JSC TOXICOLOGY AND ENVIRONMENTAL CHEMISTRY GROUP

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SUBJECT: Toxicological Assessment of ISS Air and Water Quality: December 17, 2017 – February 27, 2018 (Increment 54), Including SpX-13 Ingress

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

AIR QUALITY

Five archive air samples were scheduled to be collected in mini grab sample containers (mGSCs) on ISS during Increment 54. One sample was collected during first ingress operations in SpaceX-13 (SpX-13). The remaining four samples were part of routine monitoring; however, no representative samples were collected in February. One of the two canisters (collected in Columbus (COL)) collected on 2/27/18 contained no sample and is not reported. The other canister (collected in the LAB) contained low pressure and, although reports are presented, they are expected to be biased low. Two pairs of passive-diffusion formaldehyde badges were deployed in the Lab and Service Module (SM) on 1/2/18. With the exception of the February sample, which returned on SpX-14, all other mGSC samples were returned on SpX-13. The formaldehyde badges were returned on SpX-15. A summary of analytical results from the samples is provided in Table 1.

Table 1. Analytical summary of ISS air analyses

Return Flight	Sample Location	Sample Date	Freon 218 (mg/m^3)	Alcohols[a] (mg/m^3)	T-Value[b] (units)	Formaldehyde ($\mu g/m^3$)
SpX-13	SpX-13 Ingress	12/17/2017	107	2.7	0.2 (0.1)	
SpX-13 (GSC) and SpX-15 (FMK)	LAB	1/2/2018	354	8.5	0.3	31
SpX-13	JPM	1/2/2018	360	9.4	0.3	
SpX-15	SM	1/2/2018	-	-	-	28[d]
SpX-14	LAB	2/27/2018	273	11	0.2	
Guideline			---	*<5*	*<1*[c]	*<120*

Low pressure sample results are shaded gray
[a]Includes acetone
[b]Sum of the ratios of the measured concentration and the corresponding 180-day SMAC for each compound, excluding CO_2; parentheses indicate value based on 7-day SMACs and applicable to first ingress
[c]T-value <1 used to evaluate routine monthly sampling; <3 used to evaluate first ingress
[d]Average from pair of formaldehyde badges

Data tables containing measured concentrations and corresponding T-values based on appropriate Spacecraft Maximum Allowable Concentrations (SMACs) for compounds present at levels above the laboratory reporting limit are attached to this report. Complete data tables including compounds assessed but not detected are available upon request. The mean relative recoveries of the three surrogate standards from the SpX-13 return mGSC samples were as follows: ^{13}C-acetone, 119±13%; fluorobenzene-d_5, 109±5%; and chlorobenzene-d_5, 123±12%. Average surrogate recoveries for the mGSC returned on SpX-14 were: ^{13}C-acetone, 103±1%; fluorobenzene-d_5, 100±1%; and chlorobenzene-d_5, 97±1%. For the passive-

diffusion formaldehyde badges, positive control recoveries (1 in-flight and 1 lab control) were 110 and 108%, 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/m^3) of AQM target compounds

Compound	December Average	January Average	February Average	Increment Average
2-Propanol	0.3	0.2	0.1	0.2
Acetone	0.4	0.4	0.4	0.4
Acrolein	ND	ND	ND	ND
Benzene	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND
Decamethylcyclopentasiloxane#	0.1	0.2	0.1	0.1
Hexanal	ND	ND	ND	ND
Hexane	ND	ND	ND	ND
m,p-Xylenes#	TRACE	ND	ND	TRACE
Methanol	0.3	0.2	0.3	0.3
o-Xylene#	0.1	TRACE	TRACE	TRACE
Octamethylcylcotetrasiloxane#	TRACE	TRACE	TRACE	TRACE
Toluene#	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND
Acetaldehyde	TRACE	0.2	0.3	0.2
Dichloromethane	ND	ND	ND	ND
Ethanol	4.1	4.0	2.7	3.6
Ethyl Acetate	TRACE	ND	TRACE	TRACE
Hexamethycyclotrisiloxane#	0.1	0.1	0.1	0.1
n-Butanol	0.1	0.1	TRACE	0.1
Trimethylsilanol	0.1	0.1	0.1	0.1

Obtained from prime unit
ND: Not detected; <MDL (Minimum Detection Limit)
TRACE= >MDL, <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 and formaldehyde badges) are collected during each increment and returned for analysis in the Toxicology and Environmental Chemistry (TEC) Air Quality Laboratory. 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-13 confirmed air quality was acceptable during December and early January. As noted above, no representative archive samples were collected in February, but results from AQM analyses indicate that air quality was fairly consistent throughout the increment. **All measured values for routine samples (mGSC and AQM) met 180-d T-value guideline criteria (T < 1), indicating no concern for crew health.** The average, rounded T-value calculated from the Increment 54 mGSC samples was 0.3 (Figure 1). The sample collected in the Lab on 2/27/2018 was excluded from this calculation because it was not considered to be representative due to low sample pressure. T-values calculated from AQM (Figure 2) and GSC results were in reasonable agreement given the differences between the analytical techniques and the number of target compounds used in the calculation.

