

Controlled VOC Ozone Converter Testing

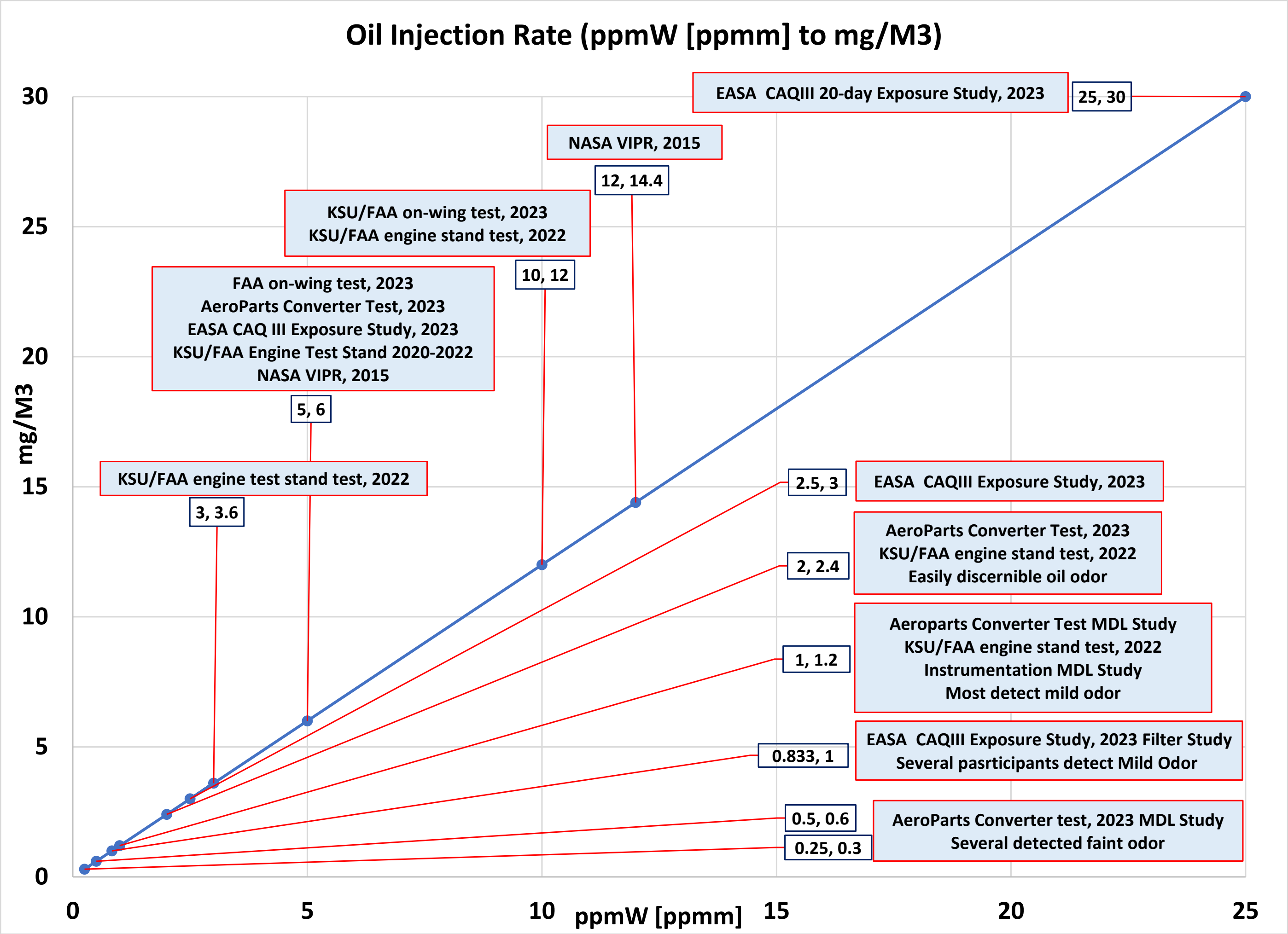
TESTING
APPROACH

- 1 non-VOC converter and 3 VOC converters
  - all 4 converters met return to service ozone reduction performance
  - Full-size ozone converters reduced subscale testing variability
- Controlled injection of contaminates
  - ozone, exhaust, engine oil and isobutylene challenges
- Real-time sensing and lab specimens
  - Real time instrument Method Detection Limit (MDL) test condition using diminishing oil levels of 5.0, 2.0, 1.0, 0.5, and 0.25 ppmW
- Odor
  - Odor olfaction performed by participants throughout testing, with and without ozone, and during final instrument MDL test.
- Risk of US Government shutdown forced revised test plan
  - Eliminated Isobutylene test
  - Limited non-VOC converter testing at lower oil injection levels and exhaust

TESTING

CONCENTRATIONS REPRESENTATIVE OF A CONTAMINATION EVENT, LIKE OTHER RECENT STUDIES

AeroParts ENCS
ENVIRONMENTAL CONTROL SOLUTIONS



AeroParts

TESTING

LOCATION

Arnold Air Force Base Propulsion Research Facility (AEDC) @ University of Tennessee Space Institute (UTSI)

- Test Launch – 26-Sep-23
- Test Wrap Up – 09-Oct-23

TESTING

LEADERSHIP

Test Setup and Test were managed by Dr. Robert Howard (AEDC PRF) under the direction of AeroParts Project Leader, Dr. Richard Fox.

TESTING

SUPPORTING COMPANIES

Aerodyne Research

JS2 Aerospace

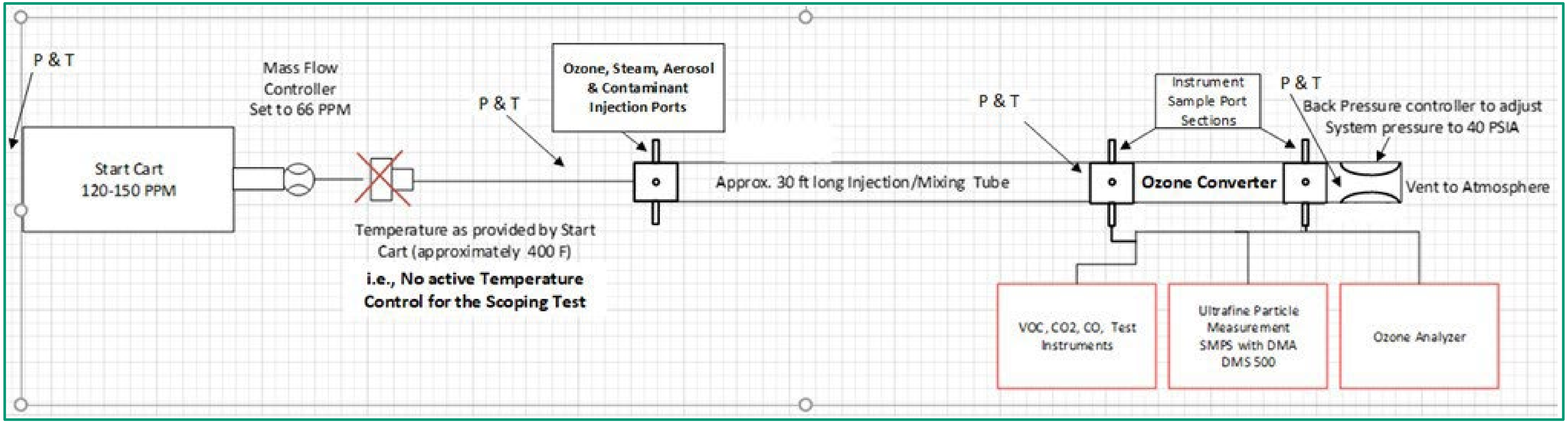
AIRSENSE ANALYTICS
www.airsense.com
Made in Germany

Syft™

ARNOLD ENGINEERING DEVELOPMENT COMPLEX

SET UP AND CONDITIONS

SCHEMATIC



SET UP AND CONDITIONS

ACCEPTANCE TEST PROCEDURE (ATP)

- Temperature 392 + 10 °F
- Pressure 14.0 psia to 18.0 psia
- Flow 1.1 lb./sec + 0.055 lb./sec (66 lb./min)
- Ozone 1.5 ppmV

SET UP AND CONDITIONS

INJECTION OF CONTAMINATES

- Mobil Jet II Engine Oil (commonly used by operators)
  - Density @ 15 C, kg/l per ASTM D4052 = 1.0035
- Eliminated Isobutylene Test
- Diluted Engine Exhaust
- Ozone – With and Without

TESTING

PRIMARY CONSTITUENTS EVALUATED

Aerosol UFP Measurements by SMPS

Aerosol UFP Measurements by Cambustion DMS500

Carboxylic Acids

Aldehydes

VOC by GC EITOR

Other Instruments

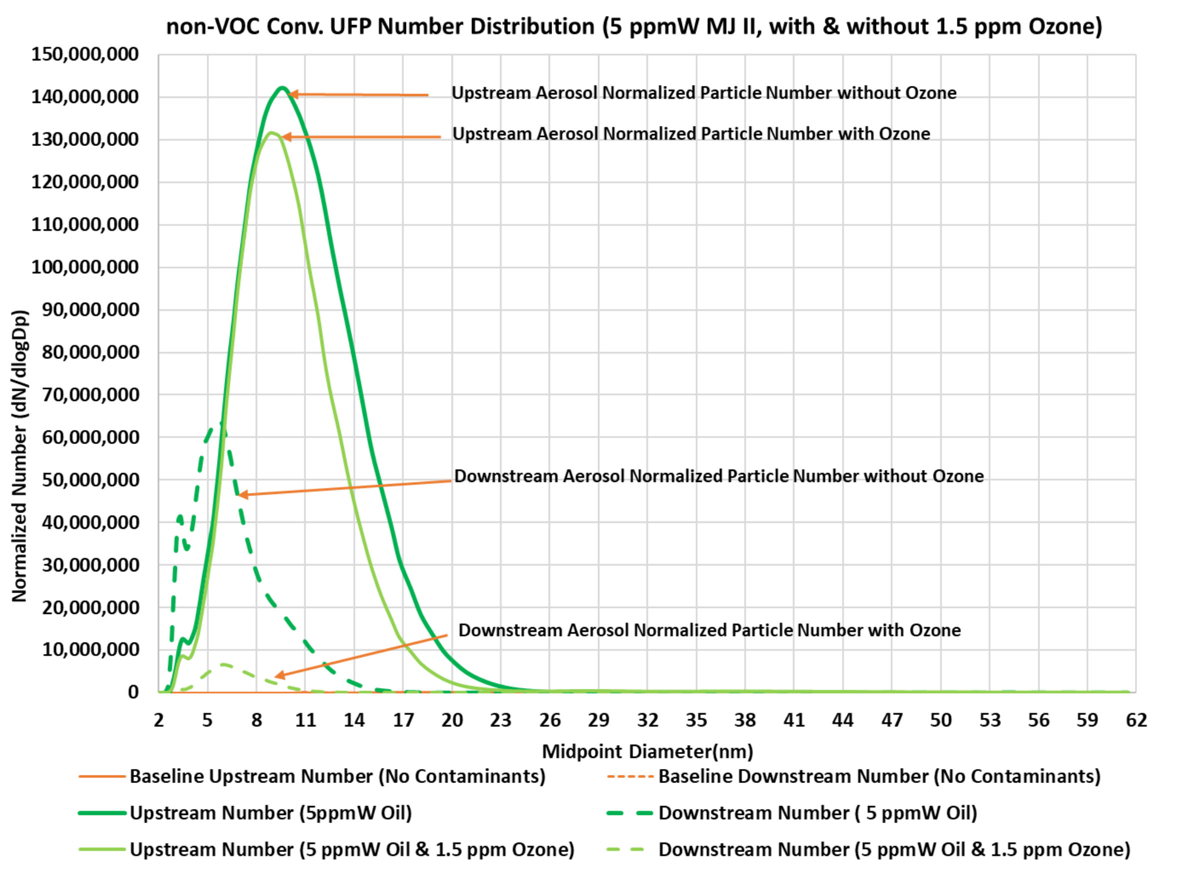
Odors

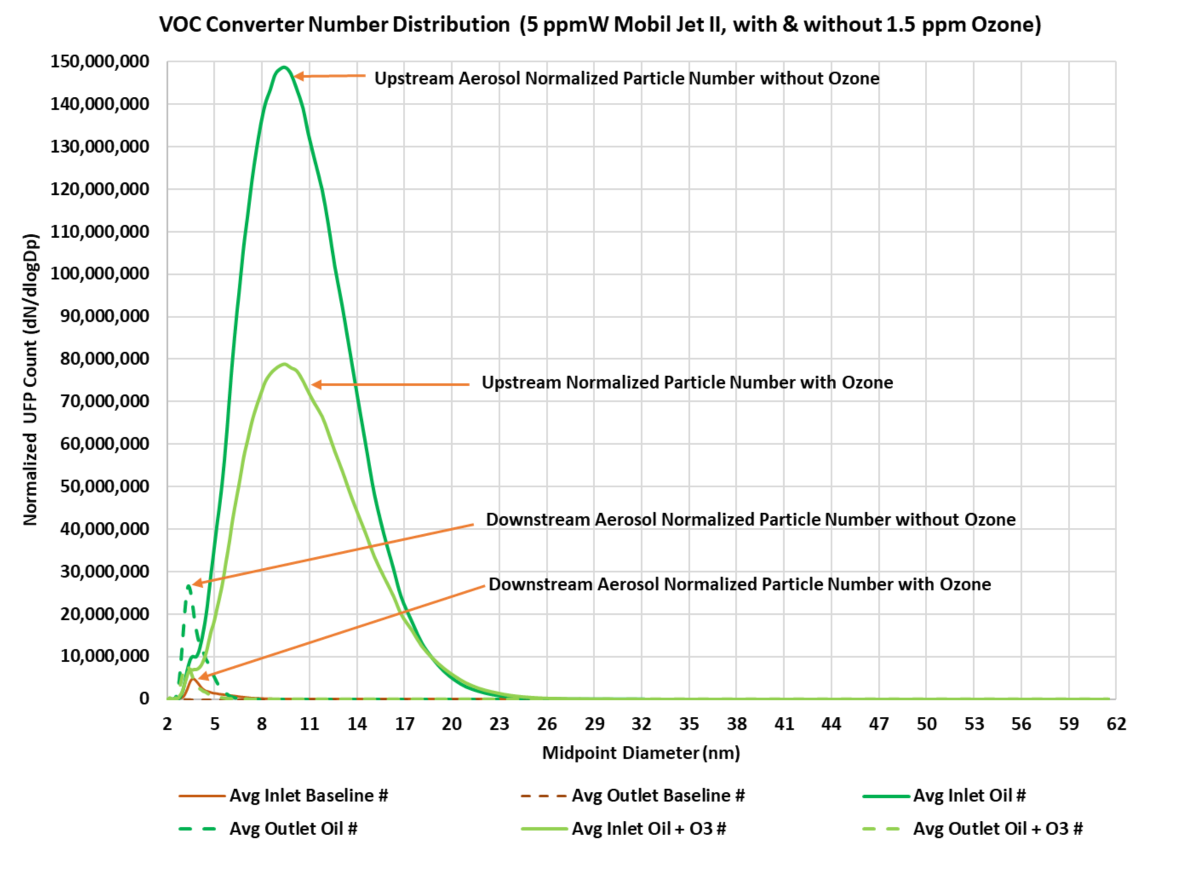
Conclusions

Aerosol UFP Measurements by SMPS

Controlled VOC Ozone Converter Testing

NON-VOC AND VOC CONVERTER UFP NUMBER-SIZE DISTRIBUTION





In this test environment data indicates:

- the downstream aerosol particle numbers are orders of magnitude lower, with or without addition of ozone.
- VOC converter shows greater drop in aerosol number than non-VOC converter.

