JSC TOXICOLOGY GROUP

Valerie Meyers, Ph.D., DABT
NASA JSC/SK4
Houston, TX 77058

Memorandum Number

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Voice: (281) 483-4989
Fax: (281) 483-3058
valerie.e.meyers@nasa.gov

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SUBJECT: Toxicological Assessment of ISS Air and Water Quality: September – November 2013 and Orb-D1 First Ingress (Increment 37)

SUMMARY: Based on these limited data, air quality was nominal on ISS for this period, and potable water remains acceptable for crew consumption.

AIR QUALITY

Seven mini grab sample containers (mGSCs) were collected on ISS during Increment 37 and were returned on 35S. Of these, 6 were collected as routine monthly samples in the Russian Service Module (SM), US Laboratory (Lab), and either the Japanese Pressurized Module (JPM) or the Columbus module (Col), and 1 was collected during Orbital-Demonstration 1 (Orb-D1) first ingress. Two pairs of passive-diffusion formaldehyde badges were also deployed in the US Lab or Russian Service Module (SM) and returned aboard 35S. A summary of the analytical results is provided in Table 1.

Table 1. Analytical Summary of ISS air analyses

Sample Location	Sample Date	NMVOCs[a] (mg/m^3)	Freon 218 (mg/m^3)	Alcohols[b] (mg/m^3)	T-Value[c] (units)	CO_2 (mg/m^3)	Formaldehyde ($\mu g/m^3$)
Orb-D1 1st ingress	9/30/2013	33	0.4	5.9	0.6[d] 2.9	1600	--
Lab	10/4/2013	8.8	3.9	4.4	0.5	7600	30
SM	10/4/2013	10	4.8	4.8	0.5	8000	15
JPM	10/4/2013	9.7	4.9	4.5	0.6	7600	--
Lab	10/30/2013	8.1	5.8	3.9	0.5	5200	28
Col	10/30/2013	10	4.1	4.2	0.6	8000	--
SM	10/30/2013	8.9	4.8	4.1	0.5	5800	18
Guideline		*<25*	---	*<5*	*<1*[e]	*<9300*	*<120*

[a]Non-methane volatile organic hydrocarbons, excluding Freon 218
[b]Includes acetone
[c]Sum of the ratios of the measured concentration and the corresponding 180-day SMAC for each compound, excluding CO_2
[d]Value based on 7-day SMACs used for evaluating first ingress.
[e]T-value <1 used to evaluate routine monthly sampling; T-value <3 used to evaluate first ingress samples

Complete data tables of all measured concentrations and corresponding T-values based on 180-day SMACs are enclosed. A data table containing T-values based on both the 7-day and 180-day SMACs is enclosed for the (Orb-D1) first ingress sample. The detection limit for all target compounds, except m/p-xylenes and hexachloro-1,3-butadiene, was 0.025 mg/m^3. The detection limit for m/p-xylenes, hexachloro-1,3-butadiene, and all non-target compounds was 0.05 mg/m^3. The average recoveries of the 3

surrogate standards from the mGSCs were as follows: ^{13}C-acetone, 112 ± 8%; fluorobenzene-d_5, 115 ± 6%; and chlorobenzene-d_5, 117 ± 7%. For the passive-diffusion formaldehyde badges, positive control recoveries (1 trip and 2 lab controls) were 109%, 100%, and 80%, respectively.

Toxicological Evaluation of ISS Air Quality: Routine monthly sampling provides a very limited set of samples on which to perform an air quality assessment, but is complimentary to in-flight air monitoring data collected by the air quality monitor (AQM). Based on these samples, there is no concern for crew health. Formaldehyde levels in the US Lab are consistent with historical levels which are generally between 30-40 μg/m^3 (Figure 1). Concentrations in the Russian SM are generally lower than the US, but all levels are below the SMAC of 120 μg/m^3. The T-value for all routine samples collected was below 1 in all locations. Primary contributors to the total T-value across all routine sampling locations throughout this time period were hexamethylcyclotrisiloxane and decamethylcyclopentasiloxane. These compounds were measured well below levels of health concern but may contribute to periodic accumulation of siloxanes in the water recovery system (see Water Quality section below). Alcohol values in all routine monthly samples were below the alcohol guideline of <5 mg/m^3, which is intended to protect the water recovery system from risk of overloading. The mGSCs provide only a snapshot of conditions and are not ideal for evaluating potential CO_2 exposures; however, reported levels were below 4 mmHg (9300 mg/m^3), as requested for this Increment in Chit 011659.