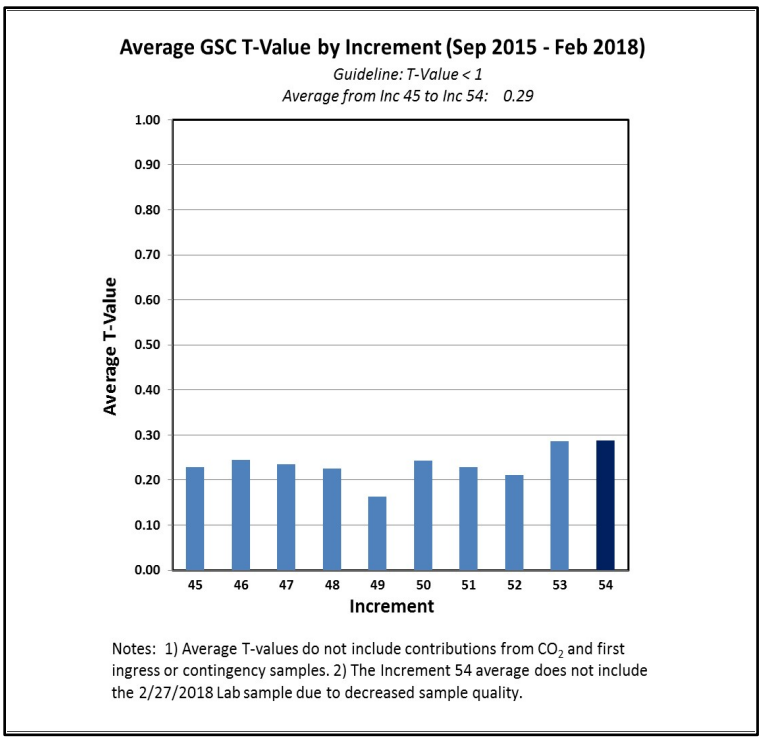

Figure 1. GSC T-values

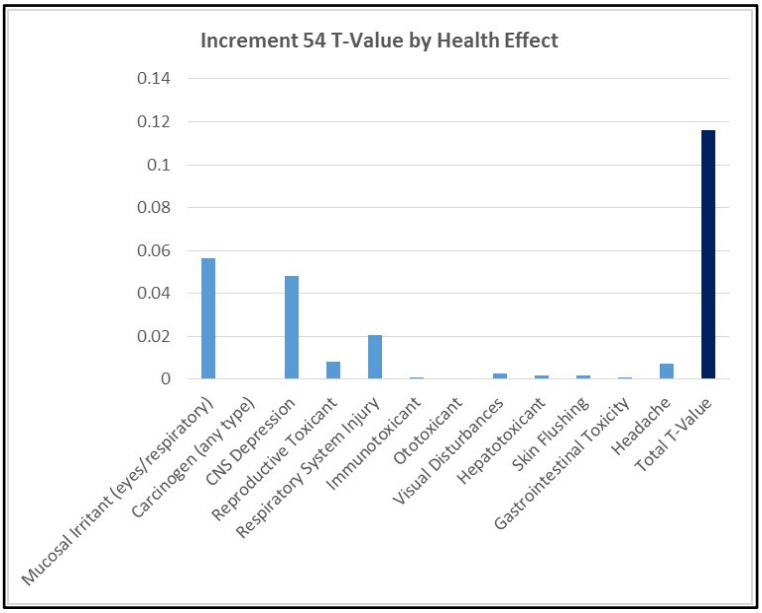

Figure 2. AQM T-values

Overall, the reported concentrations for the compounds detected during Increment 54 are similar to levels detected during recent increments. This is somewhat unexpected as the carbon filters that had been installed in Node 1 since 2015 were removed on 12/15/17. When carbon filters were first installed in May of 2015, atmospheric concentrations of most siloxanes (i.e. TMS, OMCTS, and HMCTS) were notably reduced. The carbon filters were replaced with HEPA filters on 12/15/17 after elevated fungal counts were recovered from air samples collected in Node 1. While atmospheric siloxane concentrations did increase slightly after removal of the carbon filters, the concentrations have stabilized and remain well below the levels seen

before installation of the carbon filters. The Node 1 carbon filters were originally installed as part of efforts to reduce the concentration of dimethylsilanediol (DMSD) in US condensate. Reducing the DMSD concentration in US condensate was expected to prevent DMSD from breaking through the Water Processor Assembly (WPA) and help extend the life of the Multi-Filtration (MF) beds. It was believed that reducing the concentrations of atmospheric siloxanes would lead to a concurrent reduction in the DMSD concentration in condensate. Interestingly, despite the marked reduction in atmospheric siloxanes, there was no discernable change in the DMSD concentration in condensate while the carbon filters were installed. This suggests that the mechanism and dynamics of DMSD formation are more complicated than originally thought and additional investigation is warranted.