NON-VOC AND VOC CONVERTER UFP NUMBER REMOVAL EFFICIENCY

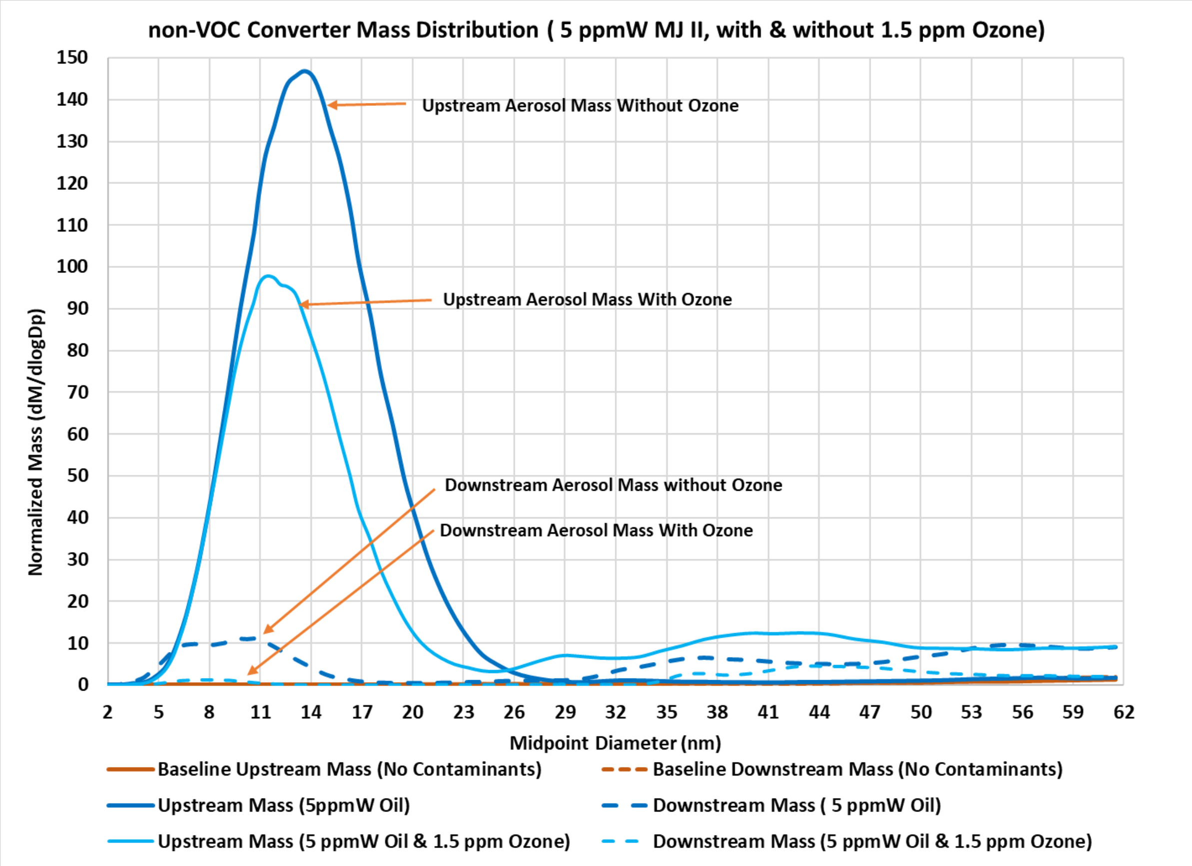
non-VOC Converter Number Reduction (#/cm3)				
	Upstream	Downstream	Amount Removed	% Reduction
Baseline	8196	5366	2830	
5 ppm Mobil Jet II	55,622,870	24,445,282	31,177,588	56.1%
5 ppm MJ II + 1.5 ppmV O_3	45,552,340	1,839,414	43,712,927	96.0%

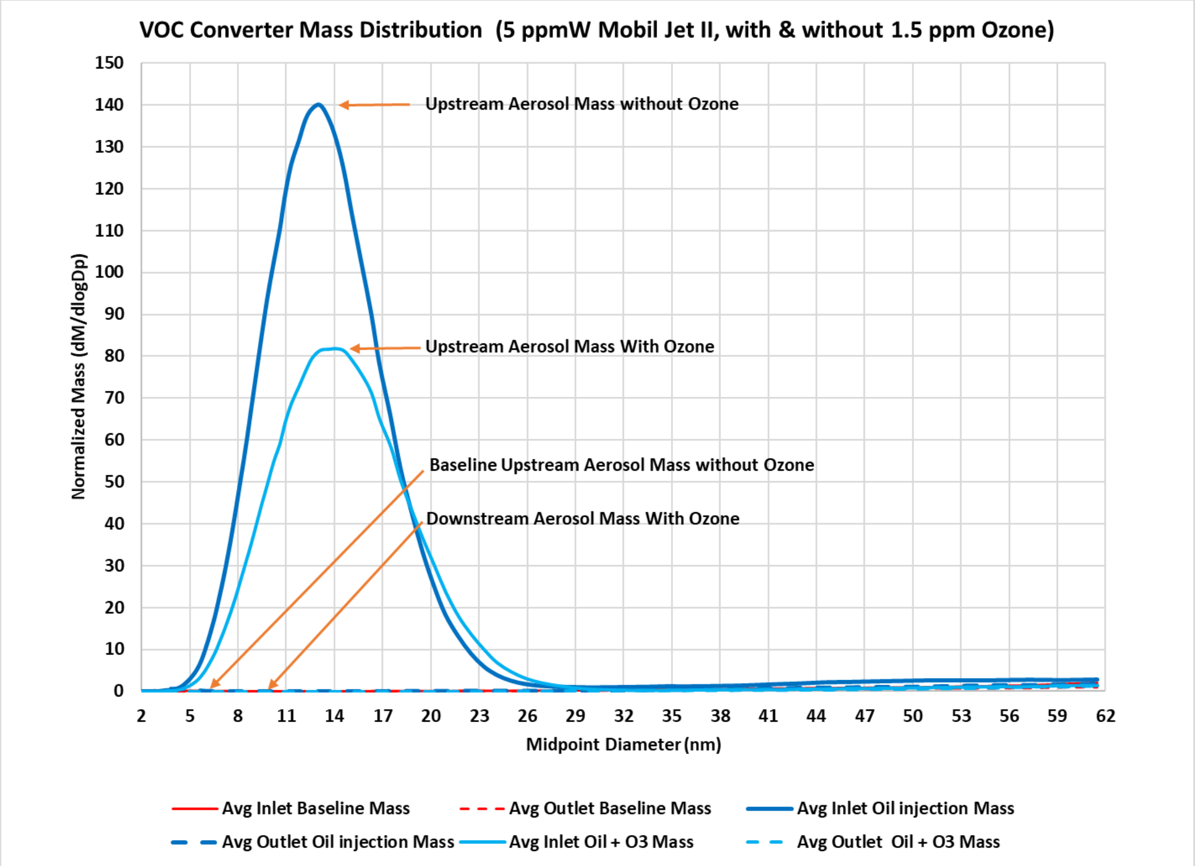
VOC Converter Number Reduction (#/cm3)				
	Upstream	Downstream	Amount Removed	% Reduction
Baseline	798,453	9,691	788,762	
5 ppm Mobil Jet II	56,430,517	4,200,963	52,229,553	92.6%
5 ppm Mobil Jet II +1.5 ppmV O_3	31,827,636	1,111,997	30,715,639	96.5%

In this test environment data indicates:

- the downstream aerosol particle numbers are orders of magnitude lower, with or without addition of ozone.
- VOC converter shows greater drop in aerosol number than non-VOC converter.

NON-VOC AND VOC CONVERTER UFP MASS-SIZE DISTRIBUTION





In this test environment data indicates:

- the downstream aerosol particle mass are orders of magnitude lower, with or without addition of ozone.
- VOC converter shows greater drop in aerosol mass than non-VOC converter.

NON-VOC AND VOC CONVERTER UFP MASS REMOVAL EFFICIENCY

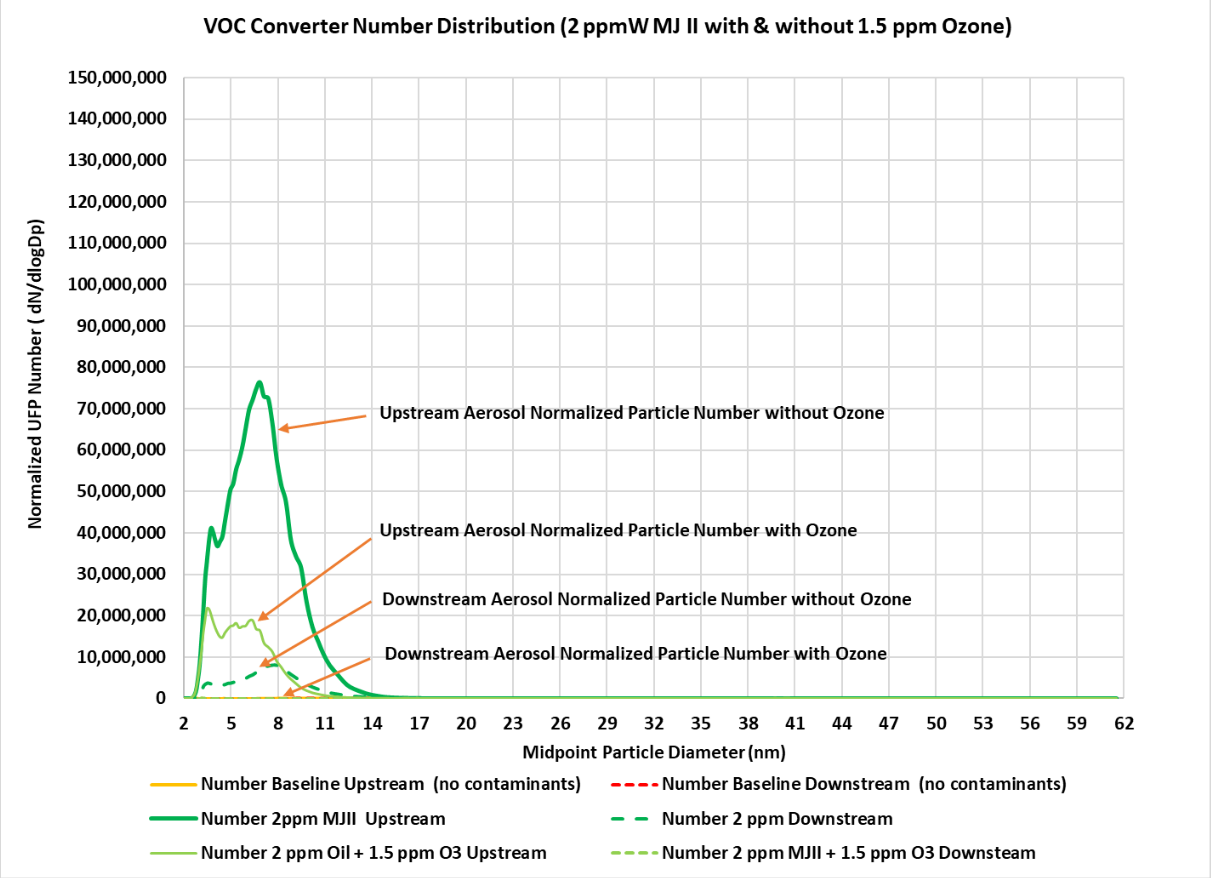
non-VOC Converter Mass Reduction (µg/m3)				
	Upstream	Downstream	Amount Removed	% Reduction
Baseline	0.2	0.2	0	
5 ppm Mobil Jet II	46.7	6.9	40	85.2%
5 ppm MJ II + 1.5 ppmV O_3	34.1	1.2	33	96.4%