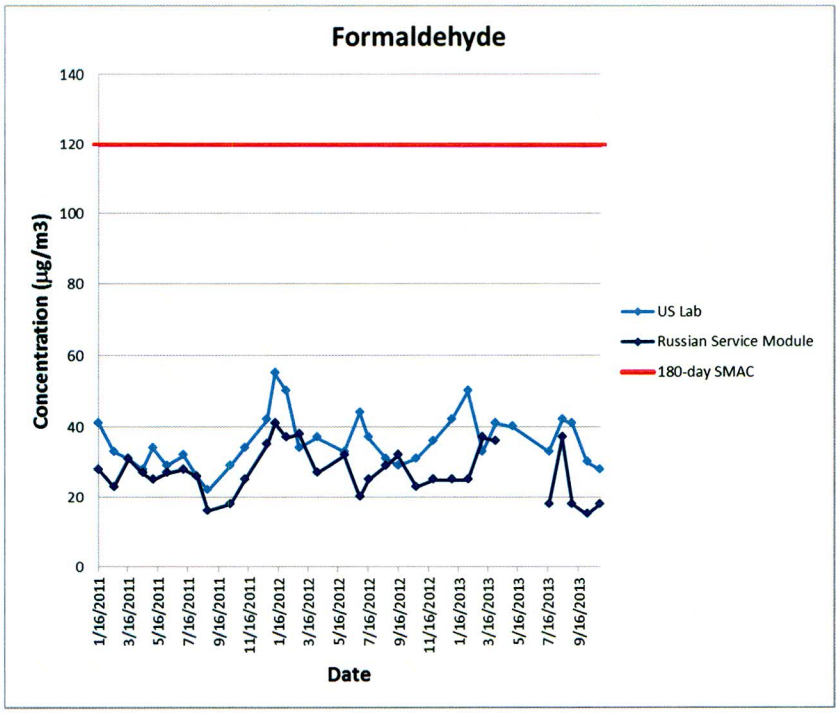

Figure 1. Formaldehyde trending in ISS air.

The CO_2 and Freon 218 levels measured in the Orb-D1 first ingress sample indicate that minimal mixing occurred with the ISS atmosphere prior to sample collection. The measured T-value of 0.6 based on 7-day SMACs at Orb-D1 first ingress was well below levels of concern for crew health. This value was lower than the predicted value of 1.1 based on the off-gas test (0.085 units/day x 13 days). This result is expected due to the conservative linear extrapolation used to predict the first ingress T-value from the off-gas test. Consistent with the off-gas test, the primary contributors to the total T-value were hexamethylcyclotrisiloxane, trimethylsilanol, and acetaldehyde. The total NMVOCs in the first entry sample did exceed the 25 mg/m^3 guideline, so odors may have been noted, but all compounds were well below their individual health-based values.

WATER QUALITY

Archive samples were collected from the potable water dispenser (PWD) in the US Lab and the SVO-ZV and the SRV-K systems in the Russian segment during Increment 37 and were returned on 35S. A summary of the analytical results from those samples is provided in Table 2. Complete data tables for the water analyses are found in analytical chemistry report #2014-WFL-ISSWQ-001.1.

Table 2. Analytical Summary of ISS water analyses

Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	Conductivity (µS/cm)	Total Iodine (mg/L)	Total Silver (µg/L)
PWD	10/8/2013	2.8	12	5	<0.05	--
PWD	11/6/2013	<0.1	<0.5	4	<0.05	--
SVO-ZV	11/6/2013	0.5	<0.5	490[a]	--	134
SRV-K	11/6/2013	0.3	<0.5	220[a]	--	21
Guideline		*<3*	*<35*	--	*<0.2*	*>100*

[a]Russian water system is intentionally mineralized.

Toxicological Evaluation of ISS Water Quality: Routine monthly sampling provides a very limited set of samples on which to perform a water quality assessment; however, data from archive samples are complimentary to in-flight monitoring data collected by the total organic carbon analyzer protoflight unit 2 (TOCA PFU2) and the colorimetric water quality monitor kit (CWQMK). Total organic carbon (TOC) trending data from in-flight and archival sampling of the US potable water system are shown in Figure 2. The multifiltration beds in the water processor assembly (WPA) were replaced on August 21, 2013. The TOC concentration in the WPA product water peaked in early October as the residual TOC was flushed out of the ion exchange bed and product water tank, but TOC concentrations remained below the health-based guideline of 3 mg/L throughout this event. The concentrations returned to normal levels (below the TOCA detection limit) by early November. The primary contributor to the TOC rise was dimethylsilanediol (DMSD). This is consistent with previous TOC increases. Throughout this time period, DMSD levels remained well below the spacecraft water exposure guideline (SWEG) of 35 mg/L and did not present a risk to crew health.