The nominal mGSC samples contained a CO_2 concentration below the increment limit documented in Chit 14468, which requests that the 24 hour average concentration not exceed 3.0 mmHg (7100 mg/m^3) on the US segment. While mGSC CO_2 sampling provides a snap-shot of the CO_2 concentration, the major constituent analyzer (MCA) routinely monitors CO_2 levels in the US segment. For this reason, data from the MCA are better suited for evaluation of short and long-term trends in CO_2. Concentrations measured by the MCA fluctuate as a result of multiple factors including the number of crew on ISS, current scrubbing capability, and processes and activities that generate CO_2. CO_2 levels (24-hour average) recorded by the Node 3 MCA were below 2 mmHg during 3 crew operations in mid-December, then increased to approximately 3 mmHg throughout the remainder of the increment. Brief excursions were observed during MetOx regeneration on 1/2/2018, and 2/16/2018, and following a brief CDRA fan failure on 2/9/2018 (see Figure 3).

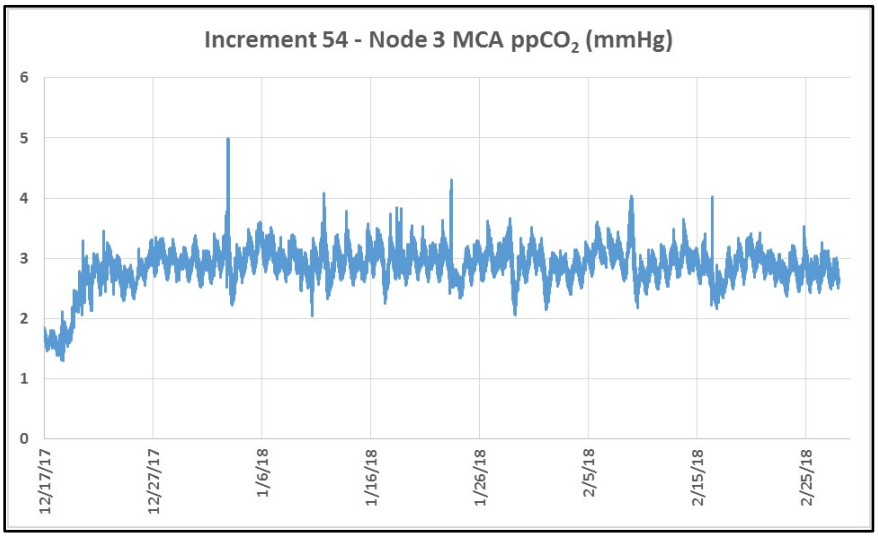

Figure 3. MCA CO_2 values

If crew is congregated into one location (e.g. during EVA preparation on 1/23/2018), rapid sampling of one area may occur, which can also result in temporarily elevated concentrations. Additional measures, including the use of LiOH canisters on the Russian segment and dual CDRA operations on the US segment, were taken to maintain average levels at or below 3 mmHg. Overall, CO_2 concentrations were well controlled throughout the increment.

Alcohol values in all routine archive samples continued to exceed the guideline of <5 mg/m^3, 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 (increment average 3.55 mg/m^3) continue to decrease relative to the Increment 53 average (3.8 mg/m^3) and levels measured in archive samples collected

in October 2017 (5.2 mg/m^3) and November 2017 (4.5 and 4.6 mg/m^3). The reason for the apparent off-set in this compound is unknown at this time, but will continue to be monitored.

Octafluoropropane (Freon 218) levels decreased to 354 and 360 mg/m^3 in the Lab and JPM, respectively, following a release from the CSAT payload during Increment 53 that caused levels to spike at 865 mg/m^3 in the JPM on 10/25. This concentration is still two orders of magnitude below the 180d SMAC value (85,000 mg/m^3) and does not constitute a toxicological risk. Prior history of leaks resulting in similar concentrations suggests that levels will remain elevated for some time.

Formaldehyde levels in the US Lab (shown in Table 1 and Figure 4) are generally consistent with historic levels and remain below the SMAC of 120 μg/m^3. The result for one of the 1/2/18 US Lab samples was unusually low compared to the duplicate sample and historical values, and is therefore considered suspect. For this reason, the concentration (31 μg/m^3) for only one sample in the Lab pair was used in Table 1 and Figure 4. The value in Table 1 and Figure 4 for the SM represents an average for the pair.

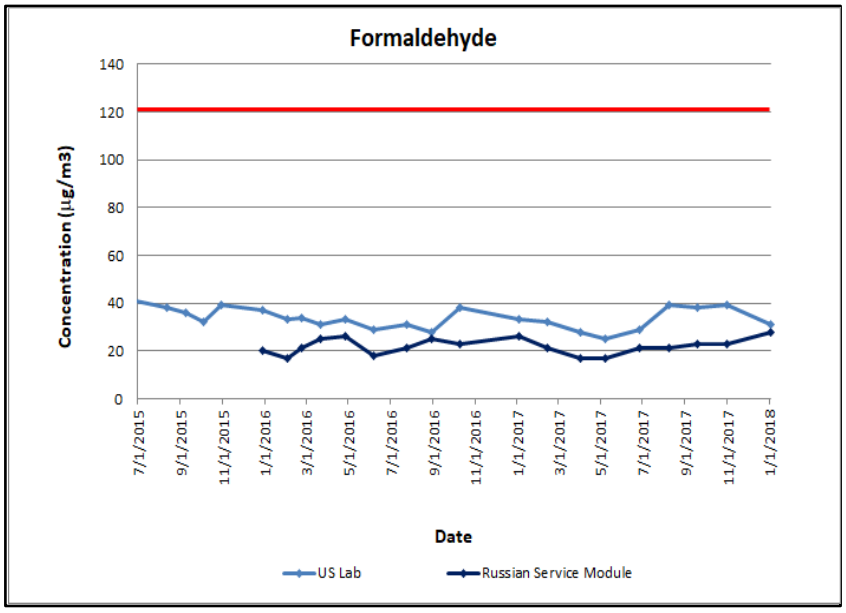

Figure 4. Formaldehyde trending in ISS air.