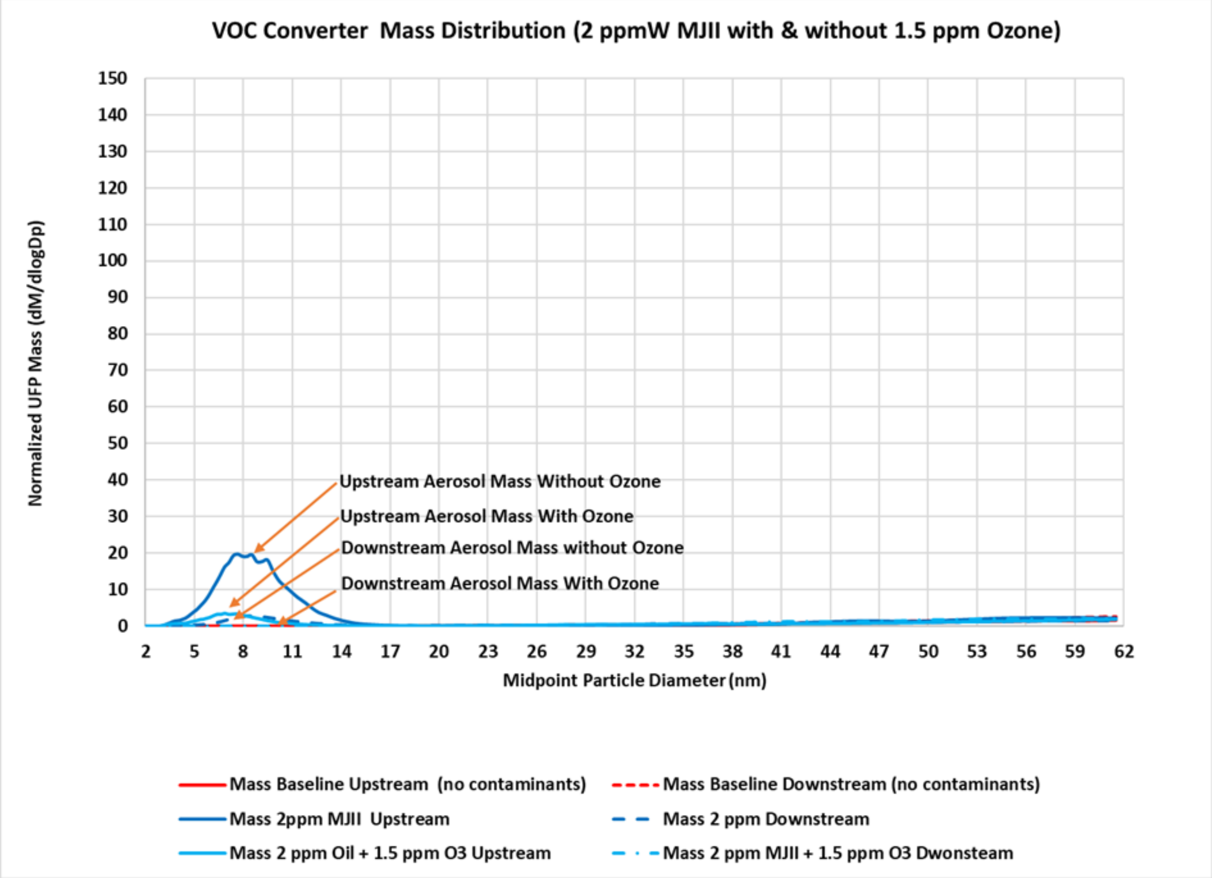
VOC Converter Mass Reduction (µg/m3)				
	Upstream	Downstream	Amount Removed	% Reduction
Baseline	0.4	0.2	0.1	
5 ppm Mobil Jet II	43.5	0.5	43.1	99.0%
5 ppm Mobil Jet II +1.5 ppmV O3	27.8	0.2	27.5	99.1%

In this test environment data indicates:

- the downstream aerosol particle mass are orders of magnitude lower, with or without addition of ozone.
- VOC converter shows greater drop in aerosol mass than non-VOC converter.

VOC CONVERTER – 2 PPMW OIL NUMBER & MASS SIZE DISTRIBUTIONS





In this test environment data indicates:

- the downstream aerosol particle numbers and particle mass are orders of magnitude lower, with or without addition of ozone.
- 2 ppmW oil consumption is close to normal operation, with most of the consumption through the gearbox oil separator.
- VOC converter shows greater drop in aerosol number than non-VOC converter.

VOC CONVERTER – 2 PPMW OIL UFP NUMBER & MASS UFP REMOVAL EFFICIENCY

VOC Converter Number Reduction (#/cm3)				
	Upstream	Downstream	Amount Removed	% Reduction
Baseline	15,328	14,215	1,113	
2 ppm Mobil Jet II	32,981,924	72,329	32,909,595	99.8%
2 ppm MJ II + 1.5 ppmV O_3	10,236,515	26,768	10,209,746	99.7%

VOC Converter Mass Reduction (µg/m3)				
	Upstream	Downstream	Amount Removed	% Reduction
Baseline	0.3	0.4	-0.1	
2 ppm Mobil Jet II	7.6	0.3	7.3	96.3%
2 ppm MJ II + 1.5 ppmV O_3	1.6	0.5	1.2	72.4%

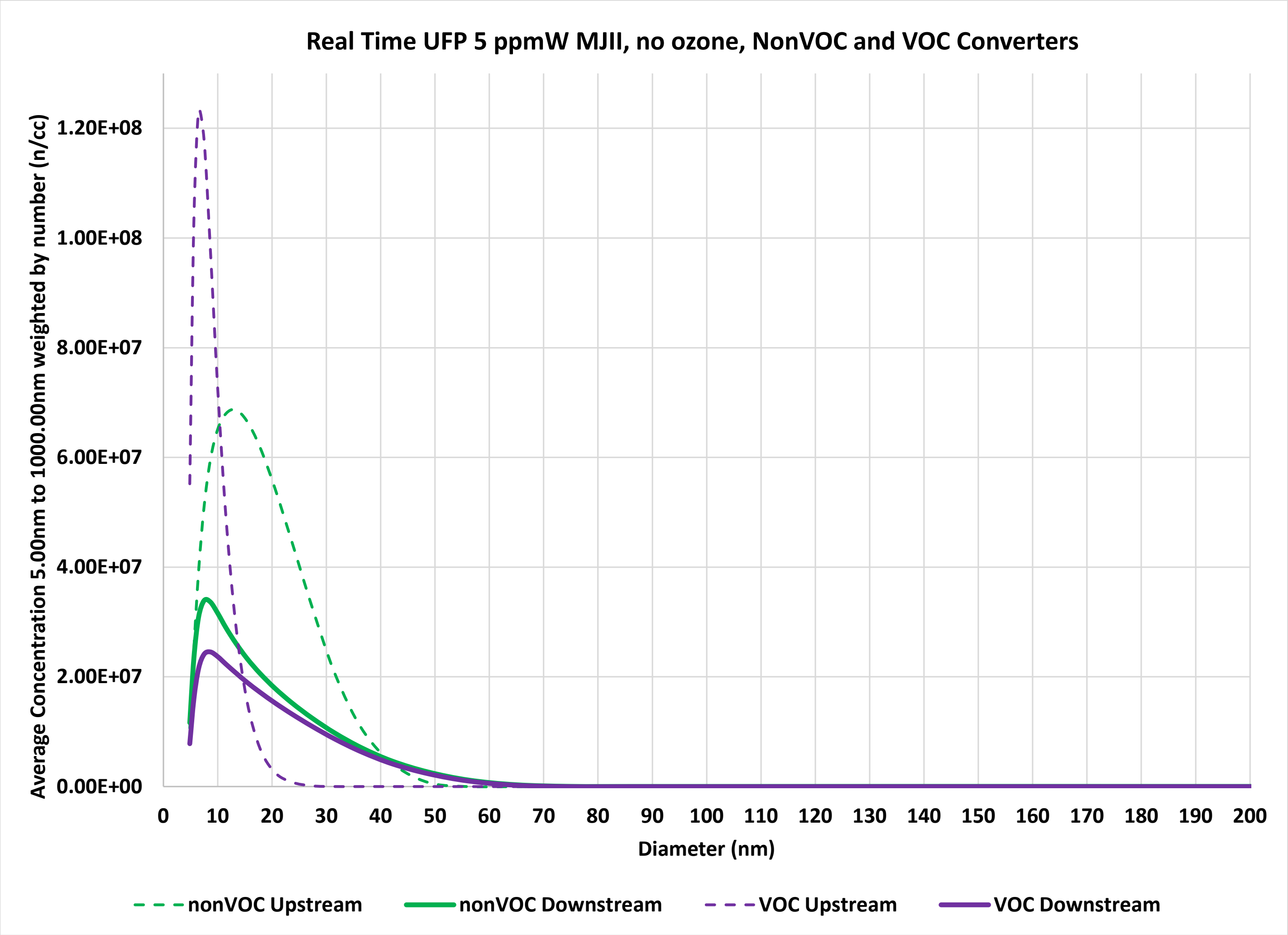
In this test environment data indicates:

- the downstream aerosol particle numbers and particle mass are orders of magnitude lower, with or without addition of ozone.
- 2 ppmW oil consumption is close to normal operation oil consumption, with most of the consumption through the gearbox oil separator.

Aerosol UFP Measurements by Cambustion DMS500

Controlled VOC Ozone Converter Testing

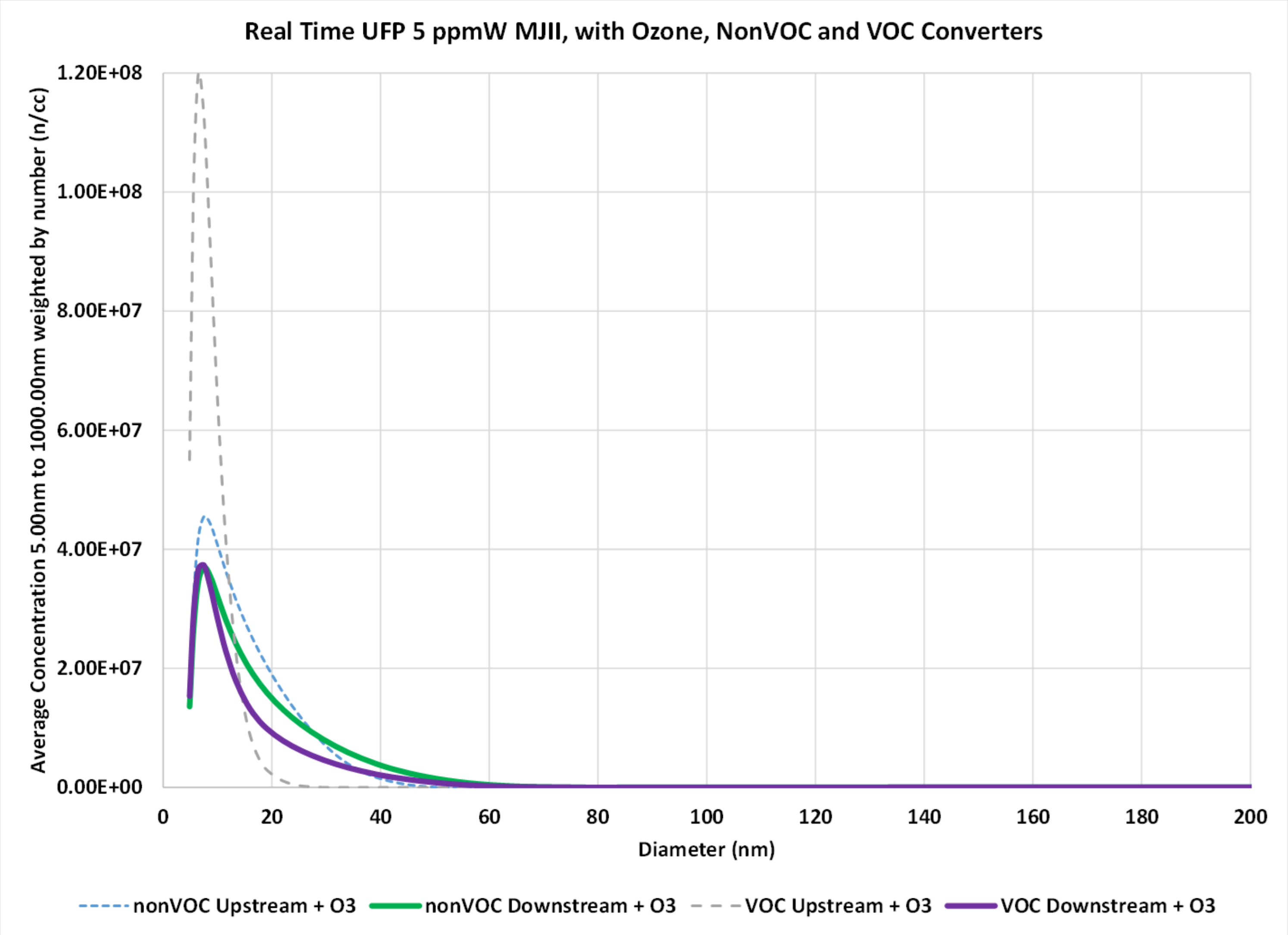
NON-VOC AND VOC CONVERTERS – 5 PPMW OIL WITHOUT OZONE



In this test environment data indicates:

- upstream baseline numbers greater than downstream numbers.
- larger particles could indicate condensation of smaller aerosol.
- Particle maxima around 10 nm or smaller.
- Upstream UFP number variation between converters due to day-to-day testing variation.
- Downstream UFP VOC Converter numbers lower than downstream non-VOC Converter UFP numbers.

