

JSC TOXICOLOGY AND ENVIRONMENTAL CHEMISTRY GROUP

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SUBJECT: Toxicological Assessment of ISS Air and Water Quality: October 31, 2016 –April 10, 2017 (Increment 50), Including HTV-6 and SpX-10 Ingress Reports

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

AIR QUALITY

Eight archive air samples were collected in mini grab sample containers (mGSCs) on ISS during Increment 50. Six of these were collected as routine samples in the US Lab, Japanese Pressurized Module (JPM), Columbus Module (COL), and Russian Service Module (SM). The two other samples were collected as part of nominal ingress operations following initial hatch opening of H-II Transfer Vehicle 6 (HTV-6) and SpaceX-10 (SpX-10). Four pairs of passive-diffusion formaldehyde badges were also deployed in the Lab and SM on 1/3/2017 and 2/14/2017. All archive samples and formaldehyde badges were returned on SpX-10. A summary of the analytical results from the samples and badges is provided in Table 1. Routine samples collected on 4/3/2017 are currently planned for return on SpX-11 and will be addressed in the next Increment report.

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 (µg/m ³)
LAB	11/24/2016	6.6	71	5.6	0.2	5300	-
JPM	11/24/2016	7.2	74	6.0	0.2	5500	-
HTV-6 Ingress	12/13/2016	25	12	4.4	2.0 (1.6)	1500	-
LAB	1/3/2017	7.8	78	6.7	0.3	5600	33 ^f
COL	1/3/2017	8.1	75	6.6	0.3	5900	-
SM	1/3/2017	-	-	-	-	-	26 ^f
LAB	2/14/2017	5.8	75	5.0	0.2	5500	32 ^f
SM	2/14/2017	4.9	57	4.7	0.1	4300	21 ^f
SpX-10 Ingress	2/23/2017	2.6	9.1	2.3	0.3 (0.1)	3600	-
<i>Guideline</i>		<25	---	<5	<1 ^d	<7100 ^e	<120

Low pressure sample results are shaded gray

^aNon-methane volatile organic hydrocarbons, excluding Freon 218

^bIncludes acetone

^cSum of the ratios of the measured concentration and the corresponding 180-day SMAC for each compound, excluding CO₂; parentheses indicate value based on 7-day SMACs and applicable to first ingress

^dT-value <1 used to evaluate routine monthly sampling; <3 used to evaluate first ingress

^eCO₂ to be controlled as low as reasonably achievable (ALARA) – currently 3 mmHg (7100 mg/m³) or lower

^fAverage from pair of formaldehyde badges

Data tables containing concentrations and corresponding T-values based on appropriate Spacecraft Maximum Allowable Concentrations (SMACs) for compounds present at levels above the laboratory reporting limit are enclosed. Results for the SM sample collected on 2/14/2017 are shaded gray in Table 1

to denote a potential bias in the results due to low sample pressure. Complete data tables including compounds assessed but not detected are available upon request. The mean relative recoveries of the 3 surrogate standards from the SpX-10 return mGSC samples were as follows: ¹³C-acetone, 101±4%; fluorobenzene-d₅, 105±6%; and chlorobenzene-d₅, 86±8%. For the passive-diffusion formaldehyde badges, positive control recoveries (1 in-flight and 2 lab controls) were 83, 101, and 85%, respectively.

Automated sampling sessions are scheduled on the Air Quality Monitors (AQMs) every 73 hours, which results in 2-3 sampling sessions per unit per week. Monthly average concentrations as well as the Increment average concentrations for compounds measured on the AQMs are presented in Table 2.

Table 2. Average monthly concentrations (mg/m³) of AQM target compounds

	November	December	January	February	March	Average
2-Propanol	TRACE	0.15	0.11	0.23	0.34	0.21
Acetone	0.21	0.35	0.33	0.32	0.37	0.32
Acrolein	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	TRACE	ND	ND	ND	ND	ND
Decamethylcyclopentasiloxane#	0.14	0.19	0.18	0.15	0.14	0.16
Hexanal	ND	ND	ND	ND	ND	ND
Hexane	ND	ND	ND	ND	ND	ND
m,p-Xylenes#	ND	ND	ND	ND	ND	ND
Methanol	0.33	0.33	0.30	0.32	0.31	0.32
o-Xylene#	TRACE	TRACE	TRACE	TRACE	0.03	TRACE
Octamethylcyclotetrasiloxane#	ND	TRACE	TRACE	TRACE	TRACE	TRACE
Toluene#	ND	ND	ND	ND	TRACE	ND
2-Butanone	ND	ND	ND	ND	ND	ND
Acetaldehyde	TRACE	TRACE	0.11	0.11	0.11	0.11
Dichloromethane	ND	ND	ND	ND	ND	ND
Ethanol	1.90	2.34	2.75	2.38	3.02	2.48
Ethyl Acetate	ND	TRACE	TRACE	TRACE	0.06	TRACE
Hexamethylcyclotrisiloxane#	0.06	0.07	0.07	0.06	0.06	0.06
n-Butanol	0.10	0.09	0.09	0.07	0.07	0.08
Trimethylsilanol	0.13	0.17	0.17	0.14	0.12	0.15

Derived from prime unit

ND: Not detected

TRACE= >MDL (Minimum Detection Limit), <MQL (Minimum Quantification Limit)

Toxicological Evaluation of ISS Air Quality

Routine air quality monitoring is performed in-flight using the AQMs. Archive air samples (mGSCs) are collected during each increment and returned for analysis in the Toxicology and Environmental Chemistry air quality laboratories. Data from the ground analyses complement the in-flight data and provide a more complete understanding of air quality on the ISS. The routine archive samples for this Increment that returned on SpX-10 confirmed air quality was acceptable during this timeframe. **All measured values for routine samples (mGSC and AQM) met T-value guideline criteria ($T < 1$), indicating no concern for crew health.** The average, rounded T-value calculated from the Increment 50 mGSC samples (not including the 2/14/2017 SM sample and ingress samples) was 0.2 (Figure 1). The average, rounded T-value calculated from the AQM data (Figure 2) was slightly lower (0.1 units), but still showed close agreement with the mGSC value. Due to a modification of the process for calculating AQM T-values, the T-value derived from AQM data is approximately half of what was documented in recent reports. In the past, the measured concentration for a compound was used to calculate the T-value. The method was changed such that if a measured value is below the MDL (minimum detection limit), there will be no contribution to the T-value.