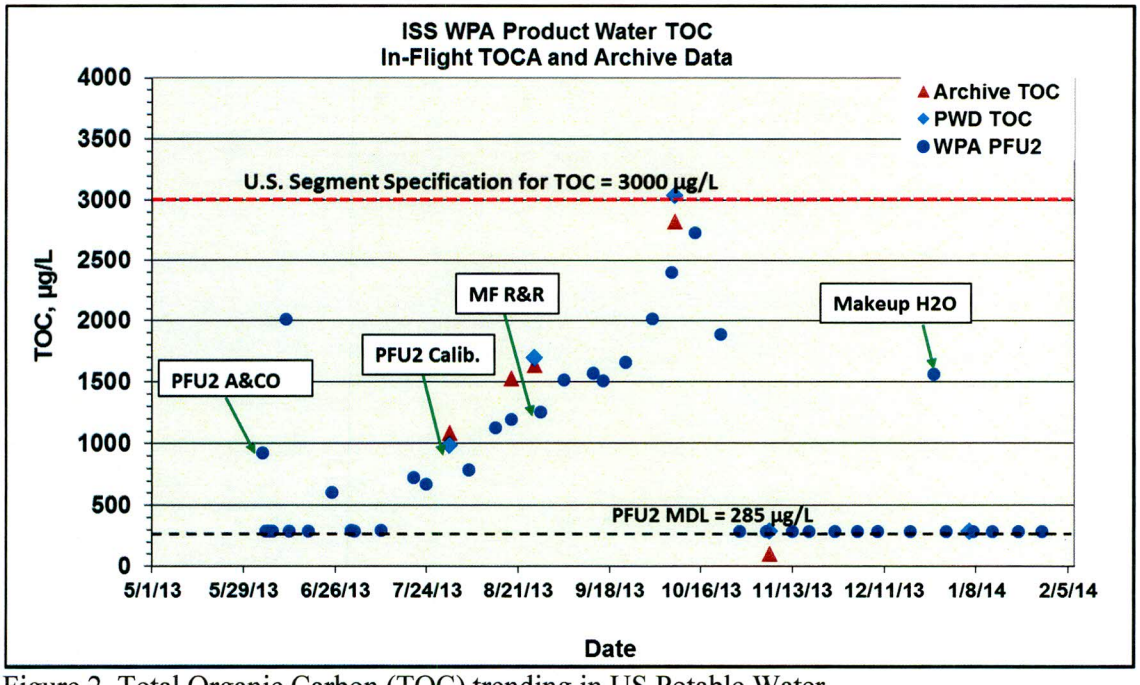

Figure 2. Total Organic Carbon (TOC) trending in US Potable Water

Conductivity provides an indirect measure of the amount of total inorganic contaminants. Inorganic levels in US water were very low, as expected. In the Russian segment, calcium, magnesium, and inorganic carbon levels in the SVO-ZV were well above historic averages, but below levels of concern for crew health. Manganese levels (58 µg/L) in the SVO-ZV exceeded the MORD limit of 50 µg/L but remained well below the US SWEG of 300 µg/L. No measured compounds exceeded MORD limits in the SRV-K sample. Iodine and silver are biocides used on the US and Russian segments, respectively. Iodine is added to the water produced by the WPA but is removed prior to crew consumption to avoid potential thyroid damage. Total iodine levels measured in the US water samples were below levels of concern for human consumption. Conversely, silver levels in Russian water samples are expected to remain above the minimal effective biocidal level of 100 µg/L. Levels in the SRV-K sample were well below this acceptable level, which increases the risk of microbial growth. See the Soyuz 35 post-flight report issued by the Environmental Microbiology for additional information on the results from microbial analyses run on the samples.

Valerie Meyers

Valerie Meyers, Ph.D., DABT
NASA Toxicologist

2/25/2014
Date

Enclosures
Table 1: Analytical concentrations of compounds found in the mGSCs returned on 35S
Table 2: T-values corresponding to analytical concentrations in Table 1, based on 180-day SMACs
Table 2A: T-values corresponding to the analytical concentrations in Table 1, based on 180-day and 7-day SMACs for Orb-D1 first ingress

