

Fraunhofer ITEM | Nikolai-Fuchs-Str. 1 | 30625 Hannover | Germany

Dr Richard Fox PhD

Aeroparts Environmental Control Solutions Manager
Aircraft Environment Solutions Inc.
Inc. 431 Rio Rancho Blvd.
NE, Rio Rancho,
NM 87124 USA

Fraunhofer Institute for Toxicology
and Experimental Medicine ITEM

Institute directors

Prof. Dr. med. Norbert Krug (Executive Director)

Prof. Dr. Dr. med. Thomas Thum

Nikolai-Fuchs-Str. 1

Main entrance: Stadtfelddamm

30625 Hannover, Germany

Dr. Sven Schuchardt

Head of Department

Bio – and Environmental Analytics

Direct Dial +49 511 5350-218 Fax -155

svs.schuchardt@item.fraunhofer.de

www.item.fraunhofer.de

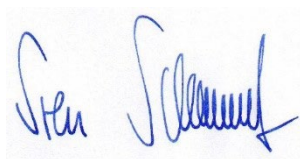
Hannover, August 30, 2023

Analytical Results Atlantic City 2023

Dear Richard,

Attached you will find the analysis results of the Atlantic City measurement campaign. These analyzes were produced free of charge as academic support for the FAA project. Therefore, when using these results for reports, publications and lectures, the origin must be named.

Sincerely yours,



Dr. Sven Schuchardt

(as representative of Fraunhofer ITEM)

Appendix - Analysis Results

Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V., München
Executive Board

Prof. Dr.-Ing. Reimund Neugebauer, President, Corporate Policy and Research Management,
Technology Marketing and Business Models

Prof. Dr. Alexander Kurz, Human Resources, Legal Affairs and IP Management

Dipl.-Kfm. Andreas Meuer, Controlling and Digital Business Processes

Cheques and transfers payable to

Deutsche Bank, München

Account 752193300 BLZ 700 700 10

IBAN DE86 7007 0010 0752 1933 00

BIC (SWIFT-Code) DEUTDEMM

V.A.T. Ident No. DE129515865

Tax number 143/215/20392

1 Appendix

Table 1 Concentrations in $\mu\text{g}/\text{m}^3$ of detected carboxylic acids of the samples C1 to C12. 0 = not detected.

ID	Propanoic acid	2-Methyl-butyric acid	Pentanoic acid	Hexanoic acid	Heptanoic acid	Octanoic acid	Nonanoic acid	Decanoic acid
[$\mu\text{g}/\text{m}^3$]								
C1	0.6	0.2	4.7	2.7	5.5	5.2	1.8	1.5
C2	0.4	0	1.5	1.3	2.4	2.1	0.8	0.3
C3	0.5	2.4	6.4	1.3	3.5	2.2	0.6	0.2
C4	0	0	0.1	0.9	1.6	0.4	0	0
C5	2.4	12.9	32.2	2.3	17.7	13.7	0	4.1
C6	13.2	152.4	280.5	15.8	113.6	65.8	0	17.5
C7	0.5	1.1	5.9	1.7	3.6	2.7	0	0
C8	0.2	0.2	17.3	1.8	6.9	4.2	6.1	3.2
C9	12.6	11.6	520.8	8.7	95.5	25.7	19.2	7.7
C10	0	0	3.6	0.5	1.7	0.3	0	0
C11	0.5	4.0	14.7	1.9	7.3	0.3	0	0
C12	3.5	105.2	272.1	10.0	117.5	39.5	25.1	9.8

Table 2 Sample plan of the organophosphate (OP) samples OP1 to OP12.

Tuesday May 16th

Position	Condition	Time	Sample No	Sampling Time [min]	Volume [L]	Flow measured [L/min]	Remarks
OZCin	315°C MJOII 5ppm	18:25	OP1	30	60	2	AB throttled back only 280°C for most of the time
OZCout	315°C MJOII 5ppm	18:25	OP2			detached	throttled back only 280°C for most of the time
Ambient	315°C MJOII 5ppm	18:25	OP3			detached	throttled back only 280°C for most of the time

Wednesday May 17th

OZCin	312°C ETO2197 5ppm	12:18	OP4	30	59.4	1.98	
OZCout	312°C ETO2197 5ppm		OP5	30	59.7	1.99	
Ambient	312°C ETO2197 5ppm		OP6	30	58.5	1.95	detached for 30-60 s; sampled 1 minute longer
OZCin	220°C ETO2197 5ppm	16:45	OP7	30	59.4	1.98	
OZCout	220°C ETO2197 5ppm		OP8	30	60.3	2.01	