SpX-13 Ingress

A first entry sample was collected upon ingress into SpX-13 on 12/17/2017, approximately three minutes after hatch opening. No background concentration of Freon 218 (octafluoropropane), a marker for ISS air dilution of first entry samples, was available near the time of first ingress sampling for comparison. Therefore the MCA carbon dioxide concentration at the time of GSC sampling (4073 mg/m^3) was used to estimate dilution. The CO_2 concentration measured in the ingress sample was 2200 mg/m^3, indicating that up to 54% mixing with the ISS atmosphere occurred prior to sample collection. The total T-value (excluding CO_2) was 0.1, which was well below the 7-d T-value limit of 3.0 units and similar compared to other SpaceX ingress results (SpX-11: 0.1; SpX-10: 0.1). The primary contributors were carbon monoxide (0.12 mg/m^3), acetaldehyde (0.03 mg/m^3), and trimethylsilanol (0.01 mg/m^3). Accounting for 54% dilution, exposure to SpX-13 vehicle air would have posed no risk to crew health.

WATER QUALITY

Three archive water samples were collected from the US segment during Increment 54 and returned on SpX-13 and 52S. Two of these were potable water samples from the ambient and hot legs of the US Potable

Water Dispenser (PWD) and the third was a product water sample collected from the PWD auxiliary port. Complete data tables with results for all measured parameters can be found in reports 2018-TEC-WQ-002 and 2018-TEC-WQ-003. Samples of US condensate and wastewater were also collected during Increment 54. These samples were returned to ground for analysis on SpaceX-14 (SpX-14). Complete data tables with results from all analyses run on the condensate and wastewater samples can be found in 2018-TEC-WQ-004. A summary of select analytical results from the Increment 54 samples is provided in Table 3. Expanded summary tables containing organic carbon recoveries and results for all analytes present at concentrations above reporting limits are included as attachments to this report.

Table 3. Analytical Summary of ISS Water Analyses

Return Mission	Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	Methyl Sulfone (mg/L)	Conductivity (µS/cm)	Total Iodine (mg/L)
SpX-13	PWD (Auxiliary Port)	1/9/2018	1.11	2.4	NA	NA	1.16
SpX-14	WPA Wastewater	1/29/2018	16.6	20.0	0.22	96	NA
SpX-14	US Condensate	1/29/2018	131	70.0	0.37	370	NA
52S	PWD (Ambient)	1/31/2018	1.09	2.4	0.31	2	<0.05
52S	PWD (Hot)	2/21/2018	1.26	3.0	0.17	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 comprehensive 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 detected in the potable water samples met the requirements listed in SSP 41000, *System Specification for the International Space Station* and JSC 63414, Spacecraft Water Exposure Guidelines (SWEGs). Total organic carbon (TOC) concentrations from in-flight (PWD TOC and WPA TOC) and ground analyses (Archive TOC) performed between February 2016 and February 2018 are shown in Figure 5. The TOC concentration was elevated in both potable samples (Ambient: 1.09 mg/L.; Hot: 1.26 mg/L) but measured concentrations were well below both the U.S. Segment Specification (3000 µg/L) and the 100-day SWEG (5000 µg/L). DMSD was the primary compound responsible for the TOC in both potable samples. While not a crew health risk, the increased levels of methyl sulfone in both samples could indicate that this compound is not being efficiently removed by the WPA. Additionally, the TOCA continues to under-report TOC results compared to the archival samples even though the TOCA calibration checks meet their specifications. Monitoring these water quality parameters should continue to assess whether additional maintenance is needed.

As mentioned, the source of the TOC in the potable samples was primarily DMSD (2.4 mg/L in both samples). Methyl sulfone, another minor contributor to the TOC, was significantly higher in the Ambient sample (0.31 mg/L) than during Increment 53 (101-151 µg/L) and the historical average for both ports (59-75 µg/L). Methyl sulfone in the Hot sample was detected at a concentration of 0.17 mg/L. Although the concentration of this compound has been trending upward over the past several increments, levels are still well below the SWEG of 1,500 mg/L. Silicon was also detected (0.76-0.91 mg/L) at levels typically seen when DMSD is present in the water. Nickel (6 µg/L in both samples) and barium (2 µg/L in the Hot sample) were found at concentrations consistent with previous samples.