If the concentration is between the MDL and MQL (minimum quantitation limit), then the concentration will contribute to the t-value at 1/2 the MQL divided by the SMAC. This method of T-value calculation is now consistent with the method applied to mGSC data.

Inlet cleaning of AQM S/N 1005 occurred on January 20, 2017 and sieve cartridges were replaced in both AQMs on January 26, 2017. Overall, the reported concentrations for the compounds detected are consistent with levels detected since installation of the Node 1 carbon filters in May 2015.

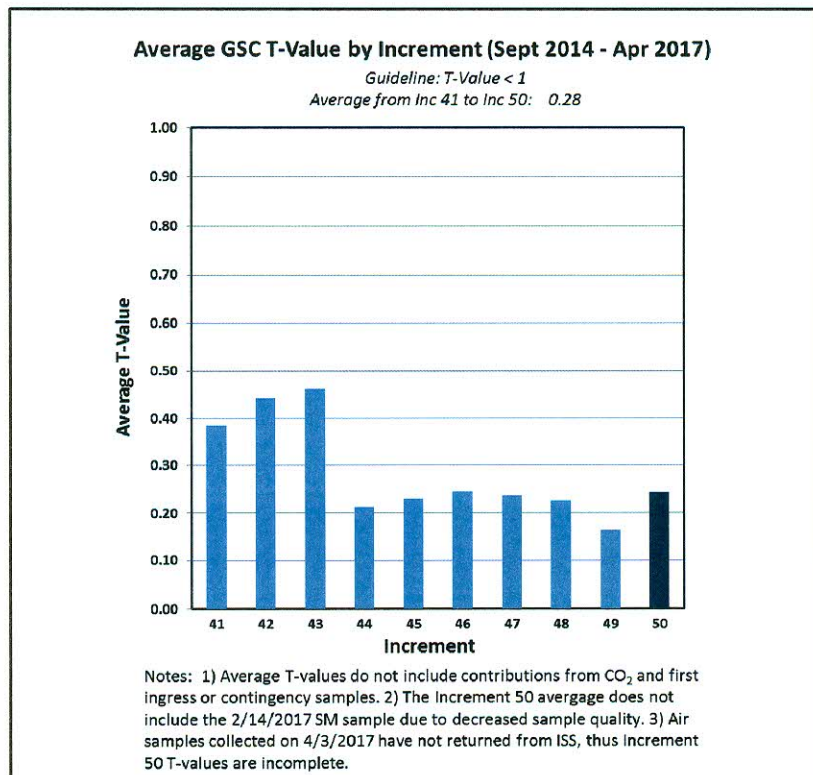


Figure 1. GSC T-values

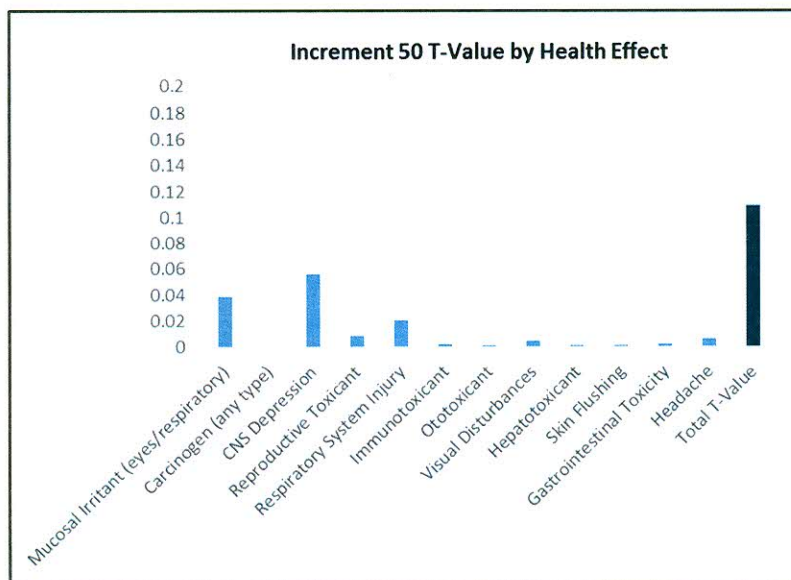


Figure 2. AQM T-values

The nominal mGSC samples contained a CO₂ concentration below the Increment limit documented in Chit 14468, which requests that the 24 hour average concentration not exceed 3.0 mmHg (7100 mg/m³). While mGSC CO₂ sampling provides a snap-shot of the CO₂ concentration, the major constituent analyzer (MCA) routinely monitors CO₂ levels in the US segment. For this reason, data from the MCA is better suited for evaluation of short and long-term trends in CO₂. The MCA data concentrations fluctuate as a result of multiple factors including the number of crew on ISS, current scrubbing capability, and processes and activities that generate CO₂. The average 24 hr CO₂ concentration was approximately 3.0 mmHg or below for the duration of the Increment with several brief excursions above the 3.0 mmHg Increment limit due to CDRA maintenance at the end of February 2016 and multiple MetOx regeneration activities in March. CO₂ concentrations were, overall, well controlled.

Alcohol values in November, January, and February routine samples continued to exceed the guideline of <5 mg/m³, which is intended to protect the water recovery system from risk of overloading. These levels are primarily due to ethanol in the ISS atmosphere. AQM results for ethanol were lower than the levels measured in the mGSCs, with an Increment average of 2.48 mg/m³. This difference may be due to temporal and spatial differences between the AQMs and mGSC sample points. Importantly, ethanol levels during the entire Increment did not present a risk for crew health. Formaldehyde levels in the US Lab (shown in Table 1 and Figure 3) are generally consistent with historic levels and remain below the SMAC of 120 µg/m³.