Thursday May 18th

OZCin	220°C MJOII 10ppm	12:32	OP10	30		2	
OZCout	220°C MJOII 10ppm		OP11	30		2.01	
Ambient	220°C MJOII 10ppm		OP12	30		1.97	detached itself shortly twice

Table 3 Concentrations in $\mu\text{g}/\text{m}^3$ of detected m- and p-TCP isomers of the samples OP1 to OP12 (OP9 no sample). Note, the associated o-TCP isomers were not detected in any sample. n.d. = not detected

C [$\mu\text{g}/\text{m}^3$]		ID	T-m-CP	T-mmp-CP	T-mpp-CP	T-p-CP	SUM TCP
Mobil Jet Oil II 5 ppm 315°C	OZC in	OP1	3.90	16.36	18.85	3.69	42.8
	OZC out	OP2	0.82	3.33	3.72	0.71	8.6
	Ambient	OP3	0.02	0.06	0.08	0.02	0.2
Eastman Oil 5 ppm 312°C	OZC in	OP4	2.24	11.23	10.32	2.15	25.9
	OZC out	OP5	0.93	4.72	4.19	0.80	10.6
	Ambient	OP6	n.d.	n.d.	n.d.	n.d.	
Eastman Oil 5 ppm 220°C	OZC in	OP7	2.03	11.87	10.06	2.06	26.0
	OZC out	OP8	1.43	7.56	6.44	1.32	16.8
		No sample					
Mobil Jet Oil II 10 ppm 220°C	OZC in	OP10	11.02	47.52	53.54	9.70	121.8
	OZC out	OP11	9.51	41.42	47.43	8.50	106.9
	Ambient	OP12	0.18	0.65	0.75	0.13	1.7

Table 4 Concentrations in ng/m³ of detected VOC of the samples FAA_005 to FAA_008. RT = retention time; 0 = not detected; LOQ = limit of quantification; * identification via NIST database search only = match not confirmed by standard compound.

RT [min]		FAA_005	FAA_006	FAA_007	FAA_008
		T1=200°C Baseline Pack Out	T2=200°C Baseline OZCin	T3=200°C Baseline OZCout	T4=200°C Baseline Ambient
7.52	Toluol	266	122	183	266
1.87	Acetone* / Allyl acetate*	1243	1136	1566	1523
2.05	tert-Butanol	0	0	0	<LOQ
2.24	Hexane*, 3,3,4,4- tetrafluoro-	1043	817	498	255
2.24	(CH ₃) ₂ NCl*	1043	817	498	255
2.54	3-Methylpentane	<LOQ	<LOQ	<LOQ	<LOQ
2.82	n-Hexane	<LOQ	0	0	0
2.77	Acetic acid	16091	4863	6486	1999
3.27	2,3-Butanedione	<LOQ	0	<LOQ	0
3.33	Butanal*	72	0	332	255
3.41	2-Butanone	0	0	0	0
4.75	Benzene	<LOQ	<LOQ	<LOQ	198
5.18	Propanoic acid	0	0	0	0
5.25	Hydroxyacetone	<LOQ	<LOQ	<LOQ	<LOQ
5.78	Cyclohexylmethane	<LOQ	<LOQ	<LOQ	<LOQ
6.47	1-Butanol, 3- methyl-	0	0	0	0
6.96	1,2-Propanediol	<LOQ	<LOQ	<LOQ	<LOQ
7.15	sec-Butyl acetate	<LOQ	<LOQ	<LOQ	<LOQ
7.68	Butanoic acid	<LOQ	<LOQ	<LOQ	<LOQ
7.90	Cyclotrisiloxane*, hexamethyl-	2851	1553	1030	502
8.23	2-Hexanone	<LOQ	0	<LOQ	0
8.53	Hexanal*	336	0	506	268
9.33	Butanoic acid, 2- methyl-	2048	<LOQ	6670	<LOQ
10.31	Nonane	<LOQ	<LOQ	<LOQ	<LOQ
10.38	Pentanoic acid	5140	4056	8856	2237
10.38	m+p-Xylene	2063	2050	2054	2076
10.65	1,3-Butanediol	0	<LOQ	0	0