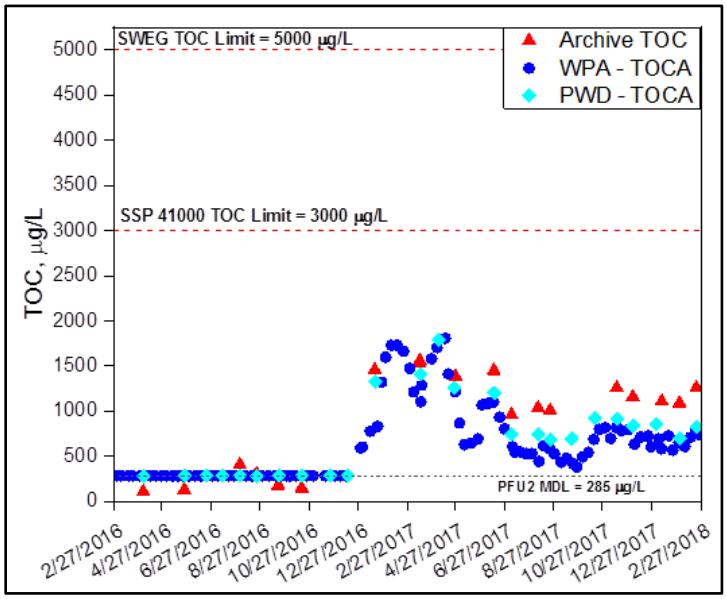

Figure 5. Total Organic Carbon (TOC) trending in US Potable Water

Iodine is a biocide used on the US segment. It is added to the water produced by the WPA, but removed prior to crew consumption to avoid potential thyroid dysfunction. The total iodine level in the samples collected from the PWD were below the reporting limit (0.05 mg/L), indicating effective removal of iodine in water intended for consumption. For additional information regarding microbial analyses, please see the Increment 54 post-flight report issued by the JSC Environmental Microbiology Laboratory.

Product Water

The TOC concentration measured in the PWD Auxiliary Port sample was 1.11 mg/L which is slightly lower than the previous Auxiliary Port sample (1.56 mg/L) collected during Increment 50. DMSD (2.4 mg/L) was detected at a level similar to Increment 54 potable water levels (2.4-3.0 mg/L) and lower than the Increment 50 Aux Port sample (4.8 mg/L). Nickel was present at a concentration (0.164 mg/L) slightly higher than the historical average (0.119 mg/L), suggesting that stagnant water in the tubing feeding into the Aux Port may not have been adequately flushed prior to sample collection. Although this water is not meant for consumption, these compounds do not pose a toxicological risk at these concentrations.

Condensate

The condensate sample collected on 1/29/2018 contained a TOC level of 131 mg/L, which is below the historical average (162 mg/L). These results are consistent with AQM results indicating that ISS air quality was well managed for the increment. Non-metal compounds detected at levels greater than 1 mg/L included DMSD (70 mg/L), ammonium (58 mg/L), silicon (25.5 mg/L), benzoic acid (2.17 mg/L), benzyl alcohol (2.55 mg/L), diethylpthalate (1.2 mg/L), 2-(2-Butoxyethoxy)ethanol, (3.1 mg/L), 2-Phenoxyethanol, (3.2 mg/L), acetone (4.09 mg/L), ethanol (35.8 mg/L), methanol (6.16 mg/L), ethylene glycol (7.96 mg/L), propylene glycol (31.3 mg/L), acetate (2.67 mg/L), and glycolate (6.4 mg/L). Concentrations for these compounds were nominal, except for glycolate, which was detected at the highest level ever measured in an ISS sample. Zinc (3.04 mg/L), nickel (0.32 mg/L), boron (0.17 mg/L), and traces of other metals were also present in this non-potable sample. All of these compounds were effectively removed by the WRS, as evidenced by the low or undetectable levels in the potable samples.

Wastewater

The wastewater sample, collected on 1/29/2018, contained a TOC level of 16.6 mg/L, which is well below the historical average of 44.6 mg/L, but only slightly higher compared to the most recent wastewater sample

(10.6 mg/L) collected on 10/30/17. The DMSD concentration was 20 mg/L, which was similar to the previous wastewater sample (17 mg/L). Non-metal compounds detected at levels greater than 1 mg/L included ammonium (15.9 mg/L) and silicon (8.23 mg/L). Metals detected above 0.1 mg/L in the samples were zinc (0.82 mg/L), nickel (0.32 mg/L), and iron (0.13 mg/L). Traces of other metals, including manganese 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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Date

Enclosures

Table 1A: Analytical concentrations of compounds quantified in the mGSC returned on SpaceX-13

Table 1B: Analytical concentrations of compounds quantified in mGSCs returned on SpaceX-14

Table 2A: T-values corresponding to concentrations for the SpX-13 Ingress sample in Table 1A, based on 7-day and 180-day SMACs

Table 2B: T-values corresponding to concentrations in Table 1A, based on 180-day SMACs

Table 2C: T-values corresponding to concentrations in Table 1B, based on 180-day SMACs

Table 3: Analytical concentrations of compounds quantified in US potable and product water samples returned on Soyuz 52 and SpX-13

Table 4: Analytical concentrations of compounds quantified in wastewater and condensate samples returned on SpX-14