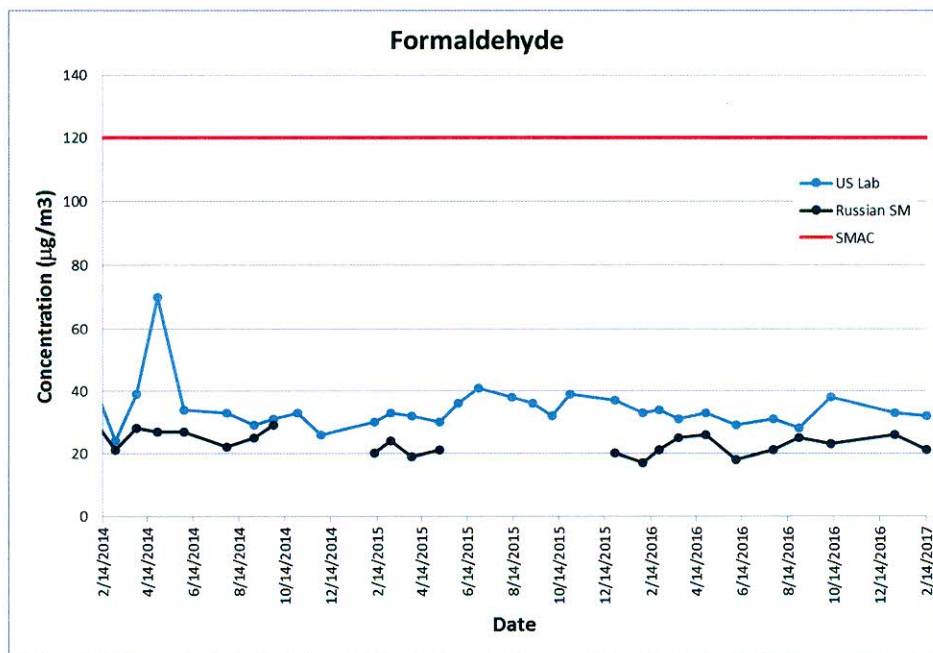


Figure 3. Formaldehyde trending in ISS air.

HTV-6 Ingress

A first ingress sample was collected on 12/13/2016, nine minutes after hatch opening. The concentration of Freon 218 (octafluoropropane), a marker for ISS air dilution of first entry samples, indicated limited (approximately 12%) mixing with the ISS atmosphere prior to sample collection. The total T-value (minus CO₂) was 1.6. This value was well below the limit of 3.0 units and lower than HTV-5 (2.6). Trimethylsilanol (1.1 mg/m³) and fluorotrimethylsilane (0.29 mg/m³) were the primary contributors to the HTV-6 T-value.

Trimethylsilanol was lower than concentrations detected in HTV-5 (8.2 mg/m³) and HTV-4 (3.6 mg/m³) ingress samples. Accounting for dilution, exposure to HTV-6 vehicle air posed no risk to crew health.

SpX-10 Ingress

A first ingress sample was collected on 2/23/2017 fourteen minutes after hatch opening. The Freon 218 concentration (9.1 mg/m³) was used to calculate sample dilution. Compared to background levels from routine samples collected before and after ingress, the ingress sample was estimated to be minimally diluted with ISS air (12%). The total T-value was quite low at 0.12 units, but similar to other recent Space-X ingress results (SpX-9: 0.34; SpX-8: 0.07; SpX-6: 0.11). The primary contributors were carbon monoxide (0.07 mg/m³) and acetaldehyde (0.02 mg/m³). The SpX-10 first entry sample T-value was approximately 25 times lower than the limit (3.0 units) for ingress samples, indicating no impact to crew health.

WATER QUALITY

Three archive samples were collected from the Potable Water Dispenser (PWD) in the US segment during Increment 50. In addition, samples of condensate (2) and wastewater (2) were also collected from the US segment during the Increment. These water samples were returned on 48S and SpX-10. Complete data tables with results from these analyses can be found in report 2017-TEC-WQ-002. A summary of select analytical results is provided in Table 3. Expanded summary tables containing organic carbon recoveries and results for analytes detected in the samples at concentrations above reporting limits are included as attachments to this report.

Table 3. Analytical Summary of ISS Water Analyses

Return Flight	Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	Conductivity (µS/cm)	Total Iodine (mg/L)
SpX-10	US Condensate	11/24/2016	29.8	36.0	300	NA
SpX-10	WPA Wastewater	11/29/2016	13.8	22.0	167	NA
SpX-10	PWD (Hot)	1/17/2017	1.46	4.4	2	<0.05
SpX-10	WPA Wastewater	2/9/2017	18.2	22.0	190	NA
SpX-10	US Condensate	2/14/2017	102	36.0	340	NA
SpX-10	PWD (Auxiliary Port)	3/14/2017	1.56	4.8	2	2.04
48S	PWD (Ambient)	3/14/2017	1.54	4.9	2	<0.05

Toxicological Evaluation of ISS Water Quality: Routine water quality monitoring is performed in-flight using the total organic carbon analyzer (TOCA). Results from these analyses provide a general indication of overall water quality. Archive water samples are collected during each Increment and returned for analysis in ground laboratories. Data from the ground analyses complement the in-flight data and provide a more complete understanding of water quality on the ISS.

Potable Water

Concentrations of all chemicals met the requirements listed in SSP 41000, *System Specification for the International Space Station*. Total organic carbon (TOC) concentrations from in-flight (PWD TOC and WPA PFU2) and ground analyses (Archive TOC) performed on samples from the U.S. potable water system between April 2016 and April 2017 are shown in Figure 4. While the TOC concentration was elevated during Increment 50 (primarily due to DMSD), the TOC concentrations measured in the U.S. potable water samples and product water sample remained below the U.S. Segment Specification (3000 µg/L).