11.15	o-Xylene	2150	0	2146	2154
11.78	a-Pinene	2002	0	0	2389
12.85	Hexanoic acid	2620	0	2777	0
12.98	Decane	<LOQ	<LOQ	<LOQ	<LOQ
13.16	b-Pinene	0	0	0	2437
13.66	Benzaldehyde*	323	277	183	843
13.98	Octanal	<LOQ	<LOQ	<LOQ	<LOQ
14.43	Limonene	0	0	0	0
14.38	2-Ethyl-1-hexanol	<LOQ	<LOQ	<LOQ	2263
14.54	p-Cymene	0	0	0	1767
14.75	Eucalyptol	0	0	0	0
15.37	Heptanoic acid	8103	3882	7485	0
15.45	Benzyl alcohol	0	0	0	0
16.48	Nonanal	2807	<LOQ	3038	2011
16,76	Hexanoic acid*, 3,5,5-trimethyl-	0	0	0	30
17.48	Triethyl phosphate	0	0	0	0
17.70	Octanoic acid	4065	0	3752	0
17.84	Dodecane	<LOQ	<LOQ	<LOQ	<LOQ
18.78	2-Nonen-1-ol*, (E)-	3660	536	3621	1481
18.81	1,8-Octanediol*	3681	536	3651	1443
18.82	Decanal	4522	<LOQ	4348	2659
18.98	Pivalic acid* vinyl ester	3596	519	3519	328
19.36	Naphthalene	<LOQ	0	<LOQ	1750
20.03	Tridecane*	379	187	353	1060
20.17	Pentanoic acid*, 2- penten-1-yl ester (Z)-	749	0	460	0
20.19	Butanal*, 3,3- dimethyl-2-oxo-, hemihydrate	745	0	464	1170
20.19	Cyclobutanone*, oxime	745	0	464	1170
21.01	Undecanal	0	0	0	0
21.98	2-Propenoic acid*, 2-methyl-, 3,3,5- trimethylcyclohexyl ester	404	7506	617	345

22.11	Tetradecane*	421	0	68	396
23.89	2-Piperidinone, N-[4-bromo-n-butyl]-	64	0	98	0
24.76	2,5-Cyclohexadiene-1,4-dione*, 2,6-bis(1,1-dimethylethyl)-	0	0	0	0
24.85	4-Methoxy-3-(isopenten-2-yl) acetophenone*	0	0	0	0
25.38	Triisobutyl phosphate*	0	0	0	0
25.51	Butylated Hydroxytoluene*	0	0	0	0
27.71	Diethyl Phthalate	0	0	0	0
27.94	Tributyl phosphate	<LOQ	<LOQ	<LOQ	<LOQ
32.09	Diisobutyl phthalate	0	0	0	<LOQ
34.06	Dibutyl phthalate	0	0	0	0

Table 5 Concentrations in ng/m³ of detected VOC of the samples FAA_0010 to FAA_0013. RT = retention time; 0 = not detected; LOQ = limit of quantification; * identification via NIST database search only = match not confirmed by standard compound.

RT [min]		FAA_010	FAA_011	FAA_012	FAA_013
		T5=315°C 5ppm MJ-II Pack Out	T6=315°C 5ppm MJ-II OZCin	T7=315°C 5ppm MJ-II OZCout	T8=315°C 5ppm MJ-II Ambient
7.52	Toluol	60.3	112	153	207
1.87	Acetone* / Allyl acetate*	3986	3021	3261	2659
2.05	tert-Butanol	0	0	<LOQ	0
2.24	Hexane*, 3,3,4,4-tetrafluoro-	241	945	286	523
2.24	(CH ₃) ₂ NCI*	241	945	286	523
2.54	3-Methylpentane	<LOQ	<LOQ	<LOQ	<LOQ
2.82	n-Hexane	3197	1737	3697	<LOQ
2.77	Acetic acid	28106	7251	11815	11282
3.27	2,3-Butanedione	25876	6681	37050	<LOQ
3.33	Butanal*	5653	1872	6091	430
3.41	2-Butanone	18327	0	32473	0