NON-VOC & VOC CONVERTER – 5 PPMW OIL WITH OZONE

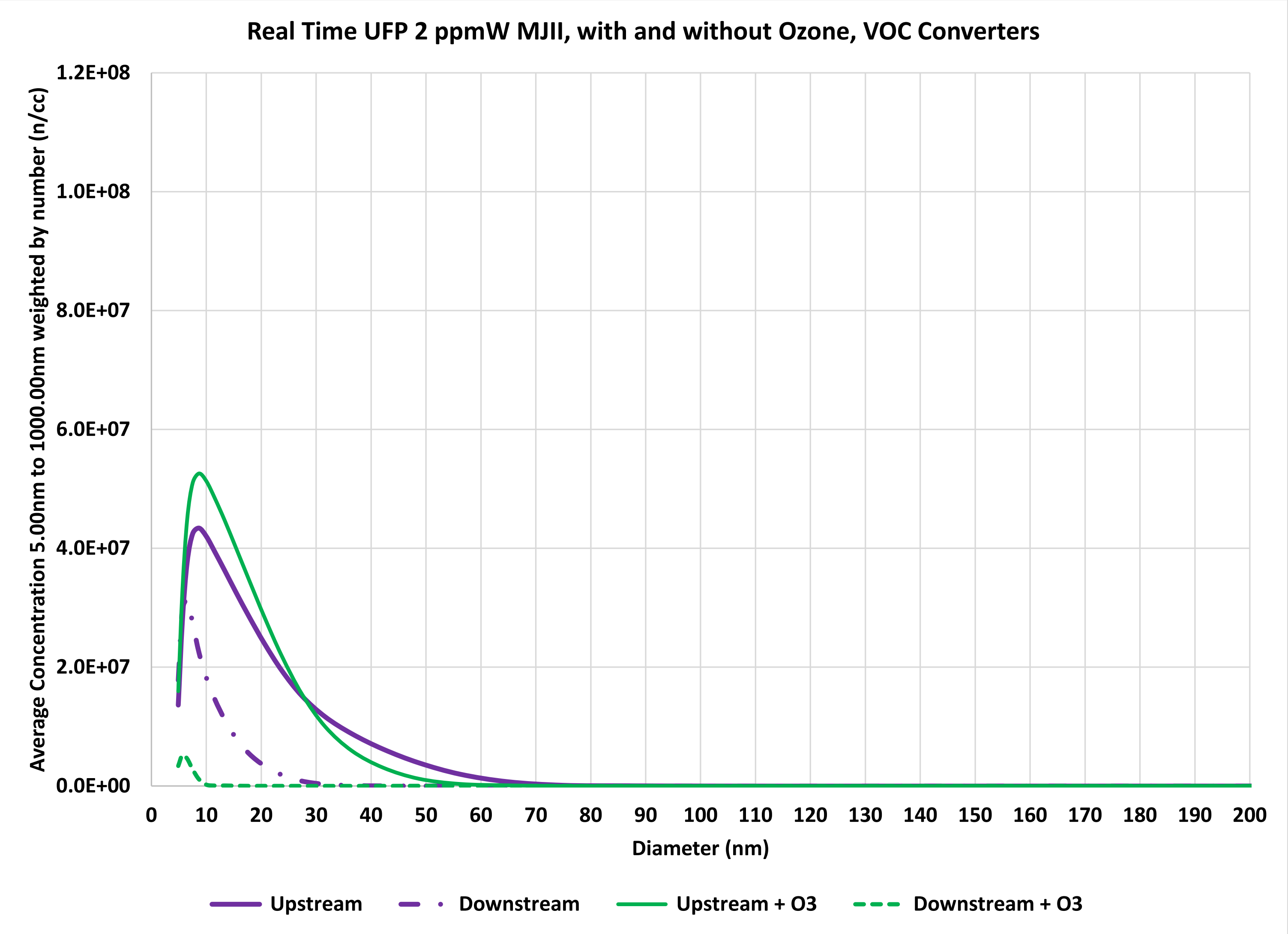


In this test environment data indicates:

- upstream baseline numbers appear greater than downstream numbers .
- larger particles could indicate condensation of smaller aerosol and heavier VOC/SVOC that could condense and re-aerosolize downstream in the ECS
- aerosol mass decreases downstream of non-VOC converter with introduction of ozone
- Upstream UFP number variation between converters due to day-to-day testing variation.
- Downstream UFP VOC Converter numbers lower than downstream Non-VOC Converter UFP numbers.
- Downstream UFP numbers similar between VOC and Non-VOC converters.

CAMBUSTION DMS 500 ULTRAFINE PARTICLES

VOC CONVERTER 2 PPMW OIL WITH AND WITHOUT OZONE

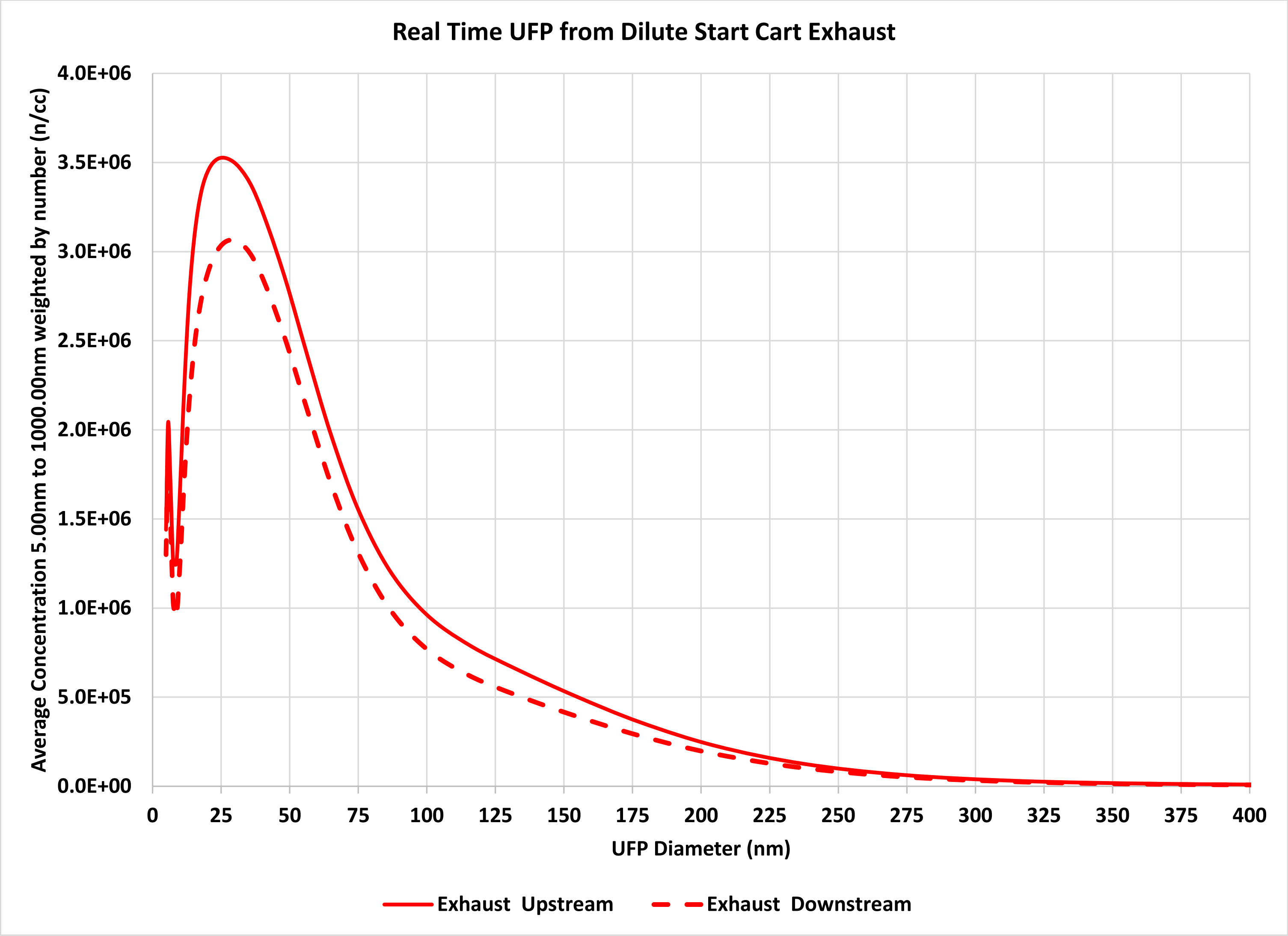


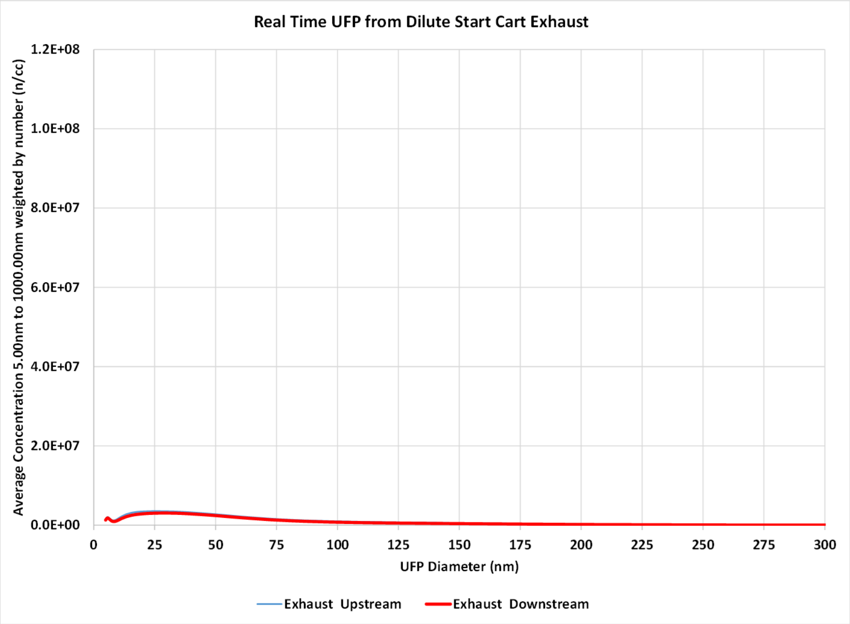
In this test environment data indicates:

- real time particle distribution shows increase in particles >62 nm Dia (limitation of Short DMA on SMPS)
- larger particles could indicate condensation of smaller aerosol and heavier VOC/SVOC that could condense and re-aerosolize downstream in the ECS
- No non-VOC Converter available to test at lower oil concentration
- 1.5 ppmV Ozone appeared to reduce particle number significantly compared to no-ozone test case

VOC CONVERTER – DILUTE EXHAUST

CAMBUSTION DMS 500 ULTRAFINE PARTICLES

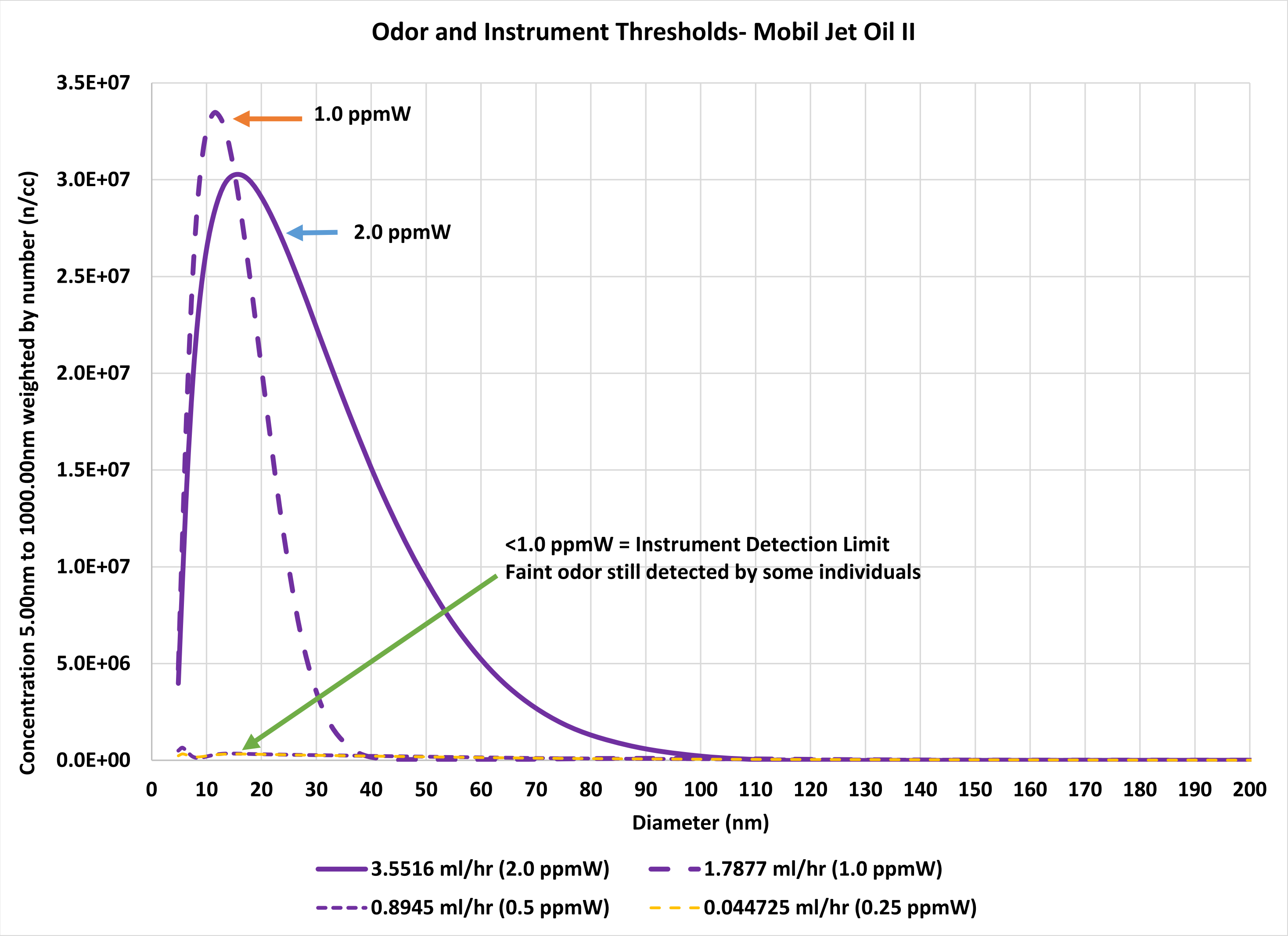




In this test environment data indicates:

- Exhaust UFP plotted on same scale as oil ingestion shows exhaust UFP much lower in UFP concentration.
- Larger plot of Exhaust UFP indicate that Maximum UFP diameter occurs at 25 nm, while oil Maximum diameter measured at the converter was around 7 nm diameter.
- Maximum particle diameter appears to be around 300 nm diameter