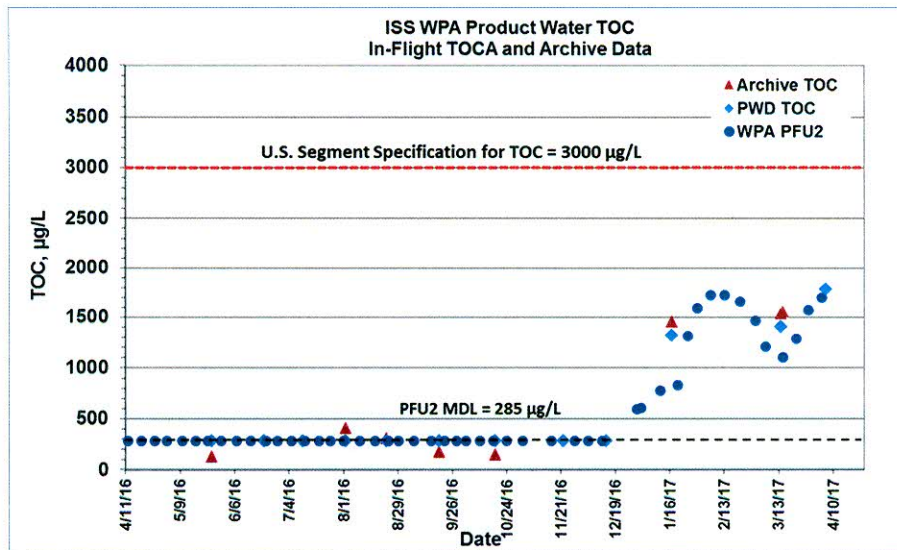


Figure 4. Total Organic Carbon (TOC) trending in US Potable Water

TOC concentrations in the U.S. archive samples (Archive TOC) were 1330 µg/L for the PWD hot sample and 1410 µg/L for the PWD ambient sample. Compared to Increment 49 archive samples (PWD hot: 180 µg/L, PWD ambient: 150 µg/L), TOC concentrations were higher, but still below the Spacecraft Water Exposure Guideline (SWEG) of 3.0 mg/L (3000 µg/L) and the updated limit of 5.0 mg/L (5000 µg/L) in flight rule B13-161, which took effect in March, 2017. Both limits were set based on formaldehyde, which was determined to be the most toxic compound that could potentially break through the Water Recovery System (WRS). The updated flight rule limit is the calculated TOC equivalent of the 100 day SWEG for formaldehyde, whereas the limit in SSP 41000 (3 mg/L) was set based on the EPA lifetime exposure limit. Both limits were documented in Volume 5 of the Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants set by the NRC and are protective of crew health.

As mentioned, the source of the TOC was determined to be primarily DMSD (ambient = 4.9 mg/L; hot = 4.4 mg/L). Methyl sulfone, another minor contributor to the TOC, was also higher (ambient = 144 µg/L; hot = 122 µg/L) than the historical average, but consistent with levels from recent Increments. Silicon was detected in both U.S. samples (PWD Ambient = 1.46 mg/L; PWD Hot = 1.21 mg/L) at levels typically seen when DMSD is present in the water. Traces of nickel (ambient and hot = 3 µg/L) and aluminum (hot = 1 µg/L) were detected, but at levels well below the applicable limits. **Importantly, all chemical parameters measured in U.S. potable water samples collected during Increment 50 met the requirements listed in SSP 41000 and the Medical Operations Requirement Document (MORD).**

Iodine is a biocide used on the US segment. It is added to the water produced by the Water Processor Assembly (WPA), but removed prior to crew consumption to avoid potential thyroid dysfunction. Total iodine levels in the samples collected from the PWD (ambient and hot) were below detection limits (0.05 mg/L), indicating effective removal of iodine in water intended for consumption. For additional information regarding microbial analyses, please see the Increment 50 post-flight report issued by the JSC Environmental Microbiology Laboratory.

Product Water

The TOC concentration measured in the PWD Auxiliary Port sample was 1.56 mg/L, which is very similar to the TOC concentration in the PWD Ambient sample collected on the same day. DMSD (4.8 mg/L) and methyl sulfone (261 µg/L) were detected at higher levels than recorded during Increment 49. The historical

average concentration of methyl sulfone is 44 µg/L. Although this water is not meant for consumption, these compounds do not pose a toxicological risk at these concentrations.

Condensate

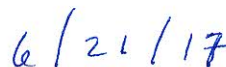
Two condensate samples were collected on 11/24/2016 and 2/14/2017. The TOC levels in these samples were 29.8 mg/L and 102 mg/L, respectively, which are both below the historical average (170 mg/L). In general, the first sample contained some of the lowest levels of contaminants ever detected in a condensate sample. For example, ethanol and 2-propanol concentrations were at historical lows. These results are consistent with AQM results indicating that ISS air quality was well managed for the Increment. The second sample contained slightly higher levels of contaminants. DMSD was the only contaminant detected at a level greater than 1 mg/L (36 mg/L) in the 11/24/2016 sample; the 2/14/2017 sample contained the same amount of DMSD, but higher levels of ethanol (41.4 mg/L), acetate (31.6 mg/L), propylene glycol (25.8 mg/L), benzyl alcohol (5.4 mg/L), and methanol (4.47 mg/L). Multiple other compounds were also detected at concentrations of approximately 1 mg/L. Zinc (4.12 mg/L), nickel (0.18 mg/L), and traces of other metals were present in this non-potable sample. These compounds were effectively removed by the WRS as evidenced by the low or undetectable levels in the potable samples.

Wastewater

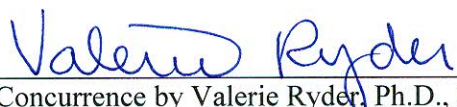
Two wastewater samples were collected on 11/29/2016 and 2/9/2017. The TOC levels in these samples (13.8 and 18.2 mg/L) were well below the historical average of 49.4 mg/L. The DMSD concentration was 22 mg/L in both samples. Metals detected above 0.1 mg/L in the samples were zinc (0.734 and 2.38 mg/L), nickel (0.349 and 0.212 mg/L), and chromium (0.103 and 0.196 mg/L). Traces of other metals, including manganese (both samples) were also present. As with the condensate samples, all compounds of toxicological interest were effectively cleaned from the samples by the WRS.