TABLE 1
ANALYTICAL RESULTS OF
35S RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)						
	AA05649 S/N 2046 Orb-D Ingress 09/30/13 @ 08:10 GMT	AA05650 S/N 2052 LAB 10/04/13 @ 17:10 GMT	AA05651 S/N 2047 SM 10/04/13 @ 17:15 GMT	AA05652 S/N 2048 JPM 10/04/13 @ 17:20 GMT	AA05653 S/N 2045 LAB 10/30/13 @ 15:40 GMT	AA05654 S/N 2040 COL 10/30/13 @ 15:44 GMT	AA05655 S/N 2051 SM 10/30/13 @ 15:48 GMT
TARGET COMPOUNDS (TO-14/POLAR)							
FREON12	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CHLOROMETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
FREON114	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
METHANOL *	**2.4**	0.48	0.49	0.53	0.40	0.49	0.42
ACETALDEHYDE	0.29	0.19	0.20	0.22	0.19	0.22	0.21
VINYLCHLORIDE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
BROMOMETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
ETHANOL *	1.2	**3.2**	**3.7**	**3.1**	**2.8**	**2.9**	**3.0**
CHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
ACETONITRILE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
PROPENAL	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
ACETONE	0.47	0.34	0.33	0.42	0.34	0.47	0.38
PROPANAL	0.028	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
ISOPROPANOL	1.7	0.15	0.13	0.36	0.15	0.15	0.16
FREON11	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
FURAN	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
ACRYLONITRILE	<0.025	TRACE	TRACE	TRACE	<0.025	TRACE	TRACE
PENTANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-METHYL-2-PROPANOL	0.047	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
METHYLACETATE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,1-DICHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
DICHLOROMETHANE	<0.025	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
3-CHLOROPROPENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
FREON113	0.37	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
N-PROPANOL	0.041	0.15	0.045	0.060	0.12	0.11	0.073
1,1-DICHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
BUTANAL	0.026	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025
2-BUTANONE	0.092	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
CIS-1,2-DICHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-METHYLFURAN	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
ETHYLACETATE	0.056	0.026	0.029	0.030	TRACE	0.028	TRACE
HEXANE	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CHLOROFORM	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-BUTENAL	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,2-DICHLOROETHANE	<0.025	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
1,1,1-TRICHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
N-BUTANOL	0.082	0.049	0.053	0.055	0.091	0.11	0.079
BENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CARBONTETRACHLORIDE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-PENTANONE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-METHYLHEXANE	0.11	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2,3-DIMETHYLPENTANE	0.13	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
PENTANAL	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
3-METHYLHEXANE	0.20	TRACE	TRACE	TRACE	<0.025	<0.025	<0.025
1,2-DICHLOROPROPANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,4-DIOXANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
TRICHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2,5-DIMETHYLFURAN	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
N-HEPTANE	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
4-METHYL2-PENTANONE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CIS-1,3-DICHLOROPROPENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-PENTENAL	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
TRANS-1,3-DICHLOROPROPENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,1,2-TRICHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
TOLUENE	0.062	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
HEXANAL	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
MESITYLOXIDE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,2-DIBROMOETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
BUTYLACETATE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
OCTANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
TETRACHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
ETHYLBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
M/P-XYLENES	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
2-HEPTANONE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CYCLOHEXANONE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
HEPTANAL	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
STYRENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,1,2,2-TETRACHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
O-XYLENE	TRACE	0.036	0.042	0.040	0.028	0.032	0.032
NONANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,3,5-TRIMETHYLBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,2,4-TRIMETHYLBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,3-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,4-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,2-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,2,4-TRICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
HEXACHLORO-1,3-BUTADIENE	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050

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SPECIAL INTEREST COMPOUNDS **							
1,3-BUTADIENE #	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
ETHYLENE OXIDE	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
2-METHYL-2-PROPENAL	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
3-BUTEN-2-ONE	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
2-ETHOXYETHANOL	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
DIMETHYL DISULFIDE	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
OCTAFLUOROPROPANE &	0.40	3.9	4.8	4.9	5.8	4.1	4.8
PERFLUORO-2-METHYLPENTANE &	<0.10	<0.11	<0.10	<0.10	<0.10	<0.10	<0.10
CARBONYL SULFIDE &	TRACE	<0.054	<0.050	<0.050	<0.050	<0.050	<0.050
ISOBUTANE &	<0.050	<0.054	<0.050	<0.050	<0.050	<0.050	<0.050
2-METHYL-1-PROPENE &	0.051	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
DIMETHYL SULFIDE &	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CARBON DISULFIDE &	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
TRIMETHYLSILANOL &	0.28	0.14	0.13	0.19	0.14	0.13	0.13
OCTAMETHYLCYCLOTETRASILOXANE &	0.42	0.090	0.094	0.089	<0.050	0.098	0.085
DECAMETHYLCYCLOPENTASILOXANE &	0.45	1.2	1.2	1.4	1.3	1.8	1.3
HEXAMETHYLCYCLOTRISILOXANE %	22	2.2	2.2	2.5	1.9	2.7	2.0
NON-TARGET COMPOUNDS **							
SULFUR HEXAFLUORIDE ##	<0.10	0.34	1.0	0.42	0.37	0.75	0.82
1,1,1,2-TETRAFLUOROETHANE	0.20	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
1,1-DIFLUOROETHANE	TRACE	<0.11	<0.10	<0.10	<0.10	<0.10	<0.10
PROPENE #	<0.10	<0.11	<0.10	<0.10	<0.10	<0.10	<0.10
DIFLUOROCHLOROMETHANE	<0.10	<0.11	<0.10	<0.10	<0.10	<0.10	<0.10
FLUOROTRIMETHYLSILANE	TRACE	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
2-METHYLBUTANE	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
ISOPRENE #	<0.050	0.073	0.070	0.082	0.065	0.097	0.070
DIMETHOXYMETHANE	TRACE	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
3,3-DICHLORO-1,1,1,2,2-PENTAFLUOROPROPANE	0.13	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
1,3-DICHLORO-1,1,1,2,3-PENTAFLUOROPROPANE	0.13	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
CARBONIC ACID DIMETHYLESTER	0.088	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
C10-ALKANE	0.098	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
C11-ALKANE	0.31	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
C11-ALKANE	0.19	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
C11-ALKANE	0.29	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
LIMONENE	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
C11-ALKANE	0.21	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
C11-ALKANE	0.22	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
C11-ALKANE	0.076	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
C11-ALKANE	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
TOTAL ALCOHOLS PLUS ACETONE	**5.9**	**4.4**	**4.8**	**4.5**	**3.9**	**4.2**	**4.1**
TARGET COMPOUNDS (GC)							
CARBON MONOXIDE	0.97	0.42	0.42	0.41	0.34	0.37	0.31
METHANE	2.1	3.9	4.0	3.8	5.7	5.7	5.8
HYDROGEN	0.96	4.1	4.1	4.1	5.8	5.8	5.8
CARBON DIOXIDE	1600	7600	8000	7600	5200	8000	5800
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**33**	**13**	**15**	**15**	**14**	**14**	**14**
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**33**	**8.8**	**10**	**9.7**	**8.1**	**10**	**8.9**