VOC CONVERTER – DMS500 LOWER DETECTION LIMIT AND ODOR OBSERVATIONS



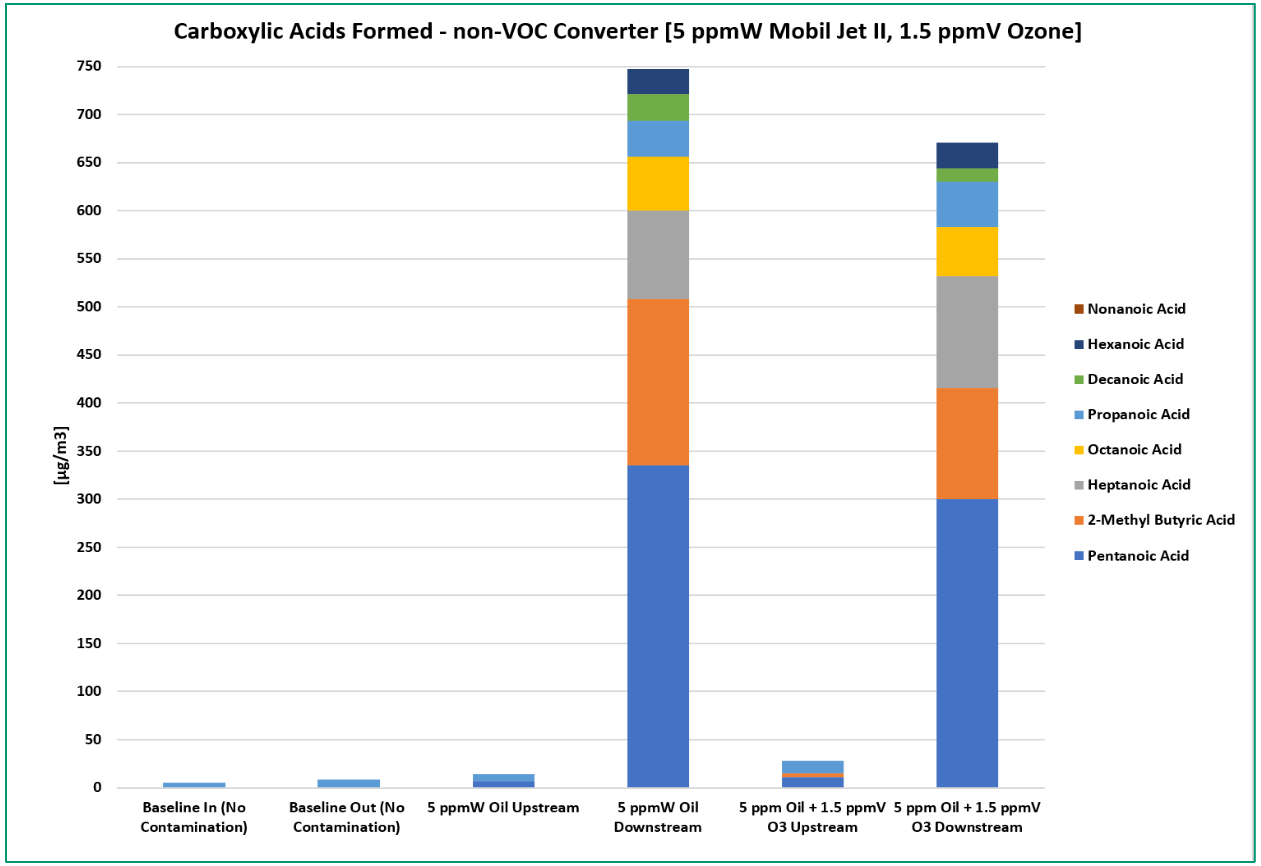
In this test environment data indicates:

- The peak particle diameter shifted down and the normalized particle number increased when ingestion rate was shifted from 2 ppmW down to 1 ppmW.
- The number of UFP particles measured fell off between 1.0 and 0.5 ppmW.
- 1 ppmW appears to be the lower detection threshold for the Cambustion DMS500.
- Several individuals at the test commented they still observed some oil odor, even though the instrument did not appear to pick it up.
- Some of this could have been residue from the walls of the Teflon tubing.

Carboxylic Acids

Controlled VOC Ozone Converter Testing

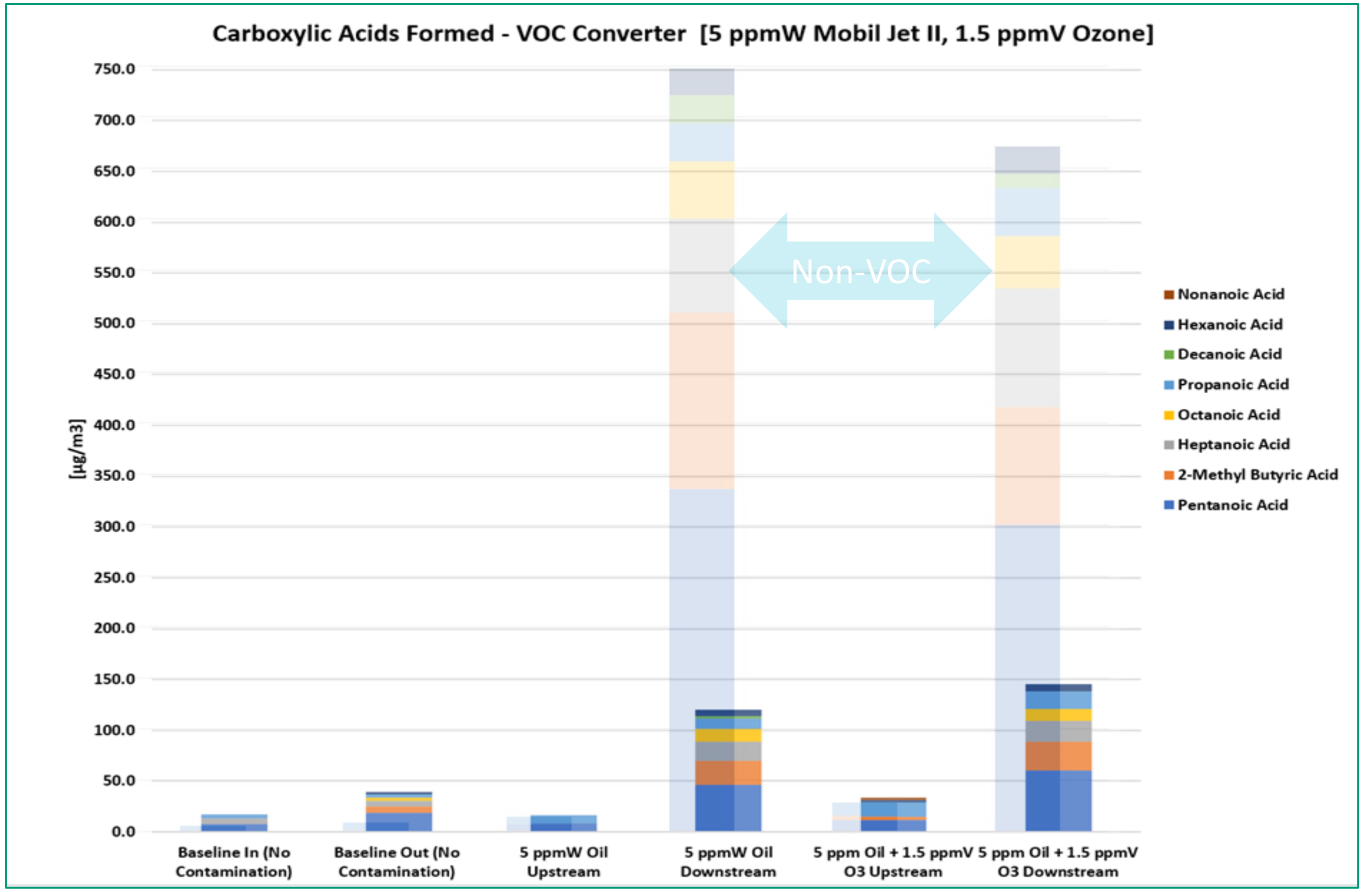
NON-VOC CONVERTER – 5 PPMW OIL



In this test environment data indicates:

- Non-VOC Converter converts a portion of oil aerosol to carboxylic acids.
- Atmospheric ozone increased carboxylic acids upstream, but reduced total downstream compared to non-VOC converters.
- Carboxylic acids may cause observable odors.

VOC CONVERTER CARBOXYLIC ACID REDUCTION CAPABILITY



In this test environment data indicates:

- Lower quantities of carboxylic acids are formed by a VOC converter than by a non-VOC converter

NON-VOC AND VOC CONVERTER CARBOXYLIC ACID QUANTITIES COMPARED

non-VOC Converter	Baseline In (No Contamination)	Baseline Out (No Contamination)	5 ppmW Oil Upstream	5 ppmW Oil Downstream	5 ppm Oil + 1.5 ppmV O3 Upstream	5 ppm Oil + 1.5 ppmV O3 Downstream
Pentanoic Acid	0	0	6.6	335.1	11.2	300.5
2-Methyl Butyric Acid	0	0	0	173.2	4	115
Heptanoic Acid	0	0	0	91.9	0	116.7
Octanoic Acid	0	0	0	56.4	0	50.6
Propanoic Acid	5.5	8.5	7.9	37.4	13.2	47.6
Decanoic Acid	0	0	0	27.6	0	13.3
Hexanoic Acid	0	0	0	25.6	0	27.4
Nonanoic Acid	0	0	0	0	0	0
Total [µg/m3]	5.5	8.5	14.5	747.2	28.4	671.1

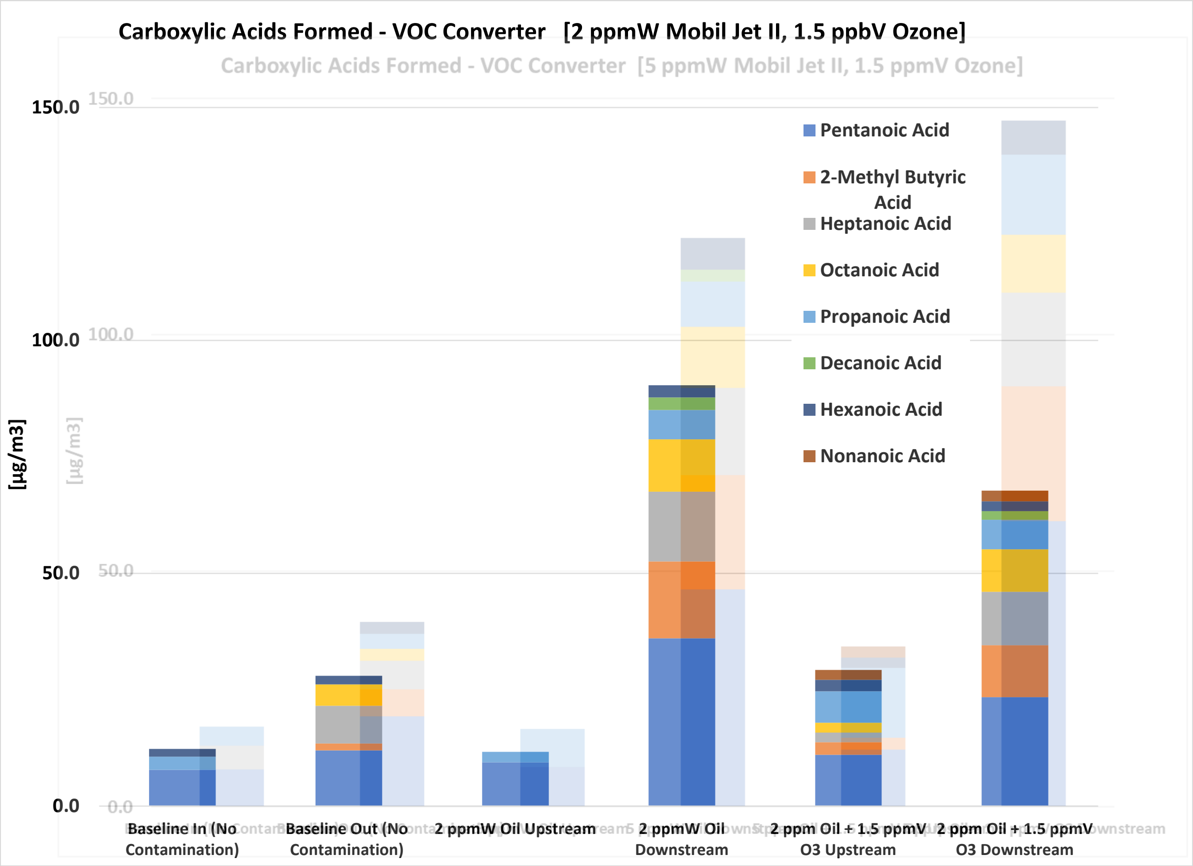
VOC Converter	Baseline In (No Contamination)	Baseline Out (No Contamination)	5 ppmW Oil Upstream	5 ppmW Oil Downstream	5 ppm Oil + 1.5 ppmV O3 Upstream	5 ppm Oil + 1.5 ppmV O3 Downstream
Pentanoic Acid	7.95	19.2	8.4	46.1	12.15	60.55
2-Methyl Butyric Acid	0	5.8	0	24.15	2.55	28.6
Heptanoic Acid	5.1	6	0	18.45	0	19.8
Octanoic Acid	0	2.45	0	13	0	12.3
Propanoic Acid	4.05	3.15	8.2	9.55	14.75	16.95
Decanoic Acid	0	0	0	2.6	0	0
Hexanoic Acid	0	2.6	0	6.65	2.25	7.15
Nonanoic Acid	0	0	0	0	2.25	0
Total [µg/m3]	17.1	39.2	16.6	120.5	33.95	145.4

In this test environment data indicates:

- Lower quantities of carboxylic acids are formed by a VOC converter than by a non-VOC converter

VOC CONVERTER – 2 PPMW OIL COMPARED TO 5 PPMW OIL

VOC Converter	Baseline In (No Contamination)	Baseline Out (No Contamination)	2 ppmW Oil Upstream	2 ppmW Oil Downstream	2 ppm Oil + 1.5 ppmV O3 Upstream	2 ppm Oil + 1.5 ppmV O3 Downstream
Pentanoic Acid	7.8	12.0	9.4	36.1	11.1	23.4
2-Methyl Butyric Acid	0.0	1.5	0.0	16.5	2.7	11.2
Heptanoic Acid	0.0	8.1	0.0	15.0	2.1	11.5
Octanoic Acid	0.0	4.6	0.0	11.3	2.1	9.2
Propanoic Acid	2.9	0.0	2.3	6.3	6.8	6.4
Decanoic Acid	0.0	0.0	0.0	2.7	0.0	1.9
Hexanoic Acid	1.7	1.9	0.0	2.6	2.5	2.1
Nonanoic Acid	0.0	0.0	0.0	0.0	2.1	2.3
Total [µg/m3]	**12.3**	**28.0**	**11.7**	**90.4**	**29.3**	**67.8**