TABLE 1A
ANALYTICAL RESULTS OF SPACEX-13 RETURN AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M3)		
	AQ180016 SN2079 SpaceX-13 Ingress 12/17/17 @ 18:11 GMT	**AQ180017 SN2082 LAB 01/02/18 @ 12:00 GMT**	**AQ180018 SN2080 JPM 01/02/18 @ 11:53 GMT**
TARGET COMPOUNDS (TO-15) **			
Propane	<0.025	TRACE	<0.025
Methanol *	**0.39**	**0.43**	**0.48**
Acetaldehyde	0.13	0.37	0.36
2-Methyl-1-propene	<0.025	TRACE	TRACE
Ethanol *	**1.3**	**7.3**	**8.1**
Acetone	0.21	0.40	0.42
2-Propanol (Isopropanol)	0.77	0.33	0.37
Isoprene (2-Methyl-1,3-butadiene)	<0.025	TRACE	TRACE
Methyl acetate	<0.025	TRACE	TRACE
1-Propanol	<0.025	0.026	0.028
Trimethylsilanol	0.05	0.082	0.11
1-Butanol	0.029	0.043	0.045
Pentanal	0.052	0.060	0.037
Hexanal	0.067	0.11	0.14
Decamethylcyclopentasiloxane	<0.175	0.22	0.25
Octafluoropropane (Perfluoropropane) *	**107**	**354**	**360**
SPECIAL INTEREST COMPOUNDS ***			
Hexamethylcyclotrisiloxane #	<0.20	0.22	0.24
NON-TARGET COMPOUNDS ***			
Dodecafluoropentane	0.19	<0.050	0.47
TOTAL ALCOHOLS PLUS ACETONE	**2.7**	**8.5**	**9.4**
TARGET COMPOUNDS (GC) **			
Methane	7.6	9.9	10
Carbon dioxide	2200	6000	6400
Hydrogen	1.6	4.1	4.1
Carbon monoxide	2.1	1.3	1.3
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**110**	**364**	**371**
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**3.2**	**9.6**	**11**

* 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

TABLE 1B
ANALYTICAL RESULTS OF SPACEX-14 RETURN

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3) AQ180133 SN2083 LAB 02/27/18 @ 18:36 GMT
TARGET COMPOUNDS (TO-15) **	
Methanol	0.89
Acetaldehyde	0.44
Ethanol	8.9
Acetone	0.66
2-Propanol (Isopropanol)	0.43
Octafluoropropane (Perfluoropropane) *	**273**
SPECIAL INTEREST COMPOUNDS	
The Special Interest Compound was below its reporting limit.	
NON-TARGET COMPOUNDS	
All Non-Target Compounds were below their reporting limit.	
TOTAL ALCOHOLS PLUS ACETONE	**11**
TARGET COMPOUNDS (GC) **	
Methane	11
Carbon dioxide	5700
Hydrogen	4.0
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**284**
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**11**

* GC/FID data results are in bold

** Quantified using a multi-point calibration

OFP - Octafluoropropane

TABLE 2A
SPACEX-13 INGRESS T-VALUES

CHEMICAL CONTAMINANT	T-VALUE	
	7-d SMAC	180-d SMAC
	AQ180016 SN2079 SpaceX-13 Ingress 12/17/17 @ 18:11 GMT	AQ180016 SN2079 SpaceX-13 Ingress 12/17/17 @ 18:11 GMT
TARGET COMPOUNDS (TO-15)		
Methanol	0.00434	0.00434
Acetaldehyde	0.03207	0.03207
Ethanol	0.00066	0.00066
Acetone	0.00399	0.00399
2-Propanol (Isopropanol)	0.00512	0.00512
Trimethylsilanol	0.01129	0.01129
1-Butanol	0.00036	0.00073
Pentanal	0.00291	0.00291
Hexanal	0.00333	0.00333
Octafluoropropane (Perfluoropropane)	0.00126	0.00126
SPECIAL INTEREST COMPOUNDS		
Hexamethylcyclotrisiloxane was below the reporting limit		
NON-TARGET COMPOUNDS		
Dodecafluoropentane	0.00064	0.00064
TARGET COMPOUNDS (GC)		
Methane	0.00218	0.00218
Carbon dioxide	0.16567	0.16567
Hydrogen	0.00476	0.00476
Carbon monoxide	0.03332	0.12348
TOTAL T-VALUE	**0.10622**	**0.19674**

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

TABLE 2B
T-VALUES FOR SPACEX-13 RETURN

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)	
	AQ180017 SN2082 LAB 01/02/18 @ 12:00 GMT	**AQ180018 SN2080 JPM 01/02/18 @ 11:53 GMT**
TARGET COMPOUNDS (TO-15)		
Propane	0.00227	ND
Methanol	0.00473	0.00536
Acetaldehyde	0.09283	0.09006
2-Methyl-1-propene	0.00054	0.00054
Ethanol	0.00364	0.00405
Acetone	0.00767	0.00808
2-Propanol (Isopropanol)	0.00217	0.00248
Isoprene (2-Methyl-1,3-butadiene)	0.00417	0.00417
Methyl acetate	0.00010	0.00010
1-Propanol	0.00027	0.00028
Trimethylsilanol	0.02054	0.02873
1-Butanol	0.00108	0.00114
Pentanal	0.00334	0.00206
Hexanal	0.00543	0.00713
Decamethylcyclopentasiloxane	0.01495	0.01643
Octafluoropropane (Perfluoropropane)	0.00417	0.00423
SPECIAL INTEREST COMPOUNDS		
Hexamethylcyclotrisiloxane	0.02493	0.02627
NON-TARGET COMPOUNDS		
Dodecafluoropentane	ND	0.00160
TARGET COMPOUNDS (GC)		
Methane	0.00284	0.00287
Carbon dioxide	0.45931	0.49406
Hydrogen	0.01219	0.01214
Carbon monoxide	0.07519	0.07505
TOTAL T-VALUE	**0.28307**	**0.29279**