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Concurrence by Valerie Ryder, Ph.D., DABT
NASA Toxicologist



Date

Enclosures Table 1: Analytical concentrations of compounds quantified in mGSCs returned on SpX10
 Table 2A: T-values corresponding to concentrations in Table 1, based on 180-day SMACs
 Table 2B: T-values corresponding to HTV-6 Ingress concentrations in Table 1, based on 7-day and 180-day SMACs
 Table 2C: T-values corresponding to SpX-10 Ingress concentrations in Table 1, based on 7-day and 180-day SMACs
 Table 3: Analytical concentrations of compounds quantified in US potable and product water samples returned on SpX-10 and 48S
 Table 4: Analytical concentrations of compounds quantified in US wastewater and condensate samples returned on SpX-10

TABLE 1
ANALYTICAL RESULTS OF SPACEX-10 RETURN AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M ³)							
	AQ170021 SN 2058	AQ170022 SN 2041	AQ170023 SN 2042	AQ170024 SN 2043	AQ170025 SN 2050	AQ170026 SN 2047	AQ170027 SN 2048	AQ170028 SN 2052
	LAB 11/24/16 @ 12:33 GMT	JPM 11/24/16 @ 12:25 GMT	HTV-6 INGRESS 12/13/16 @ 19:50 GMT	LAB 01/03/17 @ 11:30 GMT	COLUMBUS 01/03/17 @ 11:33 GMT	LAB 02/14/17 @ 07:53 GMT	SM 02/14/17 @ 07:56 GMT	SPACEX-10 INGRESS 02/23/17 @ 17:12 GMT
TARGET COMPOUNDS (TO-15) **								
Octafluoropropane (Perfluoropropane) *	71	74	12	78	75	75	57	9.1
Perfluoro(2-methylpentane) *	<0.10	<0.10	11	<0.10	<0.10	<0.10	<0.47	<0.10
Propane	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.12	TRACE
Chloromethane	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.12	TRACE
Isobutane	0.037	<0.025	0.31	<0.025	0.05	<0.025	<0.12	<0.025
Methanol	0.33	0.34	0.21	0.36	0.37	0.34	0.38	0.56
Acetaldehyde	0.22	0.24	0.19	0.26	0.27	0.22	0.23	0.09
2-Methyl-1-propene	<0.025	<0.025	0.036	TRACE	TRACE	<0.025	<0.12	<0.025
Ethanol *	4.7	5.1	0.87	5.7	5.6	3.8	3.1	1.4
Acetone	0.30	0.31	0.28	0.33	0.36	0.31	0.62	0.10
Propanal (Propionaldehyde)	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.12	<0.025
2-Propanol (Isopropanol) *	0.16	0.17	2.9	0.17	0.21	0.38	0.55	0.31
Isoprene (2-Methyl-1,3-butadiene)	TRACE	TRACE	<0.025	0.032	0.034	TRACE	<0.12	<0.025
1-Propanol	TRACE	TRACE	0.029	0.027	TRACE	TRACE	<0.12	<0.025
Trimethylsilanol	0.13	0.15	4.4	0.18	0.22	0.13	TRACE	0.030
Butanal (Butyraldehyde)	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.12	<0.025
2-Butanone (Methyl ethyl ketone)	<0.025	<0.025	0.10	<0.025	<0.025	<0.025	<0.12	<0.025
Ethyl acetate	<0.025	<0.025	0.050	TRACE	TRACE	<0.025	<0.12	<0.025
1-Butanol	0.076	0.078	0.091	0.087	0.084	0.077	<0.12	<0.025
n-Heptane	<0.025	<0.025	0.26	<0.025	<0.025	<0.025	<0.12	<0.025
Toluene	<0.025	<0.025	0.054	<0.025	<0.025	<0.025	<0.12	<0.025
Octamethylcyclotetrasiloxane	<0.125	<0.125	0.16	<0.125	<0.125	<0.125	<0.59	<0.125
Decamethylcyclopentasiloxane	TRACE	0.24	0.36	0.29	0.43	0.18	<0.82	<0.175
SPECIAL INTEREST COMPOUNDS ***								
2-Methyl-2-propenal	<0.050	<0.050	TRACE	<0.050	<0.050	<0.050	<0.24	<0.050
Hexamethylcyclotrisiloxane #	0.26	0.32	1.0	0.25	0.34	0.27	<0.94	<0.20
NON-TARGET COMPOUNDS ***								
1,1,1,2-Tetrafluoroethane	0.17	0.18	<0.050	0.10	0.10	0.055	<0.24	0.077
Fluorotrimethylsilane	<0.050	<0.050	0.23	<0.050	<0.050	<0.050	<0.24	<0.050
Pentamethyldisiloxane-1-ol	<0.050	<0.050	0.084	<0.050	<0.050	<0.050	<0.24	<0.050
C11-Alkane	<0.050	<0.050	0.095	<0.050	<0.050	<0.050	<0.24	<0.050
C11-Alkane	<0.050	<0.050	0.12	<0.050	<0.050	<0.050	<0.24	<0.050
C11-Alkane	<0.050	<0.050	0.091	<0.050	<0.050	<0.050	<0.24	<0.050
C11-Alkane	<0.050	<0.050	0.10	<0.050	<0.050	<0.050	<0.24	<0.050
Dodecamethylpentasiloxane	<0.050	<0.050	0.82	<0.050	<0.050	<0.050	<0.24	<0.050
TOTAL ALCOHOLS PLUS ACETONE								
	5.6	6.0	4.4	6.7	6.6	5.0	4.7	2.3
TARGET COMPOUNDS (GC) **								
Methane	13	13	4.3	30	30	27	20	4.8
Carbon dioxide	5300	5500	1500	5600	5900	5500	4300	3600
Hydrogen	2.7	2.7	0.83	5.5	5.5	5.3	4.2	1.5
Carbon monoxide	0.67	0.69	4.4	0.96	0.91	0.89	<1.8	4.4
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)								
	77	81	36	86	83	80	62	12
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)								
	6.6	7.2	25	7.8	8.1	5.8	4.9	2.6

* GC/FID data results are in bold

** Quantified using a multi-point calibration

*** Quantified using "B" response factor except where noted; concentrations are estimates only.

Response factor generated from an internal study

< : Value is less than the laboratory reporting limit.