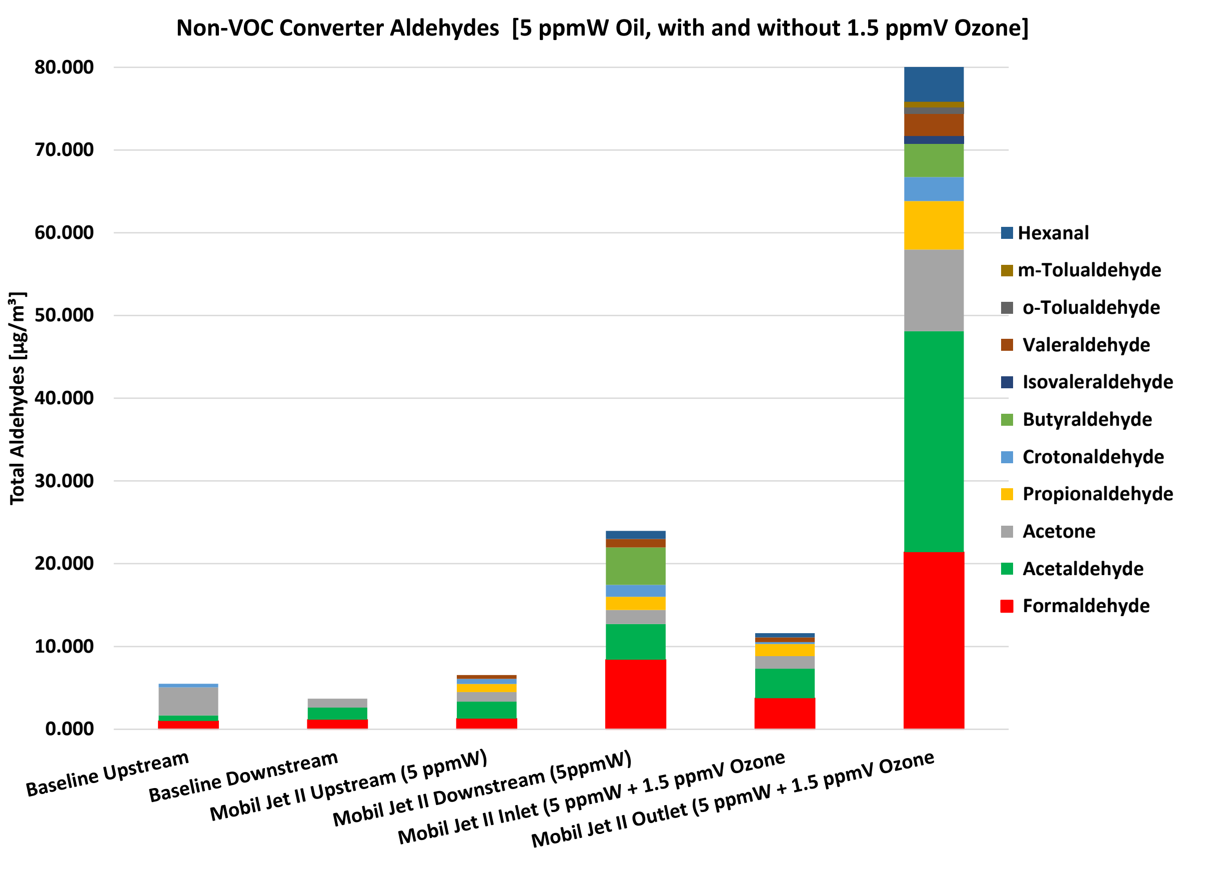
- **In this test environment data indicates:**
- Carboxylic acid quantity without ozone does not appear to change with upstream oil concentration
- Production of carboxylic acids appears to scale with dosing of oil – Indicates VOC converter is not overloaded.

Aldehydes

Controlled VOC Ozone Converter Testing

NON-VOC CONVERTER – 5 PPMW OIL

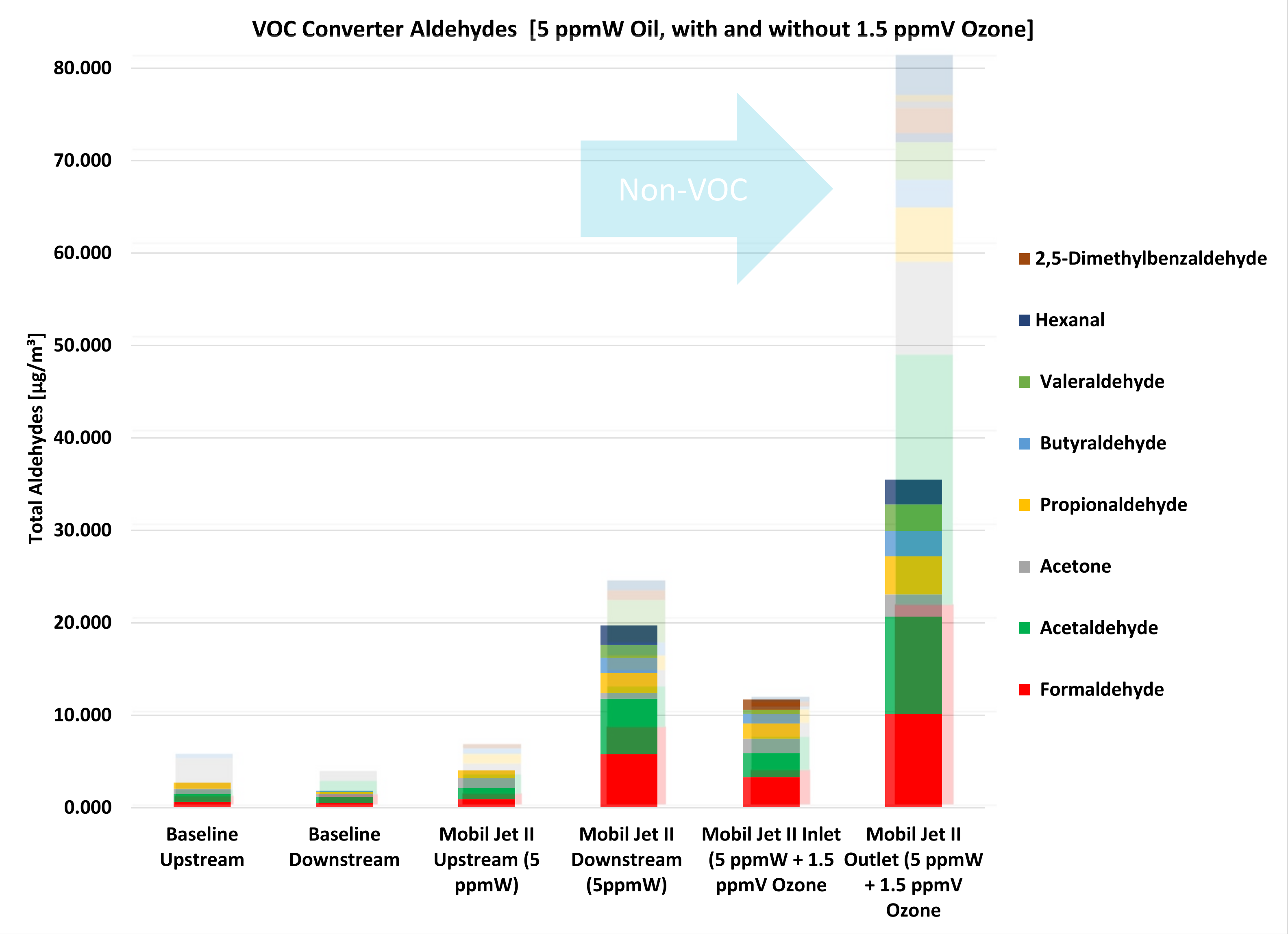
[µg/m³]	Baseline Upstream	Baseline Downstream	Mobil Jet II Upstream (5 ppmW)	Mobil Jet II Downstream (5ppmW)	Mobil Jet II Upstream (5 ppmW + 1.5 ppmV Ozone	Mobil Jet II Downstream (5 ppmW + 1.5 ppmV Ozone
Formaldehyde	0.989	1.160	1.280	8.390	3.740	21.400
Acetaldehyde	0.675	1.450	2.040	4.330	3.570	26.700
Acetone	3.380	1.090	1.160	1.700	1.520	9.870
Propionaldehyde	0.000	0.000	0.991	1.580	1.470	5.870
Crotonaldehyde	0.443	0.000	0.604	1.430	0.232	2.880
Butyraldehyde	0.000	0.000	0.000	4.530	0.000	4.040
Isovaleraldehyde	0.000	0.000	0.000	0.000	0.000	0.920
Valeraldehyde	0.000	0.000	0.470	1.030	0.561	2.690
o-Tolualdehyde	0.000	0.000	0.000	0.000	0.000	0.765
m-Tolualdehyde	0.000	0.000	0.000	0.000	0.000	0.695
Hexanal	0.000	0.000	0.000	0.984	0.523	4.380
Total ug/m3	5.487	3.700	6.545	23.974	11.616	80.210
% Increase Total Aldehydes from 5 PPM Oil Upsteam				72.70%	43.66%	91.84%



In this test environment data indicates:

- Non-VOC converter increased total aldehydes over upstream aldehyde levels.
- Ozone increased the formation of aldehydes.

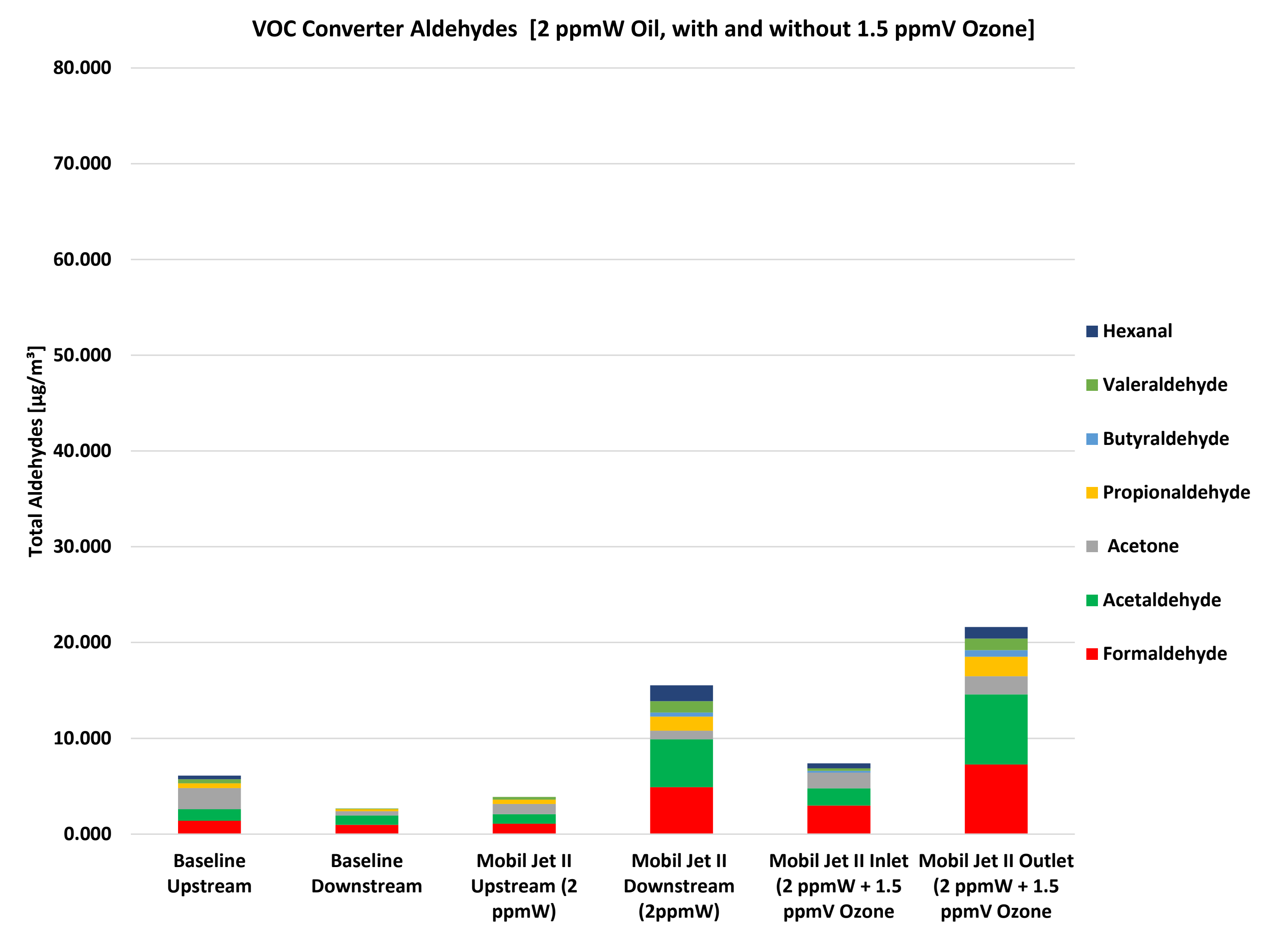
VOC CONVERTER – 5 PPMW OIL



In this test environment data indicates:

- the total aldehyde increase for VOC and Non-VOC converters is similar
- the total aldehyde increase with addition of ozone was much lower with VOC converters than the non-VOC converter
- VOC converter could potentially reduce aldehyde odors when flying through elevated ozone layers

VOC CONVERTER – 2 PPMW OIL



In this test environment data indicates:

- the percentage of total aldehydes downstream of a VOC Converter without ozone present is similar between 2 and 5 ppmW oil concentrations, indicating reaction is similar over concentration range, and the converter was not overwhelmed with oil.
- addition of ozone upstream has similar percentage reduction of aldehydes as observed with 5 ppmW oil test.
- more aldehyde species were below method limit of detection at 2 ppmW compared to the 5 ppmW test.
- reducing aldehyde species concentrations should help reduce potential for detection of odors.