4.75	Benzene	<LOQ	<LOQ	<LOQ	<LOQ
5.18	Propanoic acid	12895	2572	6030	2151
5.25	Hydroxyacetone	2609	1708	1349	1512
5.78	Cyclohexylmethane	4879	2041	5846	<LOQ
6.47	1-Butanol, 3-methyl-	0	0	0	0
6.96	1,2-Propanediol	<LOQ	<LOQ	<LOQ	<LOQ
7.15	sec-Butyl acetate	<LOQ	<LOQ	<LOQ	<LOQ
7.68	Butanoic acid	12162	3025	11760	2253
7.90	Cyclotrisiloxane*, hexamethyl-	0	2451	58	1028
8.23	2-Hexanone	3295	1884	3917	<LOQ
8.53	Hexanal*	19511	4277	19160	1043
9.33	Butanoic acid, 2-methyl-	109208	17672	85289	2749
10.31	Nonane	0	0	0	<LOQ
10.38	Pentanoic acid	0	42333	161663	5088
10.38	m+p-Xylene	1505	1656	1590	1747
10.65	1,3-Butanediol	0	0	0	0
11.15	o-Xylene	0	0	0	1761
11.78	a-Pinene	0	0	0	3618
12.85	Hexanoic acid	19397	3996	12577	2470
12.98	Decane	2168	<LOQ	<LOQ	<LOQ
13.16	b-Pinene	0	0	0	4154
13.66	Benzaldehyde*	235	71	126	1340
13.98	Octanal	2171	2000	2193	1814
14.43	Limonene	0	0	0	0
14.38	2-Ethyl-1-hexanol	1340	<LOQ	1137	2004
14.54	p-Cymene	0	0	0	1491
14.75	Eucalyptol	0	0	0	0
15.37	Heptanoic acid	350222	63218	173157	3968
15.45	Benzyl alcohol	0	0	0	0
16.48	Nonanal	5432	3698	4310	4025
16,76	Hexanoic acid*, 3,5,5-trimethyl-	225	167	0	194
17.48	Triethyl phosphate	0	0	0	0
17.70	Octanoic acid	172146	36235	65670	0

17.84	Dodecane	0	0	0	<LOQ
18.78	2-Nonen-1-ol*, (E)-	945	213	2067	7734
18.81	1,8-Octanediol*	1259	5008	1863	7819
18.82	Decanal	4511	4653	4713	5614
18.98	Pivalic acid* vinyl ester	62888	3294	33688	7177
19.36	Naphthalene	1276	<LOQ	1333	1418
20.03	Tridecane*	43228	2572	23525	5184
20.17	Pentanoic acid*, 2-penten-1-yl ester (Z)-	43087	2827	23339	34
20.19	Butanal*, 3,3-dimethyl-2-oxo-, hemihydrate	43306	3009	23194	0
20.19	Cyclobutanone*, oxime	43306	3009	23194	0
21.01	Undecanal	0	0	0	0
21.98	2-Propenoic acid*, 2-methyl-, 3,3,5-trimethylcyclohexyl ester	0	223	292	3304
22.11	Tetradecane*	2115	141	321	3463
23.89	2-Piperidinone, N-[4-bromo-n-butyl]-	8356	453	4873	1018
24.76	2,5-Cyclohexadiene-1,4-dione*, 2,6-bis (1,1-dimethylethyl)-	0	0	0	0
24.85	4-Methoxy-3-(isopenten-2-yl) acetophenone*	0	0	0	0
25.38	Triisobutyl phosphate*	0	0	0	0
25.51	Butylated Hydroxytoluene*	0	0	0	0
27.71	Diethyl Phthalate	0	0	0	0
27.94	Tributyl phosphate	<LOQ	<LOQ	<LOQ	<LOQ
32.09	Diisobutyl phthalate	0	0	0	0
34.06	Dibutyl phthalate	0	0	0	0

Table 6 Concentrations in ng/m³ of detected VOC of the samples FAA_0015 to FAA_0019. RT = retention time; 0 = not detected; LOQ = limit of quantification; * identification via NIST database search only = match not confirmed by standard compound.