TRACE: Amount detected is sufficient for compound identification only. One-half of the reporting limit was used in the Total Concentration summation.

OFP - Octafluoropropane

Note: Shaded results are estimates only.

**TABLE 2A
T-VALUES FOR SPACEX-10 RETURN**

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)					
	AQ170021 SN 2058	AQ170022 SN 2041	AQ170024 SN 2043	AQ170025 SN 2050	AQ170026 SN 2047	AQ170027 SN 2048
	LAB	JPM	LAB	COLUMBUS	LAB	SM
	11/24/16 @ 12:33 GMT	11/24/16 @ 12:25 GMT	01/03/17 @ 11:30 GMT	01/03/17 @ 11:33 GMT	02/14/17 @ 07:53 GMT	02/14/17 @ 07:56 GMT
TARGET COMPOUNDS (TO-15)						
Octafluoropropane (Perfluoropropane)	0.00083	0.00087	0.00092	0.00088	0.00088	0.00068
Isobutane	0.00015	ND	ND	0.00023	ND	ND
Methanol	0.00362	0.00382	0.00403	0.00416	0.00383	0.00418
Acetaldehyde	0.05613	0.06097	0.06472	0.06645	0.05402	0.05757
2-Methyl-1-propene	ND	ND	0.00001	0.00001	ND	ND
Ethanol	0.00237	0.00256	0.00285	0.00278	0.00191	0.00156
Acetone	0.00576	0.00588	0.00637	0.00685	0.00604	0.01187
2-Propanol (Isopropanol)	0.00110	0.00114	0.00113	0.00139	0.00255	0.00370
Isoprene (2-Methyl-1,3-butadiene)	0.00417	0.00417	0.01059	0.01131	0.00417	ND
1-Propanol	0.00013	0.00013	0.00027	0.00013	0.00013	ND
Trimethylsilanol	0.03205	0.03792	0.04612	0.05510	0.03373	0.01469
Ethyl acetate	ND	ND	0.00007	0.00007	ND	ND
1-Butanol	0.00189	0.00194	0.00217	0.00210	0.00192	ND
Decamethylcyclopentasiloxane	0.00583	0.01610	0.01909	0.02862	0.01219	ND
SPECIAL INTEREST COMPOUNDS						
Hexamethylcyclotrisiloxane	0.02933	0.03514	0.02815	0.03806	0.02993	ND
NON-TARGET COMPOUNDS						
1,1,1,2-Tetrafluoroethane	0.00166	0.00171	0.00098	0.00098	0.00053	ND
TARGET COMPOUNDS (GC)						
Methane	0.00372	0.00376	0.00861	0.00866	0.00768	0.00558
Carbon dioxide	0.40904	0.42351	0.42774	0.45215	0.42341	0.33457
Hydrogen	0.00802	0.00787	0.01622	0.01619	0.01568	0.01232
Carbon monoxide	0.03955	0.04036	0.05671	0.05336	0.05230	ND
TOTAL T-VALUE	0.60537	0.64783	0.69677	0.74948	0.65088	0.44671
TOTAL T-VALUE - CO2	0.19633	0.22432	0.26904	0.29733	0.22747	0.11214

ND : Value is less than the laboratory reporting limit.

Note 1: Number of decimal places in T-Values do not represent significant figures of measurements.

Note 2: Shaded results are estimates only.

**TABLE 2B
T-VALUES FOR HTV-6 INGRESS**

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)	T-VALUE (180-d SMAC)
	AQ170023 SN 2042 HTV-6 INGRESS 12/13/16 @ 19:50 GMT	AQ170023 SN 2042 HTV-6 INGRESS 12/13/16 @ 19:50 GMT
TARGET COMPOUNDS (TO-15)		
Octafluoropropane (Perfluoropropane)	0.00014	0.00014
Perfluoro(2-methylpentane) &	0.00008	0.00008
Carbonyl sulfide (Carbon oxide sulfide)	0.00486	0.00486
Isobutane	0.00129	0.00129
Methanol	0.00229	0.00229
Acetaldehyde	0.04713	0.04713
2-Methyl-1-propene	0.00003	0.00003
Ethanol	0.00044	0.00044
Acetone	0.00530	0.00530
Propanal (Propionaldehyde)	0.00104	0.00104
2-Propanol (Isopropanol)	0.01923	0.01923
Carbon disulfide	0.01059	0.01059
1-Propanol	0.00030	0.00030
Trimethylsilanol	1.09125	1.09125
Butanal (Butyraldehyde)	0.00085	0.00085
2-Butanone (Methyl ethyl ketone)	0.00339	0.00339
Ethyl acetate	0.00028	0.00028
1-Butanol	0.00113	0.00226
n-Heptane	0.00105	0.02196
Toluene	0.00358	0.00358
Octamethylcyclotetrasiloxane	0.00056	0.01314
Decamethylcyclopentasiloxane	0.00362	0.02412
SPECIAL INTEREST COMPOUNDS		
2-Methyl-2-propenal	0.01471	0.01471
Hexamethylcyclotrisiloxane	0.01107	0.11074
NON-TARGET COMPOUNDS		
Fluorotrimethylsilane	0.29173	0.29173
Pentamethyldisiloxane-1-ol	0.00168	0.00168
C11-Alkane	0.00197	0.00197
C11-Alkane	0.00249	0.00249
C11-Alkane	0.00189	0.00189
C11-Alkane	0.00214	0.00214
Dodecamethylpentasiloxane	0.00412	0.00412
TARGET COMPOUNDS (GC)		
Methane	0.00122	0.00122
Carbon dioxide	0.11900	0.11900
Hydrogen	0.00244	0.00244
Carbon monoxide	0.06914	0.25621
TOTAL T-VALUE	1.72203	2.06388
TOTAL T-VALUE - CO2	1.60302	1.94488

Note: Number of decimal places in T-Values do not represent significant figures of measurements.