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

TABLE 2C
T-VALUES FOR SPACEX-14 RETURN

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC) AQ180133 SN2083 LAB 02/27/18 @ 18:36 GMT
TARGET COMPOUNDS (TO-15)	
Methanol	0.00989
Acetaldehyde	0.11107
Ethanol	0.00445
Acetone	0.01277
2-Propanol (Isopropanol)	0.00286
Octafluoropropane (Perfluoropropane)	0.00321
SPECIAL INTEREST COMPOUNDS	
Hexamethylcyclotrisiloxane was below its reporting limit.	
NON-TARGET COMPOUNDS	
All Non-Target Compounds were below their reporting limit.	
TARGET COMPOUNDS (GC)	
Methane	0.00322
Hydrogen	0.01186
TOTAL T-VALUE	**0.15932**

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]: Normal detection limits could not be obtained due to the low initial sample pressure.

Table 3: Analytical concentrations of compounds quantified in US potable and product water samples returned on Soyuz 52 and SpX-13

Increment					54		
Mission					SpaceX-13	Soyuz 52	
Sample Location					WPA PWD Aux Port	WPA PWD Ambient	WPA PWD Hot
Sample Description					WPA Product Water	Potable Water	Potable Water
Sample Date					1/9/2018	1/31/2018	2/21/2018
Analysis/Sample ID	Units	Test Conducted by	Potable Water Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	WQ180013	WQ180086	WQ180087
Physical Characteristics							
Conductivity	µS/cm	U.S.			NA	2	2
pH	pH units	U.S.	4.5-8.5	41000	NA	7.08	6.33
Iodine LCV							
Iodide	mg/L	U.S.			0.71	< 0.05	< 0.05
Iodine	mg/L	U.S.			1.16	< 0.05	< 0.05
Total I	mg/L	U.S.	6/0.2	41000 (tl I max/tl I at pt of consumption)	1.88	< 0.05	< 0.05
Minerals ICPMS							
Calcium	mg/L	U.S.	30	41000	< 0.05	0.01	0.01
Potassium	mg/L	U.S.	340	41000	< 0.05	0.02	< 0.01
Trace Metals ICPMS							
Barium	µg/L	U.S.	10,000	SWEG&41000	< 5	< 1	2
Nickel	µg/L	U.S.	300	SWEG&41000	164	6	6
Silicon ICPMS							
Silicon	µg/L	U.S.			666	756	908
Total Organic Carbon-Sievers & Total Organic Carbon-OI							
Total Inorganic Carbon (TIC)	mg/L	U.S.			0.50	0.91	0.90
Total Organic Carbon (TOC)	mg/L	U.S.		SWEG / 41000	1.11	1.09	1.26
Semi-volatile Organics-Targets							
Methyl sulfone	µg/L	U.S.	1,500,000	interim SWEG (06-2017)	NA	307	168
Silanols LCRI (Semi-Quantitative-NIST traceable standard not available)							
Dimethylsilanediol (DMSD)	µg/L	U.S.	35,000	SWEG	2,400	2,400	3,000
Organic Carbon Recovery	percent	U.S.			N/A	64.50	65.40
Unaccounted Organic Carbon	mg/L	U.S.			N/A	0.39	0.44

Comments: WQ180013: Sample labeled as potable water, but sample schedule indicates product water.
Data Qualifiers: None.

Table 4: Analytical concentrations of compounds quantified in wastewater and condensate samples returned on SpX-14