* GC/FID data results are in bold

** Quantified using "B" response factors except where noted

& Quantified using a multi-point calibration

Quantified using a single-point calibration

Estimated concentrations (Results section)

% Response factor generated from an internal study

< : Value is less than the laboratory report detection limit.

TRACE: Amount detected is sufficient for compound identification only.

OFP - Octafluoropropane

TABLE 2
T-VALUES for 35S RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)						
	AA05649 S/N 2046 Orb-D Ingress 09/30/13 @ 08:10 GMT	AA05650 S/N 2052 LAB 10/04/13 @ 17:10 GMT	AA05651 S/N 2047 SM 10/04/13 @ 17:15 GMT	AA05652 S/N 2048 JPM 10/04/13 @ 17:20 GMT	AA05653 S/N 2045 LAB 10/30/13 @ 15:40 GMT	AA05654 S/N 2040 COL 10/30/13 @ 15:44 GMT	AA05655 S/N 2051 SM 10/30/13 @ 15:48 GMT
TARGET COMPOUNDS (TO-14/POLAR)							
FREON12	ND	ND	ND	ND	ND	ND	ND
CHLOROMETHANE	ND	ND	ND	ND	ND	ND	ND
FREON114	ND	ND	ND	ND	ND	ND	ND
METHANOL	0.02678	0.00535	0.00550	0.00588	0.00444	0.00540	0.00464
ACETALDEHYDE	0.07279	0.04676	0.04962	0.05549	0.04694	0.05390	0.05209
VINYLCHLORIDE	ND	ND	ND	ND	ND	ND	ND
BROMOMETHANE	ND	ND	ND	ND	ND	ND	ND
ETHANOL	0.00058	0.00160	0.00187	0.00154	0.00141	0.00145	0.00151
CHLOROETHANE	ND	ND	ND	ND	ND	ND	ND
ACETONITRILE	ND	ND	ND	ND	ND	ND	ND
PROPENAL	ND	ND	ND	ND	ND	ND	ND
ACETONE	0.00896	0.00658	0.00644	0.00807	0.00658	0.00901	0.00723
PROPANAL	0.00253	0.00114	0.00114	0.00114	0.00114	0.00114	0.00114
ISOPROPANOL	0.01141	0.00102	0.00085	0.00240	0.00098	0.00103	0.00106
FREON11	ND	ND	ND	ND	ND	ND	ND
FURAN	ND	ND	ND	ND	ND	ND	ND
ACRYLONITRILE	ND	0.00446	0.00446	0.00446	ND	0.00446	0.00446
PENTANE	ND	ND	ND	ND	ND	ND	ND
2-METHYL-2-PROPANOL	0.00040	ND	ND	ND	ND	ND	ND
METHYLACETATE	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHENE	ND	ND	ND	ND	ND	ND	ND
DICHLOROMETHANE	ND	0.00125	0.00125	0.00125	0.00125	0.00125	0.00125
3-CHLOROPROPENE	ND	ND	ND	ND	ND	ND	ND
FREON113	0.00093	ND	ND	ND	ND	ND	ND
N-PROPANOL	0.00042	0.00150	0.00046	0.00062	0.00121	0.00111	0.00074
1,1-DICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND
BUTANAL	0.00203	ND	ND	ND	0.00096	ND	ND
2-BUTANONE	0.00307	0.00042	0.00042	0.00042	0.00042	0.00042	0.00042
CIS-1,2-DICHLOROETHENE	ND	ND	ND	ND	ND	ND	ND
2-METHYLFURAN	ND	ND	ND	ND	ND	ND	ND
ETHYLACETATE	0.00031	0.00015	0.00016	0.00016	0.00007	0.00015	0.00007
HEXANE	0.00114	ND	ND	ND	ND	ND	ND
CHLOROFORM	ND	ND	ND	ND	ND	ND	ND
2-BUTENAL	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHANE	ND	0.00781	0.00781	0.00781	0.00781	0.00781	0.00781
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND
N-BUTANOL	0.00206	0.00124	0.00132	0.00137	0.00228	0.00264	0.00199
BENZENE	ND	ND	ND	ND	ND	ND	ND
CARBONTETRACHLORIDE	ND	ND	ND	ND	ND	ND	ND
2-PENTANONE	ND	ND	ND	ND	ND	ND	ND
2-METHYLHEXANE	0.00951	ND	ND	ND	ND	ND	ND
2,3-DIMETHYLPENTANE	0.01119	ND	ND	ND	ND	ND	ND
PENTANAL	0.00078	ND	ND	ND	ND	ND	ND
3-METHYLHEXANE	0.01627	0.00104	0.00104	0.00104	ND	ND	ND
1,2-DICHLOROPROPANE	ND	ND	ND	ND	ND	ND	ND
1,4-DIOXANE	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	ND	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLFURAN	ND	ND	ND	ND	ND	ND	ND
N-HEPTANE	0.00104	ND	ND	ND	ND	ND	ND
4-METHYL2-PENTANONE	ND	ND	ND	ND	ND	ND	ND
CIS-1,3-DICHLOROPROPENE	ND	ND	ND	ND	ND	ND	ND
2-PENTENAL	ND	ND	ND	ND	ND	ND	ND
TRANS-1,3-DICHLOROPROPENE	ND	ND	ND	ND	ND	ND	ND
1,1,2-TRICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND
TOLUENE	0.00411	0.00083	0.00083	0.00083	0.00083	0.00083	0.00083
HEXANAL	0.00069	ND	ND	ND	ND	ND	ND
MESITYLOXIDE	ND	ND	ND	ND	ND	ND	ND
1,2-DIBROMOETHANE	ND	ND	ND	ND	ND	ND	ND
BUTYLACETATE	ND	ND	ND	ND	ND	ND	ND
OCTANE	ND	ND	ND	ND	ND	ND	ND
TETRACHLOROETHENE	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND
M/P-XYLENES	ND	ND	ND	ND	ND	ND	ND
2-HEPTANONE	ND	ND	ND	ND	ND	ND	ND
CYCLOHEXANONE	ND	ND	ND	ND	ND	ND	ND
HEPTANAL	ND	ND	ND	ND	ND	ND	ND
STYRENE	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-TETRACHLOROETHANE	ND	ND	ND	ND	ND	ND	ND
O-XYLENE	0.00034	0.00096	0.00112	0.00108	0.00076	0.00087	0.00086
NONANE	ND	ND	ND	ND	ND	ND	ND
1,3,5-TRIMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND
1,2,4-TRIMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND
1,3-DICHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND
1,4-DICHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND
1,2,4-TRICHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND
HEXACHLORO-1,3-BUTADIENE	ND	ND	ND	ND	ND	ND	ND