**TABLE 2C
T-VALUES FOR SPACEX-10 INGRESS**

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)	T-VALUE (7-d SMAC)
	AQ170028 SN 2052 SPACEX-10 INGRESS 02/23/17 @ 17:12 GMT	AQ170028 SN 2052 SPACEX-10 INGRESS 02/23/17 @ 17:12 GMT
TARGET COMPOUNDS (TO-15)		
Octafluoropropane (Perfluoropropane)	0.00011	0.00011
Propane	0.00227	0.00012
Chloromethane	0.00030	0.00030
Methanol	0.00617	0.00617
Acetaldehyde	0.02191	0.02191
Ethanol	0.00068	0.00068
Acetone	0.00197	0.00197
2-Propanol (Isopropanol)	0.00207	0.00207
Trimethylsilanol	0.00743	0.00743
SPECIAL INTEREST COMPOUNDS		
No special interest compounds were detected		
NON-TARGET COMPOUNDS		
1,1,1,2-Tetrafluoroethane	0.00074	0.00074
TARGET COMPOUNDS (GC)		
METHANE	0.00138	0.00138
CARBON DIOXIDE	0.27458	0.27458
HYDROGEN	0.00431	0.00431
CARBON MONOXIDE	0.25768	0.06953
TOTAL T-VALUE	0.58161	0.39131
TOTAL T-VALUE - CO2	0.30703	0.11673

Note: Number of decimal places in T-Values do not represent significant figures of measurements.

**Table 3. Expedition 50 Water Sample Summary Report
US Potable Water Samples**

Increment Mission Sample Location Sample Description Sample Date Analysis/Sample ID	Units	Test Conducted by	Potable Water maximum Contaminant Level (MCL)	maximum Contaminant Level Source	50		
					SpX-10	Soyuz 48	SpX-10
					WPA PWD Hot Potable Water 1/17/2017 20170321006	WPA PWD Ambient Potable Water 3/14/2017 20170411001	WPA PWD Aux Port Product Water 3/14/2017 20170321007
Physical Characteristics							
pH	pH units	U.S.	4.5-8.5	41000	5.82	5.42	5.23
Conductivity	µS/cm	U.S.			2	2	2
Iodine (LCV)							
Total I	mg/L	U.S.	6/0.2	41000 (tit max/tit at pt of consumption)	<0.05	<0.05	2.04
Iodine	mg/L	U.S.			<0.05	<0.05	1.52
Iodide	mg/L	U.S.			<0.05	<0.05	0.52
Trace Metals (ICP/MS)							
Calcium	mg/L	U.S.	30	41000	0.01	0.01	0.02
Sodium	mg/L	U.S.			0.08	<0.01	0.05
Aluminum	µg/L	U.S.			1	<1	1
Nickel	µg/L	U.S.	300	SWEG& 41000	3	3	59
Zinc	µg/L	U.S.	2,000	SWEG& 41000	<1	<1	5
Silicon (ICP/MS)							
Silicon	µg/L	U.S.			1,210	1,460	1,300
Total Organic Carbon (Sievers)							
Inorganic Carbon	mg/L	U.S.			1.04	1.15	0.80
Organic Carbon	mg/L	U.S.	3	41000	1.46	1.54	1.56
Semi-volatiles (GC/MS) - Target List							
Methyl sulfone	µg/L	U.S.			122	144	261
Silanol (LC/RI) (R & D Method -NIST traceable standard not available)							
Dimethylsilanediol (DMSD)	µg/L	U.S.	35,000	SWEG	4,400	4,900	4,800
Organic Carbon Recovery	percent	U.S.			80.61	85.24	84.39
Unaccounted Organic Carbon	mg/L	U.S.			0.28	0.23	0.24

Comments: 20170321006 - Description & location not marked on sample bag.

Data Qualifiers: 20170321009 - Possible low bias - glyoxylate, isobutyrate & propionate.
20170321010 - Possible low bias - acetate & formate.