VOC CONVERTER – 2 PPMW VS. 5 PPMW OIL

[µg/m³]	Baseline Upstream	Baseline Downstream	Mobil Jet II Upstream (2 ppmW)	Mobil Jet II Downstream (2ppmW)	Mobil Jet II Inlet (2 ppmW + 1.5 ppmV Ozone	Mobil Jet II Outlet (2 ppmW + 1.5 ppmV Ozone
Formaldehyde	1.400	0.961	1.085	4.900	2.975	7.260
Acetaldehyde	1.203	0.984	0.989	4.995	1.800	7.320
Acetone	2.190	0.441	1.077	0.894	1.630	1.891
Propionaldehyde	0.513	0.221	0.437	1.470	0.000	2.045
Butyraldehyde	0.000	0.000	0.000	0.424	0.203	0.685
Valeraldehyde	0.411	0.070	0.294	1.185	0.256	1.220
Hexanal	0.386	0.000	0.000	1.678	0.520	1.202
Total ug/m3	6.102	2.676	3.880	15.545	7.384	21.623
% Increase Total Aldehydes from 2 PPM Oil Upstream				75.04%	47.45%	82.06%

[µg/m³]	Baseline Upstream	Baseline Downstream	Mobil Jet II Upstream (5 ppmW)	Mobil Jet II Downstream (5ppmW)	Mobil Jet II Inlet (5 ppmW + 1.5 ppmV Ozone	Mobil Jet II Outlet (5 ppmW + 1.5 ppmV Ozone
Formaldehyde	0.635	0.538	0.934	5.800	3.295	10.165
Acetaldehyde	0.860	0.629	1.215	5.995	2.610	10.500
Acetone	0.566	0.288	1.040	0.620	1.560	2.410
Propionaldehyde	0.664	0.222	0.837	2.155	1.650	4.105
Butyraldehyde	0.000	0.159	0.000	1.645	1.043	2.745
Valeraldehyde	0.000	0.000	0.000	1.408	0.477	2.890
Hexanal	0.000	0.000	0.000	2.105	0.000	2.685
2,5-Dimethylbenzaldehyde	0.000	0.000	0.000	0.000	1.066	0.000
Total ug/m3	2.724	1.835	4.025	19.727	11.701	35.500
% Increase Total Aldehydes from 5 PPM Oil Upsteam				79.60%	65.60%	88.66%

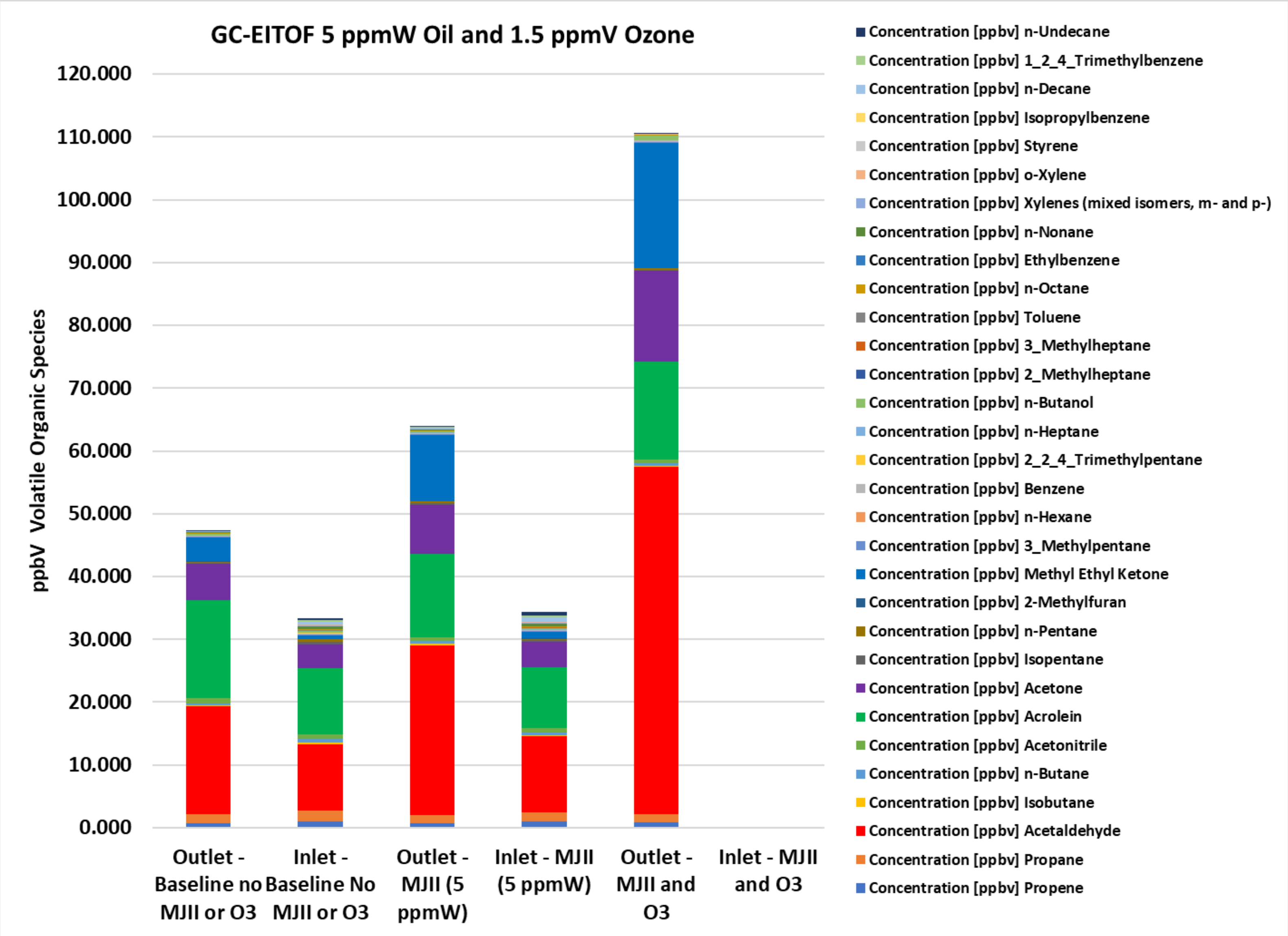
In this test environment data indicates:

- the percentage of total aldehydes downstream of a VOC Converter without ozone present is similar between 2 and 5 ppmW oil concentrations, indicating reaction is similar over concentration range, and the converter was not overwhelmed with oil.
- addition of ozone upstream has similar percentage reduction of aldehydes as observed with 5 ppmW oil test.
- more aldehyde species were below method limit of detection at 2 ppmW compared to the 5 ppmW test.
- reducing aldehyde species concentrations should help reduce potential for detection of odors.

VOC by Gas Chromatography -Electron Ionization Time of Flight (EITOF)

Controlled VOC Ozone Converter Testing

VOC BY GAS CHROMATOGRAPHY -ELECTRON IONIZATION TIME OF FLIGHT (EITOF)



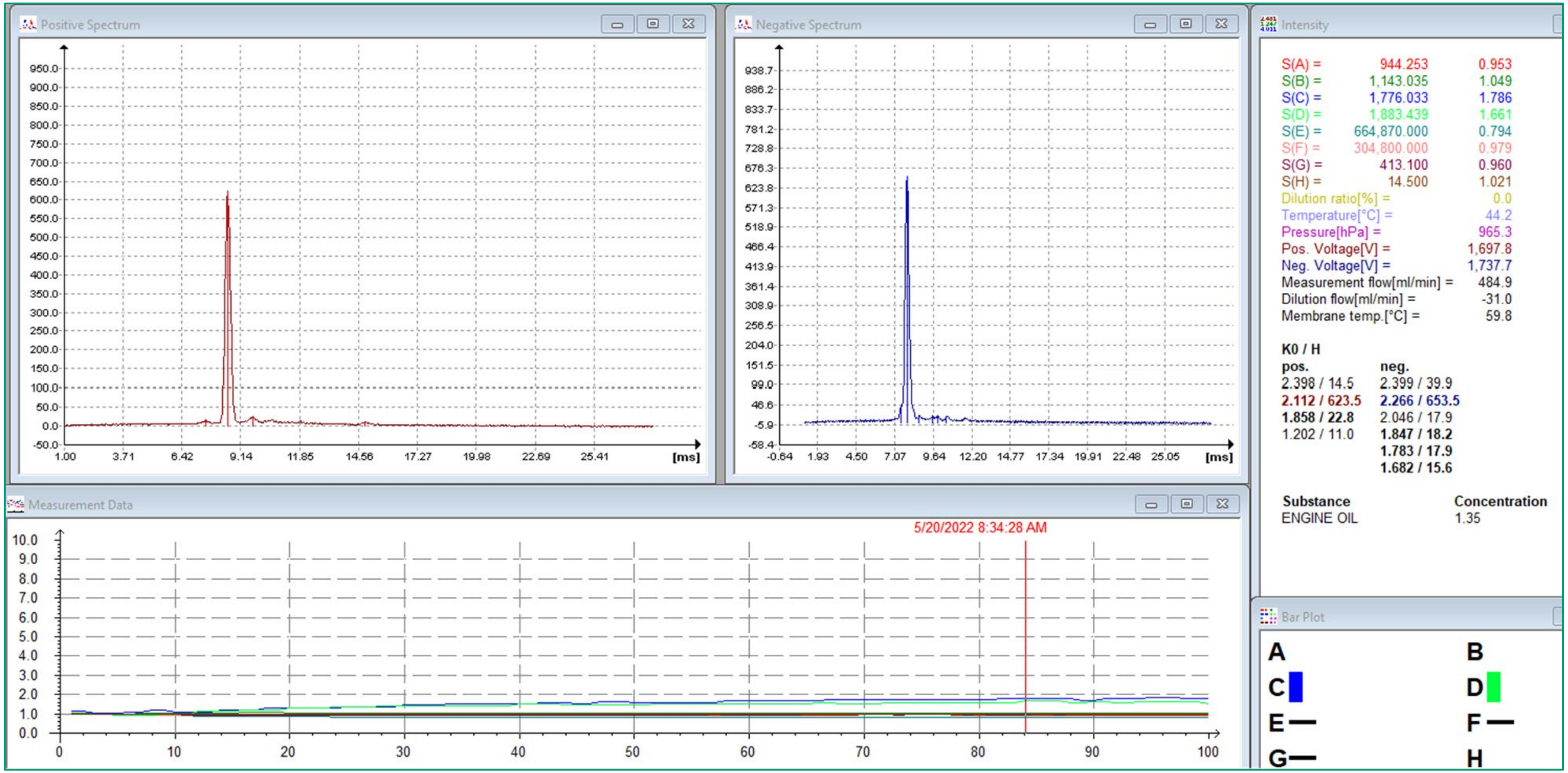
In this test environment data indicates:

- major species included acetaldehyde, acrolein, acetone, and MEK
- greatest concentrations appear to be from exhaust, not oil

Other Instruments

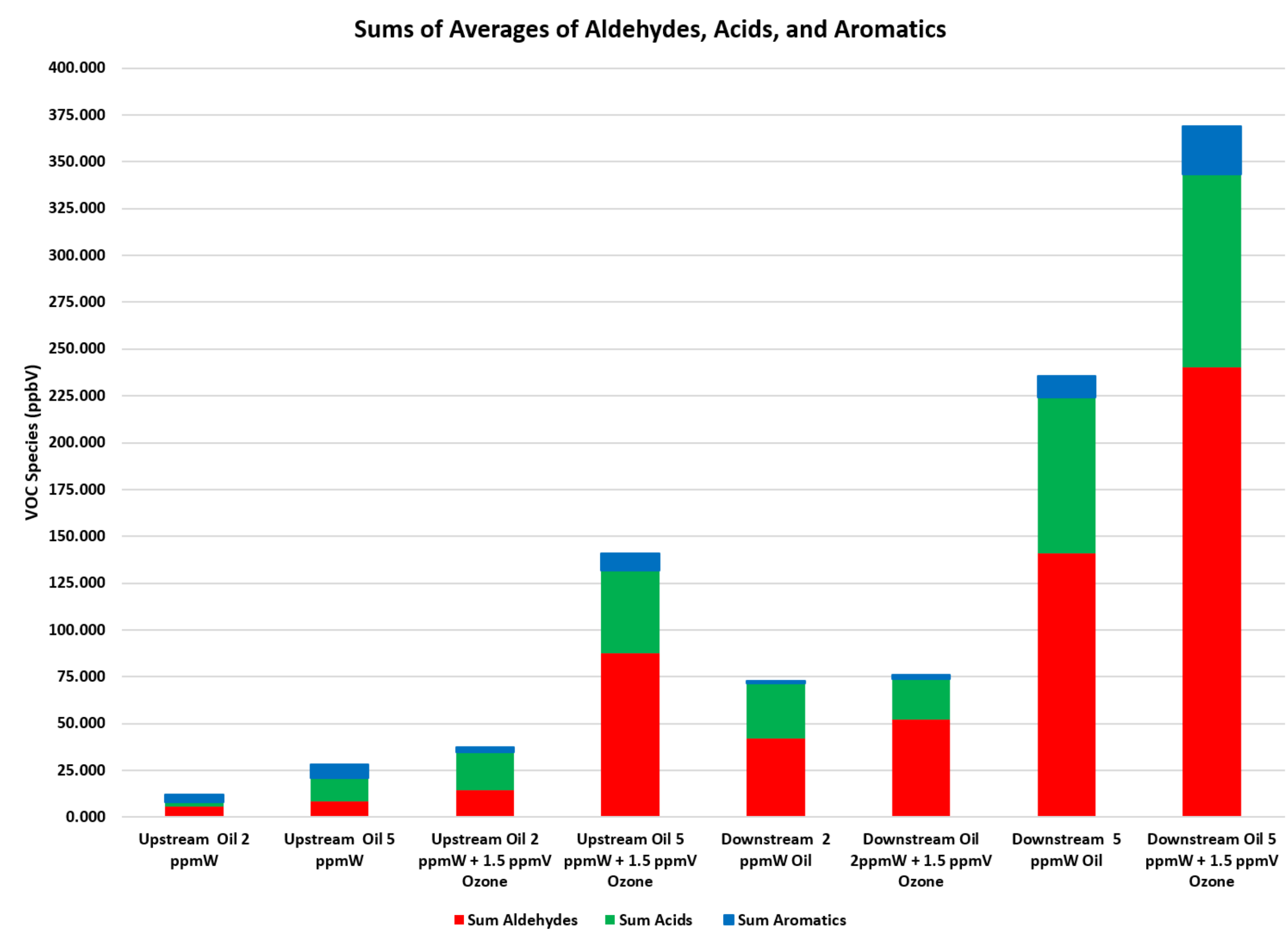
Controlled VOC Ozone Converter Testing

AEROTRACER + AND - SPECTRA: ODOR CONCENTRATION 1.35 UNITS



- Lower limit of detection of the Aerotracer is near 1.0 ppmW oil.
- More sensitivity is gained by sampling downstream of VOC and non-VOC converters.

SYFT VOICE 200 – 7 REAGENT IONS



SYFT Voice 200 is easiest to utilize once a procedure has been developed to provide direct concentrations from target analytes.

Significant analysis has been performed to sum types of species to more easily visualize Upstream vs. Downstream Concentrations of VOC

In this test environment data indicates:

- aldehydes dominate the mixture, while carboxylic acids are slightly lower, and aromatics are lowest in concentration.