Increment					54	
Mission					SpaceX-14	
Sample Location					WPA Wastewater ORU	WPA Condensate Sample Port
Sample Description					WPA Wastewater	US Condensate
Sample Date					1/29/2018	1/29/2018
Analysis/Sample ID	Units	Test Conducted by	Potable Water Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	WQ180291	WQ180292
Physical Characteristics						
Conductivity	µS/cm	U.S.			96	370
pH	pH units	U.S.	4.5-8.5	41000	7.49	7.72
Anions IC						
Fluoride	mg/L	U.S.			0.3	0.6
Cations IC						
Ammonium (as N)	mg/L	U.S.	1	SWEG&41000	15.9	58.0
Minerals ICPMS						
Calcium	mg/L	U.S.	30	41000	0.07	0.14
Potassium	mg/L	U.S.	340	41000	0.08	0.02
Sodium	mg/L	U.S.			0.08	< 0.02
Trace Metals ICPMS						
Aluminum	µg/L	U.S.			7	9
Boron	µg/L	U.S.			45	172
Chromium	µg/L	U.S.	230	41000	17	3
Copper	µg/L	U.S.	1,000	41000	2	< 2
Iron	µg/L	U.S.	300	41000	134	< 10
Manganese	µg/L	U.S.	300	SWEG&41000	79	13
Nickel	µg/L	U.S.	300	SWEG&41000	320	323
Silver	µg/L	U.S.	400	SWEG&41000	9	5
Zinc	µg/L	U.S.	2,000	SWEG&41000	823	3,040
Silicon ICPMS						
Silicon	µg/L	U.S.			8,230	25,500
Total Organic Carbon-Sievers & Total Organic Carbon-OI						
Total Inorganic Carbon (TIC)	mg/L	U.S.			10.5	32.6
Total Organic Carbon (TOC)	mg/L	U.S.		SWEG / 41000	16.6	131
Volatile Organics-Special Interest Compounds (Semi-quantitative)						
Trimethylsilanol	µg/L	U.S.			110	260
Volatile Organics-Non-Targets (estimated conc.)						
Dimethyl sulfide	µg/L	U.S.			not found	93
Semi-volatile Organics-Targets						
Benzothiazole	µg/L	U.S.			57	78
Decamethylcyclopentasiloxane (DMCPS)	µg/L	U.S.			144	164
Dodecamethylcyclohexasiloxane	µg/L	U.S.			107	90
Methyl sulfone	µg/L	U.S.	1,500,000	interim SWEG (06-2017)	222	369
N-n-Butylbenzenesulfonamide	µg/L	U.S.			95	134
Tris(2-Chloroethyl)phosphate	µg/L	U.S.			< 40	137
Acid Extractables-EPA 625 List GCMS						
Benzoic acid	µg/L	U.S.			< 200	2,170
Phenol	µg/L	U.S.	4,000	SWEG	< 40	409
Base and Neutral Extractables-EPA 625 List GCMS						
Benzyl alcohol	µg/L	U.S.			< 40	2,550
Di-n-butylphthalate	µg/L	U.S.	40,000	SWEG	< 40	105
Diethylphthalate	µg/L	U.S.			449	1,200
Semi-volatile Organics-Special Interest Compounds (Semi-quantitative)						
1,3,5-Triallyl-1,3,5-triazine-2,4,6(1H,3H,5H)-trione	µg/L	U.S.			49	130
1-Methyl-2-pyrrolidinone	µg/L	U.S.			not found	840
2-(2-Butoxyethoxy)ethanol	µg/L	U.S.			not found	3,100
2-Butoxyethanol	µg/L	U.S.			not found	160
2-Ethoxyethanol	µg/L	U.S.			not found	360
2-Ethyl-1-hexanol	µg/L	U.S.			not found	200
2-Methyl-2,4-pentanediol	µg/L	U.S.			not found	130
2-Phenoxyethanol	µg/L	U.S.			not found	3,200
2-Phenyl-2-propanol	µg/L	U.S.			99	210
Acetophenone	µg/L	U.S.			not found	24
Benzaldehyde	µg/L	U.S.			not found	68
Butylated hydroxyanisole (BHA)	µg/L	U.S.			150	220
Diethylene glycol monoethyl ether	µg/L	U.S.			140	220
Dipropylene glycol methyl ether	µg/L	U.S.			230	840
Monomethyl phthalate	µg/L	U.S.			67	260
N,N-Diethylformamide	µg/L	U.S.			not found	65
N,N-Dimethyl acetamide	µg/L	U.S.			220	940
N,N-Dimethylformamide	µg/L	U.S.			300	680
Neomenthol	µg/L	U.S.			not found	64
Phenethyl alcohol	µg/L	U.S.			not found	36
Tetramethyl thiourea	µg/L	U.S.			not found	30
Tributyl phosphate	µg/L	U.S.			53	69
Alcohols & Acetone GCMS						
2-Propanol (Isopropanol)	µg/L	U.S.			< 400	668
Acetone	µg/L	U.S.	15000	SWEG	< 50	4,090
Ethanol	µg/L	U.S.			< 400	35,800
Methanol	µg/L	U.S.	40,000	SWEG	< 400	6,160
Glycols GCMS						
1,2-Ethanediol (Ethylene glycol)	µg/L	U.S.	4000	SWEG	< 1000	7,960
1,2-Propanediol (Propylene glycol)	µg/L	U.S.	1,700,000	SWEG	< 1000	31,300
Silanols LCRI (Semi-Quantitative-NIST traceable standard not available)						
Dimethylsilanediol (DMSD)	µg/L	U.S.	35,000	SWEG	20,000	70,000
Carboxylates IC						
Acetate	µg/L	U.S.			< 500	2,670
Glycolate	µg/L	U.S.			< 1000	6,400
Aldehydes GCMS						
Formaldehyde	µg/L	U.S.	12,000	SWEG	< 10	15
Organic Carbon Recovery	percent	U.S.			39.34	57.71
Unaccounted Organic Carbon	mg/L	U.S.			10.07	55.40

Comments: None

Data Qualifiers: WQ180291& WQ180292: Fluoride possible low bias (MS Rec. 65%).