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable

**Table 4. Expedition 50 Water Sample Summary Report
WPA Wastewater and Condensate Samples**

Increment Mission	Sample Location	Sample Description	Sample Date Analysis/Sample ID	Units	Test Conducted by	Potable Water maximum Contaminant Level (MCL)	maximum Contaminant Level Source	50			
								SpX-10			
								WPA Wastewater ORU WPA Wastewater 11/29/2016 20170321008	WPA Wastewater ORU WPA Wastewater 2/9/2017 20170321009	WPA Condensate Sample Port US Condensate 11/24/2016 20170321010	WPA Condensate Sample Port US Condensate 2/14/2017 20170321011
Physical Characteristics											
	pH	pH units	U.S.	4.5-8.5	41000	7.68	7.48	7.68	7.69		
	Conductivity	µS/cm	U.S.			167	190	300	340		
Anions (IC)											
	Chloride	mg/L	U.S.			0.7	1.6	<0.5	<0.5		
	Fluoride	mg/L	U.S.			0.3	0.4	0.5	0.4		
	Phosphate as P (PO4-P)	mg/L	U.S.			0.5	1.0	<0.1	<0.1		
	Sulfate	mg/L	U.S.	250	41000	0.7	1.8	<0.5	<0.5		
Cations (IC)											
	Ammonia as Nitrogen (NH3-N)	mg/L	U.S.	1	SWEG&41000	19.9	22.2	35.9	41.4		
Trace Metals (ICP/MS)											
	Calcium	mg/L	U.S.	30	41000	0.13	0.18	0.11	0.11		
	Potassium	mg/L	U.S.	340	41000	0.36	0.86	<0.05	<0.05		
	Sodium	mg/L	U.S.			0.71	1.86	<0.05	2.31		
	Aluminum	µg/L	U.S.			<10	17	12	9		
	Chromium	µg/L	U.S.	230	41000	103	196	<5	<5		
	Iron	µg/L	U.S.	300	41000	<50	32	<25	<25		
	Manganese	µg/L	U.S.	300	SWEG&41000	10	10	<5	9		
	Nickel	µg/L	U.S.	300	SWEG&41000	349	212	452	180		
	Silver	µg/L	U.S.	400	SWEG&41000	<10	<5	9	<5		
	Zinc	µg/L	U.S.	2,000	SWEG&41000	734	2,380	2,460	4,120		
Silicon (ICP/MS)											
	Silicon	µg/L	U.S.			6,660	7,030	12,300	11,700		
Total Organic Carbon (Sievers)											
	Inorganic Carbon	mg/L	U.S.			17.1	19.0	30.0	28.5		
	Organic Carbon	mg/L	U.S.	3	41000	13.8	18.2	29.8	102		
Volatile Organics											
	Acetone	µg/L	U.S.	15,000	SWEG	<50	<50	<50	2,500		
Volatile Organics -Special Interest Compounds (Semi-quantitative)											
	Trimethylsilanol	µg/L	U.S.			170	190	320	280		
Semi-volatiles (GC/MS) - Target List											
	Benzothiazole	µg/L	U.S.			<100	51	59	<100		
	N-n-Butylbenzenesulfonamide	µg/L	U.S.			<100	67	74	123		
	Tris(2-Chloroethyl)phosphate	µg/L	U.S.			<100	117	102	<100		
	Decamethylcyclopentasiloxane	µg/L	U.S.			<100	75	81	<100		
	Dodecamethylcyclohexasiloxane	µg/L	U.S.			<100	61	<40	<100		
	Methyl sulfone	µg/L	U.S.			<100	248	284	553		
Acid Extractables-EPA 625 List											
	Benzoic acid	µg/L	U.S.			<500	<250	<200	1,260		
	Phenol	µg/L	U.S.	4,000	SWEG	<100	<50	<40	367		
Base/Neutral Extractables - EPA 625 List											
	Benzyl alcohol	µg/L	U.S.			<100	<50	<40	5,400		
	Dibutylphthalate	µg/L	U.S.	40,000	SWEG	<100	<50	<40	260		
	Diethylphthalate	µg/L	U.S.			<100	<50	901	1,450		
Semi-volatiles (GC/MS) - Special Interest Compounds (Semi-quantitative - 2 pt curve)											
	Benzaldehyde	µg/L	U.S.			not found	not found	not found	100		
	2-Butoxyethanol	µg/L	U.S.			not found	not found	not found	270		
	2-(2-Butoxyethoxy)ethanol	µg/L	U.S.			not found	not found	not found	1,500		
	Butylated hydroxyanisole (BHA)	µg/L	U.S.			<200	<100	not found	220		
	N,N-Diethylformamide	µg/L	U.S.			not found	not found	42	not found		
	N,N-Dimethyl acetamide	µg/L	U.S.			not found	not found	650	1,200		
	N,N-Dimethylformamide	µg/L	U.S.			not found	450	530	1,400		
	Dipropylene glycol methyl ether	µg/L	U.S.			510	370	820	750		
	2-Ethoxyethanol	µg/L	U.S.			not found	not found	not found	1,300		
	2-Ethylhexanoic acid	µg/L	U.S.			not found	not found	not found	360		
	Hexanoic acid	µg/L	U.S.			not found	not found	not found	1,500		
	1-Methyl-2-pyrrolidinone	µg/L	U.S.			not found	not found	450	590		
	Monomethyl phthalate	µg/L	U.S.			not found	not found	330	210		
	(+)-Neomenthol	µg/L	U.S.			not found	not found	52	110		
	2-Phenoxyethanol	µg/L	U.S.			not found	not found	not found	2,700		
	Tributyl phosphate	µg/L	U.S.			97	51	56	110		

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable

**Table 4. Expedition 50 Water Sample Summary Report
WPA Wastewater and Condensate Samples**

Increment Mission	Sample Location	Sample Description	Sample Date Analysis/Sample ID	Units	Test Conducted by	Potable Water maximum Contaminant Level (MCL)	maximum Contaminant Level Source	50			
								SpX-10			
								WPA Wastewater ORU WPA Wastewater 11/29/2016 20170321008	WPA Wastewater ORU WPA Wastewater 2/9/2017 20170321009	WPA Condensate Sample Port US Condensate 11/24/2016 20170321010	WPA Condensate Sample Port US Condensate 2/14/2017 20170321011
Alcohols (DAI/GC/MS)											
	1-Butanol			µg/L	U.S.			<400	<400	<400	689
	Ethanol			µg/L	U.S.			<400	<400	<400	41,400
	Methanol			µg/L	U.S.	40,000	SWEG	<400	<400	<400	4,470
	2-Propanol (Isopropanol)			µg/L	U.S.			<400	<400	<400	1,310
Glycols (DAI/GC/MS)											
	1,2-Ethanediol (Ethylene glycol)			µg/L	U.S.	4000	SWEG	<1000	<1000	<1000	2,190
	1,2-Propanediol (Propylene glycol)			µg/L	U.S.	1,700,000	SWEG	<1000	1090	<1000	25,800
Silanols (LC/RI) (R & D Method -NIST traceable standard not available)											
	Dimethylsilanediol (DMSD)			µg/L	U.S.	35,000	SWEG	22,000	22,000	36,000	36,000
Carboxylates (IC)											
	Acetate			µg/L	U.S.			<1000	MI	<500	31,600
Non-volatiles (LC/UV-VIS)											
	Caprolactam			µg/L	U.S.	100,000	SWEG	<500	<500	<500	1,990
Organic Carbon Recovery											
				percent	U.S.			44.48	38.39	40.07	75.33
Unaccounted Organic Carbon											
				mg/L	U.S.			7.66	11.21	17.86	25.17

Comments: 20170321006 - Description & location not marked on sample bag.

Data Qualifiers: 20170321009 - Possible low bias - glyoxylate, isobutyrate & propionate.
20170321010 - Possible low bias - acetate & formate.