Odors

Controlled VOC Ozone Converter Testing

ODOR ELIMINATION OBJECTIVE

- Smelling odor ≠ Toxicity; non-Smelling odor ≠ no oil contamination event
- Smelling odor is a trigger for returning to the gate and flight cancellations
- In this test environment, utilization of VOC/ozone converter reduced odorous and non-odorous VOC

In this test environment

- precision instrumentation at odor detection thresholds of most sensitive test participants

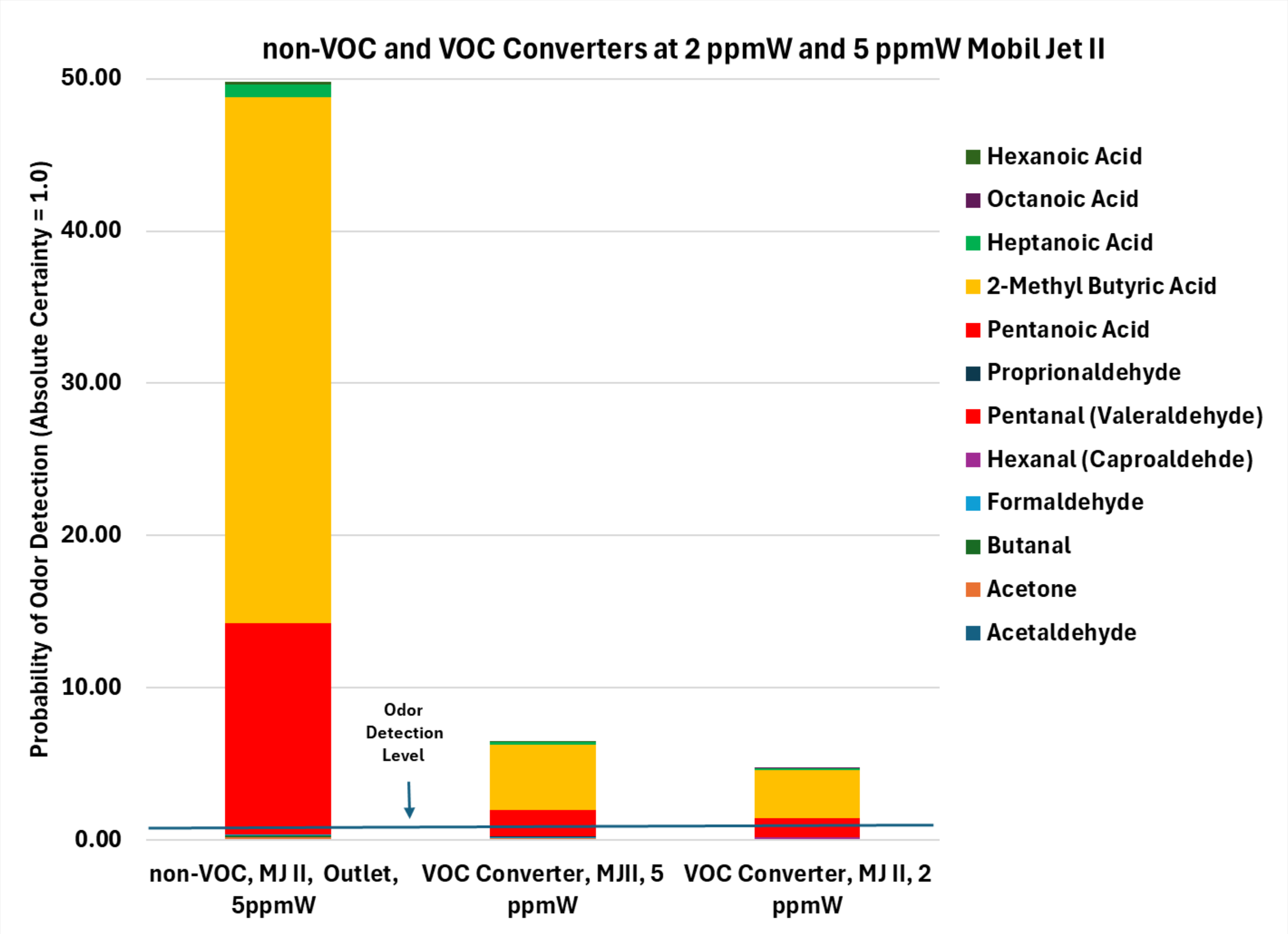
PROBABILITY OF ODOR DETECTION

Odor Detectability- Cranial Nerve I	non-VOC Converter, MJ II, Outlet, 5ppmW	VOC Converter, MJII, 5 ppmW	VOC Converter, MJ II, 2 ppmW	Odor Threshold
Acetaldehyde	0.03	0.02	0.03	ppb
Acetone	0.15	0.12	0.03	90.917
Butanal	0.13	0.01	0.00	4.84
Formaldehyde	0.05	0.02	0.04	11.96
Hexanal (Caproaldehde)	0.04	0.03	0.09	126.43
Pentanal (Valeraldehyde)	0.03	0.02	0.04	6.2276
Proprionaldehyde	0.00	0.00	0.00	10.632
Pentanoic Acid	13.83	1.79	1.24	408.6
2-Methyl Butyric Acid	34.55	4.25	3.13	5.8
Heptanoic Acid	0.82	0.16	0.10	1.2
Octanoic Acid	0.00	0.00	0.00	21
Hexanoic Acid	0.14	0.03	0.00	5000
Sum of Probabilities	49.78	6.45	4.71	38

In this test environment

- Several aldehydes and carboxylic acids at very low odor thresholds are greatest contributors to detectability

PROBABILITY OF ODOR DETECTION



- The probability of odor detectability - inlet corrected: 0.3 = minimum detectability;
- 1.0 = absolute certainty: reference (Fox ,2012)*.
- Carboxylic Acids are primary cause of odor in this model
- Approximate Odor Detection Threshold observed was between 0.25 to 0.5 ppmW by non trained odor observers at AEDC and 0.5-1 mg/m3 at Fraunhofer Bleed Air Contamination Simulator for engine oil.

* https://search.proquest.com/openview/bc0e381dc707e39b77cfae6ce13333ab/1?pq-origsite=gscholar&cbl=18750

Conclusions

Controlled VOC Ozone Converter Testing

CONCLUSIONS

OBSERVATIONS & RECOMMENDATIONS

- Observations & notations:
  - Quantities are extremely small when trying to measure with real time instrumentation.
  - Test conditions were intentionally low to minimize potential for damage to sensitive spectrometers.
  - New sample lines were installed on some instruments one or more times per day, due to sample condensation.

CONCLUSIONS

OBSERVATIONS & RECOMMENDATIONS

- Observations in this test environment,
  - SMPS test data indicate that particle level downstream of converter was lower than particle level entering converter.
  - VOC levels increase downstream of converters when compared to levels upstream of the converter as aerosol quantities are consumed,
  - The Odor Calculation Model presented a rationalize means to evaluate the various VOC created and assign odor impact based on comparison to odor threshold ratios.

CONCLUSIONS

LIMITATIONS & FURTHER STUDY

- The statistical power of this study was low
  - A statistically relevant sample size using different converters and altered environments was beyond the scope of this test.
- Only a single oil type was utilized
  - Utilizing other types of oil with variations in proportions of Carboxylic Acids may yield different results for UFP, Acids, Aldehydes, and Aromatic Compounds.
- One level of ozone was utilized in this study
  - Operators who fly through various ranges of ozone concentrations will have a continually changing mixture of VOC, dependent upon trace levels of contaminants and quantities of ozone entering the bleed air.

LIMITATIONS & FURTHER STUDY

- Converter performance when challenged with exhaust was tested but could not be presented here due to limitations of time.

- Environmental, maintenance, and equipment variables, human factors, and variable flight operating conditions may result in differing data than presented herein.

REVISITING PRE-TEST QUESTIONS

1. Do VOC Ozone Converters reduce odors in aircraft bleed air directed into the cabin?

   In this test environment the data indicates that:

   - converters reduce oil aerosol UFP in the bleed air but cause a resultant increase in acids and aldehydes (odor causing substances).
   - VOC converters create less odor causing substances compared with a non-VOC converter.
   - VOC converters might help, but....
     - reducing oil aerosol entering the bleed system to levels at or below 2 ppmW may adequately minimize aerosol passing through a VOC converter and may reduce odor to lower levels of detectability.
     - cleaning of systems will still be required.

2. Should owner/operators install/maintain VOC converters to reduce SOF events?

   - Properly maintained VOC converters along with efforts to minimize ingestion of contaminates and employment of effective ECS decontamination protocols should reduce SOF events.

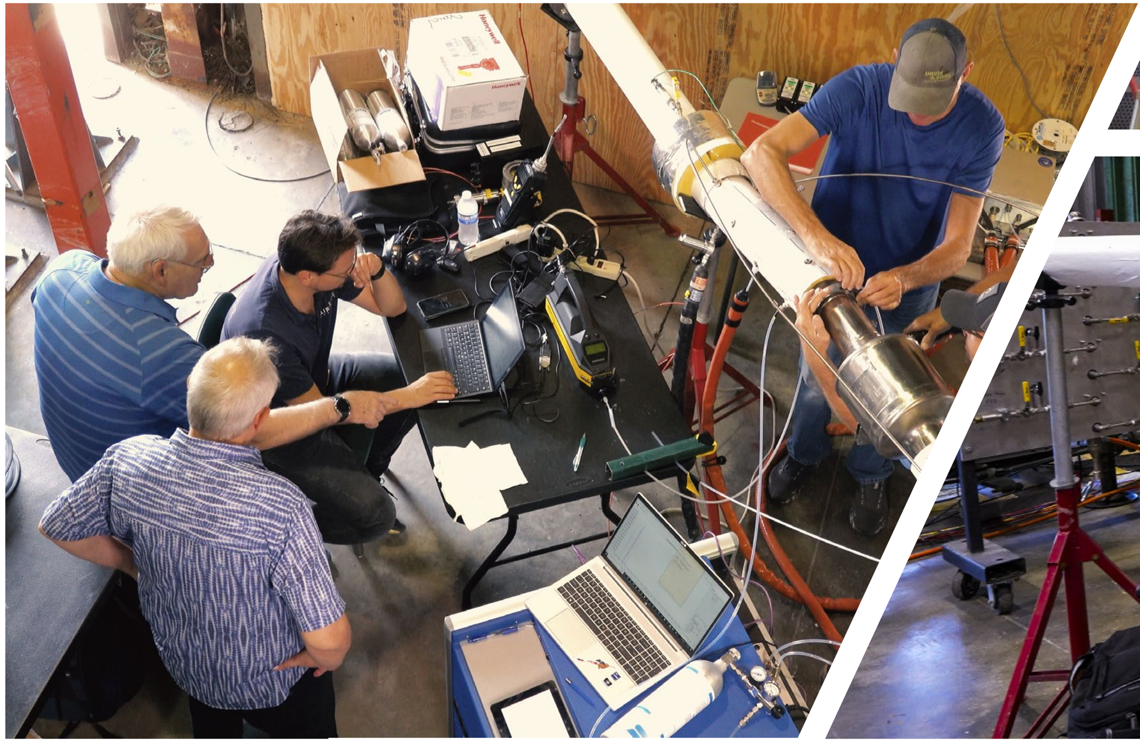
AeroParts

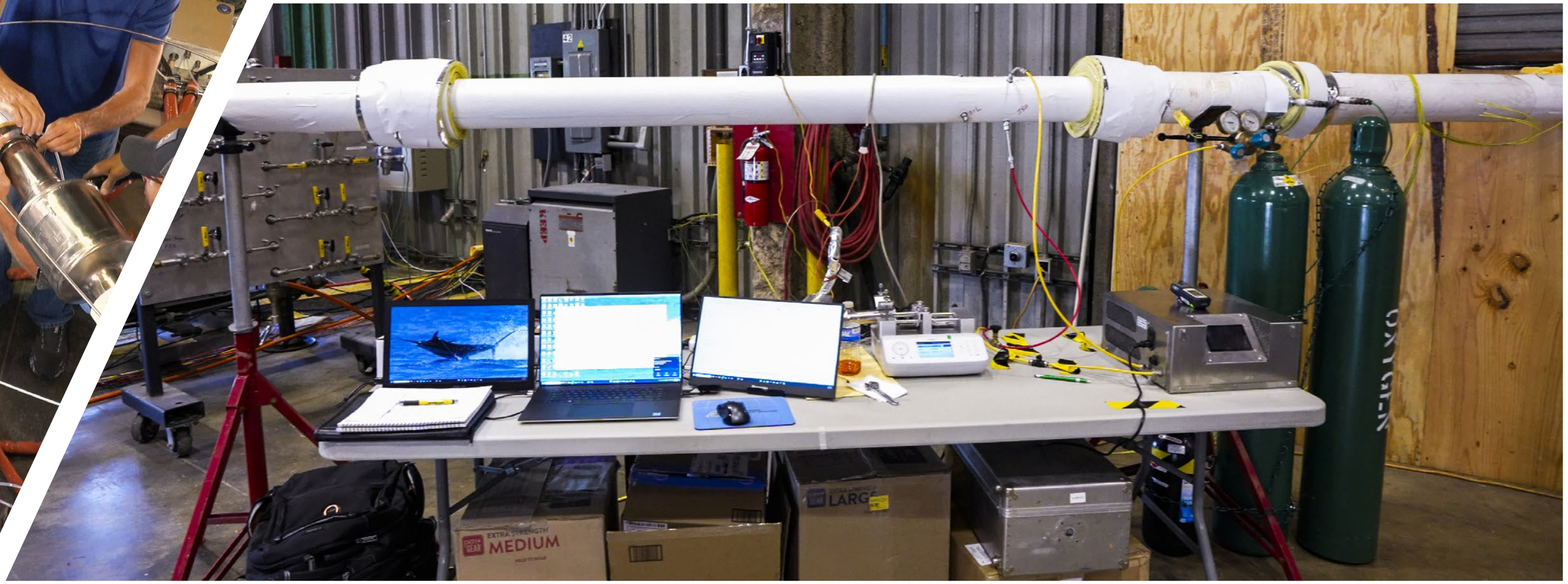
first-class performance

Photos

Controlled VOC Ozone Converter Testing


O2
CAI
FID
CAI
600
CAI




OXYGEN
MEDIUM


CO low ppm 1of3 150c
NITRIC OXIDE (PF) 150C
Temp (C)
12:02:46
RESEARCH, Inc.


aerotracer
A joint product of AIRSENSE and Lufthansa Technik


M210
CAMBUSTION
DMS500 Mk II
Fast Particulate Analyzer
DMS 500
ON / OFF
SAMPLE IN
DILUTION
AIR OUT
HEATER
POWER
DIRECT
2nd DIL / ZERO
ELEC TX
CON TX
SWITCH OFF
M210


VOICE


PELTOR