TABLE 2
T-VALUES for 35S RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)						
	AA05649 S/N 2046 Orb-D Ingress 09/30/13 @ 08:10 GMT	AA05650 S/N 2052 LAB 10/04/13 @ 17:10 GMT	AA05651 S/N 2047 SM 10/04/13 @ 17:15 GMT	AA05652 S/N 2048 JPM 10/04/13 @ 17:20 GMT	AA05653 S/N 2045 LAB 10/30/13 @ 15:40 GMT	AA05654 S/N 2040 COL 10/30/13 @ 15:44 GMT	AA05655 S/N 2051 SM 10/30/13 @ 15:48 GMT
SPECIAL INTEREST COMPOUNDS							
1,3-BUTADIENE	ND	ND	ND	ND	ND	ND	ND
ETHYLENE OXIDE	ND	ND	ND	ND	ND	ND	ND
2-METHYL-2-PROPENAL	ND	ND	ND	ND	ND	ND	ND
3-BUTEN-2-ONE	ND	ND	ND	ND	ND	ND	ND
2-ETHOXYETHANOL	ND	ND	ND	ND	ND	ND	ND
DIMETHYL DISULFIDE	ND	ND	ND	ND	ND	ND	ND
OCTAFLUOROPROPANE	0.00000	0.00005	0.00006	0.00006	0.00007	0.00005	0.00006
PERFLUORO-2-METHYLPENTANE	ND	ND	ND	ND	ND	ND	ND
CARBONYL SULFIDE	0.00208	ND	ND	ND	ND	ND	ND
ISOBUTANE	ND	ND	ND	ND	ND	ND	ND
2-METHYL-1-PROPENE	0.00005	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
DIMETHYL SULFIDE	ND	ND	ND	ND	ND	ND	ND
CARBON DISULFIDE	0.00078	0.00078	0.00078	0.00078	0.00078	0.00078	0.00078
TRIMETHYLSILANOL	0.07008	0.03596	0.03363	0.04851	0.03577	0.03181	0.03130
OCTAMETHYLCYCLOTETRASILOXANE	0.03520	0.00748	0.00782	0.00740	ND	0.00820	0.00709
DECAMETHYLCYCLOPENTASILOXANE	0.03009	0.08170	0.07935	0.09128	0.08948	0.12267	0.08827
HEXAMETHYLCYCLOTRISILOXANE	2.43792	0.23905	0.24680	0.28163	0.20868	0.30444	0.21759
NON-TARGET COMPOUNDS							
SULFUR HEXAFLUORIDE	ND	0.00029	0.00087	0.00036	0.00031	0.00063	0.00069
1,1,1,2-TETRAFLUOROETHANE	0.00197	0.00052	0.00048	0.00048	0.00048	0.00048	0.00048
1,1-DIFLUOROETHANE	0.00074	ND	ND	ND	ND	ND	ND
PROPENE #	ND	ND	ND	ND	ND	ND	ND
DIFLUOROCHLOROMETHANE	ND	ND	ND	ND	ND	ND	ND
FLUOROTRIMETHYLSILANE	0.05000	ND	ND	ND	ND	ND	ND
2-METHYLBUTANE	ND	ND	ND	ND	ND	ND	ND
ISOPRENE #	ND	0.02422	0.02337	0.02730	0.02169	0.03236	0.02341
DIMETHOXYMETHANE	0.00004	ND	ND	ND	ND	ND	ND
3,3-DICHLORO-1,1,1,2,2-PENTAFLUOROPROPANE	0.00063	ND	ND	ND	ND	ND	ND
1,3-DICHLORO-1,1,1,2,3-PENTAFLUOROPROPANE	0.00061	ND	ND	ND	ND	ND	ND
CARBONIC ACID DIMETHYLESTER	0.00003	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
C10-ALKANE	0.00222	ND	ND	ND	ND	ND	ND
C11-ALKANE	0.00639	ND	ND	ND	ND	ND	ND
C11-ALKANE	0.00406	ND	ND	ND	ND	ND	ND
C11-ALKANE	0.00613	ND	ND	ND	ND	ND	ND
LIMONENE	ND	ND	ND	ND	ND	ND	ND
C11-ALKANE	0.00444	ND	ND	ND	ND	ND	ND
C11-ALKANE	0.00461	ND	ND	ND	ND	ND	ND
C11-ALKANE	0.00159	ND	ND	ND	ND	ND	ND
C11-ALKANE	ND	ND	ND	ND	ND	ND	ND
TARGET COMPOUNDS (GC)							
CARBON MONOXIDE	0.05713	0.02475	0.02497	0.02434	0.01988	0.02156	0.01825
METHANE	0.00059	0.0011	0.00114	0.00109	0.00163	0.00163	0.00165
HYDROGEN	0.00281	0.01191	0.01204	0.01194	0.01702	0.01708	0.01713
CARBON DIOXIDE	0.11960	0.58282	0.61501	0.58189	0.40222	0.61260	0.44429
TOTAL T-VALUE	**3.01715**	**1.09276**	**1.13065**	**1.17062**	**0.87511**	**1.24578**	**0.93710**
TOTAL T-VALUE - CO2	**2.89755**	**0.50994**	**0.51564**	**0.58873**	**0.47289**	**0.63318**	**0.49281**