RT [min]		FAA_015	FAA_016	FAA_017	FAA_019
		T9=312°C ET02197 OZCin	T10=312°C ET02198 OZCout	T11=312°C ET02199 Ambient	T12=220°C Skydrol 5ppm APU
7.52	Toluol	20.0	70.2	91.2	23.3
1.87	Acetone* / Allyl acetate*	1429	5138	1465	2245
2.05	tert-Butanol	0	<LOQ	0	0
2.24	Hexane*, 3,3,4,4- tetrafluoro-	335	162	82	158
2.24	(CH ₃) ₂ NCI*	335	162	82	158
2.54	3-Methylpentane	<LOQ	<LOQ	<LOQ	<LOQ
2.82	n-Hexane	0	5600	0	0
2.77	Acetic acid	1538	65573	2584	4531
3.27	2,3-Butanedione	0	5098	0	0
3.33	Butanal*	940	15857	131	3069
3.41	2-Butanone	0	0	0	0
4.75	Benzene	<LOQ	<LOQ	<LOQ	<LOQ
5.18	Propanoic acid	0	19263	0	0
5.25	Hydroxyacetone	<LOQ	2859	<LOQ	<LOQ
5.78	Cyclohexylmethane	<LOQ	5203	<LOQ	<LOQ
6.47	1-Butanol, 3- methyl-	0	0	0	0
6.96	1,2-Propanediol	<LOQ	<LOQ	<LOQ	<LOQ
7.15	sec-Butyl acetate	<LOQ	<LOQ	<LOQ	<LOQ
7.68	Butanoic acid	<LOQ	23568	<LOQ	3953
7.90	Cyclotrisiloxane*, hexamethyl-	2347	0	222	343
8.23	2-Hexanone	<LOQ	1989	<LOQ	<LOQ
8.53	Hexanal*	1004	20981	243	813
9.33	Butanoic acid, 2- methyl-	<LOQ	14644	<LOQ	1612
10.31	Nonane	<LOQ	0	<LOQ	<LOQ
10.38	Pentanoic acid	10963	2046	3418	3357
10.38	m+p-Xylene	0	0	1660	1603
10.65	1,3-Butanediol	0	0	0	0

11.15	o-Xylene	0	0	1733	1650
11.78	a-Pinene	0	0	1772	0
12.85	Hexanoic acid	2007	17488	2074	2013
12.98	Decane	<LOQ	1933	<LOQ	<LOQ
13.16	b-Pinene	0	0	1716	0
13.66	Benzaldehyde*	152	562	2051	988
13.98	Octanal	<LOQ	8000	<LOQ	<LOQ
14.43	Limonene	0	0	0	0
14.38	2-Ethyl-1-hexanol	<LOQ	1909	<LOQ	2173
14.54	p-Cymene	0	0	1421	0
14.75	Eucalyptol	0	0	0	0
15.37	Heptanoic acid	7203	374211	2154	3277
15.45	Benzyl alcohol	0	0	0	0
16.48	Nonanal	1830	7182	1540	2543
16,76	Hexanoic acid*, 3,5,5-trimethyl-	3164	123784	80	138
17.48	Triethyl phosphate	0	0	0	0
17.70	Octanoic acid	3727	87039	0	0
17.84	Dodecane	<LOQ	0	<LOQ	<LOQ
18.78	2-Nonen-1-ol*, (E)-	4221	18611	1368	7963
18.81	1,8-Octanediol*	4209	18507	1365	8096
18.82	Decanal	2470	10011	1744	4210
18.98	Pivalic acid* vinyl ester	4169	351	1282	8005
19.36	Naphthalene	<LOQ	1414	1404	1340
20.03	Tridecane*	580	91728	733	3636
20.17	Pentanoic acid*, 2-penten-1-yl ester (Z)-	562	93847	844	3681
20.19	Butanal*, 3,3-dimethyl-2-oxo-, hemihydrate	560	93382	849	123
20.19	Cyclobutanone*, oxime	560	93382	849	123
21.01	Undecanal	0	0	0	0
21.98	2-Propenoic acid*, 2-methyl-, 3,3,5-trimethylcyclohexyl ester	76	846	661	0

22.11	Tetradecane*	565	270	668	1651
23.89	2-Piperidinone, N-[4-bromo-n-butyl]-	1518	7175	319	1413
24.76	2,5-Cyclohexadiene-1,4-dione*, 2,6-bis(1,1-dimethylethyl)-	0	0	0	2893
24.85	4-Methoxy-3-(isopenten-2-yl) acetophenone*	0	0	0	7211
25.38	Triisobutyl phosphate*	0	0	0	75063
25.51	Butylated Hydroxytoluene*	0	0	0	7536
27.71	Diethyl Phthalate	0	0	0	0
27.94	Tributyl phosphate	<LOQ	<LOQ	<LOQ	<LOQ
32.09	Diisobutyl phthalate	0	0	0	0
34.06	Dibutyl phthalate	0	0	0	0