ND : Value is less than the laboratory report detection limit.
Note: Number of decimal places in T-Values do not represent significant figures of measurements.

TABLE 2A
T-VALUES for 35S RETURN ORB-D INGRESS AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)	T-VALUE (180-d SMAC)
	AA05649 S/N 2046 Orb-D Ingress 09/30/13 @ 08:10 GMT	AA05649 S/N 2046 Orb-D Ingress 09/30/13 @ 08:10 GMT
TARGET COMPOUNDS (TO-14/POLAR)		
FREON12	ND	ND
CHLOROMETHANE	ND	ND
FREON114	ND	ND
METHANOL	0.02678	0.02678
ACETALDEHYDE	0.07279	0.07279
VINYLCHLORIDE	ND	ND
BROMOMETHANE	ND	ND
ETHANOL	0.00058	0.00058
CHLOROETHANE	ND	ND
ACETONITRILE	ND	ND
PROPENAL	ND	ND
ACETONE	0.00896	0.00896
PROPANAL	0.00253	0.00253
ISOPROPANOL	0.01141	0.01141
FREON11	ND	ND
FURAN	ND	ND
ACRYLONITRILE	ND	ND
PENTANE	ND	ND
2-METHYL-2-PROPANOL	0.00032	0.00040
METHYLACETATE	ND	ND
1,1-DICHLOROETHENE	ND	ND
DICHLOROMETHANE	ND	ND
3-CHLOROPROPENE	ND	ND
FREON113	0.00093	0.00093
N-PROPANOL	0.00042	0.00042
1,1-DICHLOROETHANE	ND	ND
BUTANAL	0.00203	0.00203
2-BUTANONE	0.00307	0.00307
CIS-1,2-DICHLOROETHENE	ND	ND
2-METHYLFURAN	ND	ND
ETHYLACETATE	0.00031	0.00031
HEXANE	0.00006	0.00114
CHLOROFORM	ND	ND
2-BUTENAL	ND	ND
1,2-DICHLOROETHANE	ND	ND
1,1,1-TRICHLOROETHANE	ND	ND
N-BUTANOL	0.00103	0.00206
BENZENE	ND	ND
CARBONTETRACHLORIDE	ND	ND
2-PENTANONE	ND	ND
2-METHYLHEXANE	0.00046	0.00951
2,3-DIMETHYLPENTANE	0.00054	0.01119
PENTANAL	0.00078	0.00078
3-METHYLHEXANE	0.00078	0.01627
1,2-DICHLOROPROPANE	ND	ND
1,4-DIOXANE	ND	ND
TRICHLOROETHENE	ND	ND
2,5-DIMETHYLFURAN	ND	ND
N-HEPTANE	0.00005	0.00104
4-METHYL2-PENTANONE	ND	ND
CIS-1,3-DICHLOROPROPENE	ND	ND
2-PENTENAL	ND	ND
TRANS-1,3-DICHLOROPROPENE	ND	ND
1,1,2-TRICHLOROETHANE	ND	ND
TOLUENE	0.00411	0.00411
HEXANAL	0.00069	0.00069
MESITYLOXIDE	ND	ND
1,2-DIBROMOETHANE	ND	ND
BUTYLACETATE	ND	ND
OCTANE	ND	ND
TETRACHLOROETHENE	ND	ND
CHLOROBENZENE	ND	ND
ETHYLBENZENE	ND	ND
M/P-XYLENES	ND	ND
2-HEPTANONE	ND	ND
CYCLOHEXANONE	ND	ND
HEPTANAL	ND	ND
STYRENE	ND	ND
1,1,2,2-TETRACHLOROETHANE	ND	ND
O-XYLENE	0.00017	0.00034
NONANE	ND	ND
1,3,5-TRIMETHYLBENZENE	ND	ND
1,2,4-TRIMETHYLBENZENE	ND	ND
1,3-DICHLOROBENZENE	ND	ND
1,4-DICHLOROBENZENE	ND	ND
1,2-DICHLOROBENZENE	ND	ND
1,2,4-TRICHLOROBENZENE	ND	ND
HEXACHLORO-1,3-BUTADIENE	ND	ND

TABLE 2A
T-VALUES for 35S RETURN ORB-D INGRESS AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)	T-VALUE (180-d SMAC)
	AA05649 S/N 2046 Orb-D Ingress 09/30/13 @ 08:10 GMT	AA05649 S/N 2046 Orb-D Ingress 09/30/13 @ 08:10 GMT
SPECIAL INTEREST COMPOUNDS		
1,3-BUTADIENE	ND	ND
ETHYLENE OXIDE	ND	ND
2-METHYL-2-PROPENAL	ND	ND
3-BUTEN-2-ONE	ND	ND
2-ETHOXYETHANOL	ND	ND
DIMETHYL DISULFIDE	ND	ND
OCTAFLUOROPROPANE	0.00000	0.00000
PERFLUORO-2-METHYLPENTANE	ND	ND
CARBONYL SULFIDE	0.00208	0.00208
ISOBUTANE	ND	ND
2-METHYL-1-PROPENE	0.00005	0.00005
DIMETHYL SULFIDE	ND	ND
CARBON DISULFIDE	0.00078	0.00078
TRIMETHYLSILANOL	0.07008	0.07008
OCTAMETHYLCYCLOTETRASILOXANE	0.00151	0.03520
DECAMETHYLCYCLOPENTASILOXANE	0.00451	0.03009
HEXAMETHYLCYCLOTRISILOXANE	0.24379	2.43792
NON-TARGET COMPOUNDS		
SULFUR HEXAFLUORIDE	ND	ND
1,1,1,2-TETRAFLUOROETHANE	0.00197	0.00197
1,1-DIFLUOROETHANE	0.00074	0.00074
PROPENE #	ND	ND
DIFLUOROCHLOROMETHANE	ND	ND
FLUOROTRIMETHYLSILANE	0.05000	0.05000
2-METHYLBUTANE	ND	ND
ISOPRENE #	ND	ND
DIMETHOXYMETHANE	0.00004	0.00004
3,3-DICHLORO-1,1,1,2,2-PENTAFLUOROPROPANE	0.00063	0.00063
1,3-DICHLORO-1,1,1,2,3-PENTAFLUOROPROPANE	0.00061	0.00061
CARBONIC ACID DIMETHYLESTER	0.00003	0.00003
C10-ALKANE	0.00222	0.00222
C11-ALKANE	0.00639	0.00639
C11-ALKANE	0.00406	0.00406
C11-ALKANE	0.00613	0.00613
LIMONENE	ND	ND
C11-ALKANE	0.00444	0.00444
C11-ALKANE	0.00461	0.00461
C11-ALKANE	0.00159	0.00159
C11-ALKANE	ND	ND
TARGET COMPOUNDS (GC)		
CARBON MONOXIDE	0.01542	0.05713
METHANE	0.00059	0.00059
HYDROGEN	0.00281	0.00281
CARBON DIOXIDE	0.11960	0.11960
TOTAL T-VALUE	**0.68350**	**3.01715**
TOTAL T-VALUE - CO2	**0.56390**	**2.89755**

ND : Value is less than the laboratory report detection limit.
Note: Number of decimal places in T-Values do not represent significant figures of measurements.