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SUBJECT: Toxicological Assessment of ISS Air and Water Quality: March 14, 2019 – June 24, 2019 (Increment 59)

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

AIR QUALITY

Six archive air samples were collected in mini grab sample containers (mGSCs) on ISS during Increment 59; two each on March 26, May 14, and June 10, 2019. The March and May samples were returned on SpX-17 while the June samples were returned on SpX-18. Two sets of formaldehyde badges were returned on 57S, providing formaldehyde data for the US Lab and Russian Service Module (SM) for the sample dates in March and May. Formaldehyde badges were also deployed on June 10, 2019, but the badges were not analyzed as they were from a lot that had previously been determined to be unreliable.

Table 1. Analytical summary of ISS air analyses (Increment 59)

Return Flight	Sample Location	Sample Date	Freon 218 (mg/m^3)	Alcohols[a] (mg/m^3)	T-Value[b] (units)	Formaldehyde ($\mu g/m^3$)
SpaceX-17	Lab	3/26/2019	34	4.3	0.2	34
SpaceX-17	Columbus	3/26/2019	34	4.5	0.2	23[c]
SpaceX-17	NG-11 Ingress	4/19/2019	6.6	2.2	0.3 (0.1)	--
SpaceX-17	SpX-17 Ingress	5/6/2019	3.8	3.0	0.4 (0.1)	--
SpaceX-17	Lab	5/14/2019	28	5.8	0.1	32
SpaceX-17	SM	5/14/2019	27	5.1	0.1	16
SpaceX-18	Lab	6/10/2019	29	6.7	0.5	--
SpaceX-18	JEM	6/10/2019	28	6.5	0.5	--
Guideline			—	*<5*	*<1*[d]	*<120*

[a] Includes acetone
[b] Sum of the ratios of the measured concentrations and the corresponding 180-day SMAC for each compound,; parenthesis indicate value based on 7-day SMACs and applicable to first ingress
[c] Formaldehyde sample only was taken in Russian SM
[d] T-value <1 used to evaluate routine monthly sampling; <3 used to evaluate first ingress
Note: All formaldehyde badges were returned on Soyuz 57.

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, which include compounds assessed but not detected, are available upon request. Pressure readings for the mGSCs indicate that all

samples in Increment 59 were reliable. The mean relative recoveries of the three surrogate standards from the mGSC samples returned on SpX-17 and -18 were all within acceptable limits.

On-orbit, the Air Quality Monitors (AQMs) automatically collect and analyze samples 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	March Average	April Average	May Average	June Average	Increment Average
2-Propanol	3.0	0.3	MI	MI	1.6
Acetone	0.2	0.2	0.3	0.3	0.3
Acrolein	ND	ND	ND	TRACE	ND
Benzene	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND
Decamethylcyclopentasiloxane#	0.5	0.6	TRACE	TRACE	0.1
Hexanal	TRACE	TRACE	ND	ND	ND
Hexane	ND	ND	ND	ND	ND
m,p-Xylenes#	ND	ND	ND	ND	ND
Methanol	0.2	0.2	0.2	0.2	0.2
o-Xylene#	0.04	0.2	ND	ND	TRACE
Octamethylcylcotetrasiloxane#	TRACE	TRACE	ND	ND	TRACE
Toluene#	0.03	0.04	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND
Acetaldehyde	0.4	0.4	0.3	0.2	0.3
Dichloromethane	ND	ND	ND	ND	ND
Ethanol	3.0	3.2	2.2	1.3	2.4
Ethyl Acetate	ND	ND	ND	ND	ND
Hexamethycyclotrisiloxane#	0.2	0.2	TRACE	TRACE	0.1
n-Butanol	0.1	0.1	ND	ND	ND
Trimethylsilanol	0.1	0.1	ND	ND	ND

ND: Not detected; <MDL (Minimum Detection Limit)
TRACE: >MDL, <MQL (Minimum Quantification Limit)
MI: matrix interference

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 mGSC and formaldehyde samples for this Increment that returned on SpX-17, SpX-18, and 57S confirmed air quality was acceptable. **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 nominal Increment 59 mGSC samples was 0.3 (Figure 1). T-values increased slightly in samples collected in June 2019. The increase is attributable to higher levels of HMCTS and a trace amount of acrylonitrile that was below the level of quantitation. T-values calculated from GSC results (Figure 1) and AQM (Figure 2) were in reasonable agreement given the differences between the analytical techniques and the number of target compounds used in the calculation.

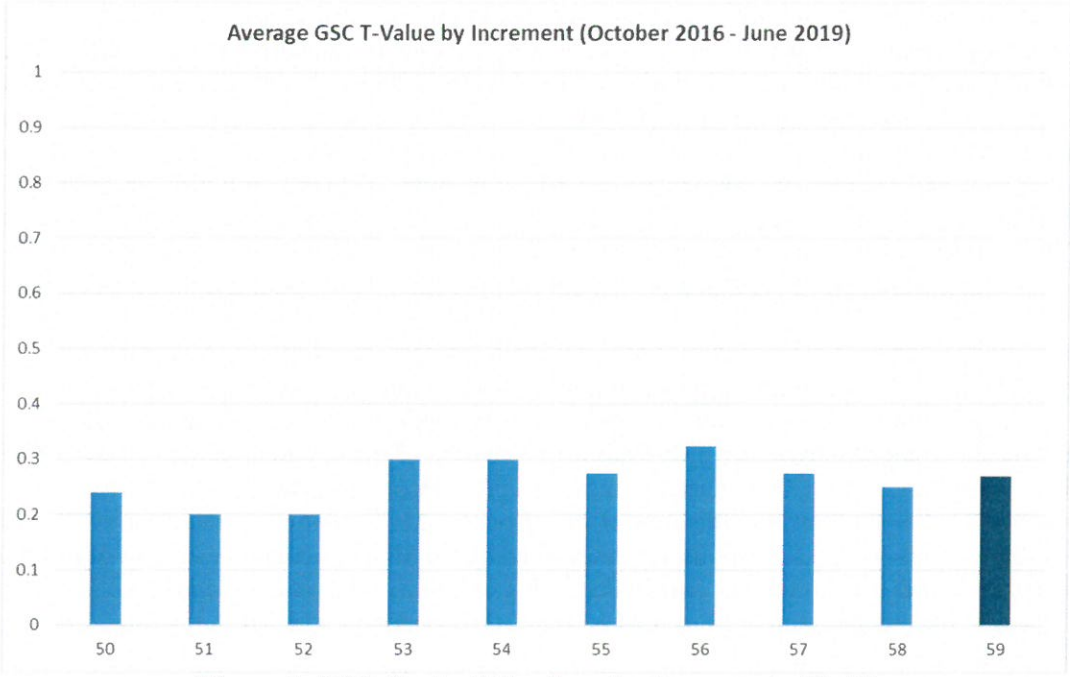

Figure 1. GSC-Derived T-values for Increments 50- 59

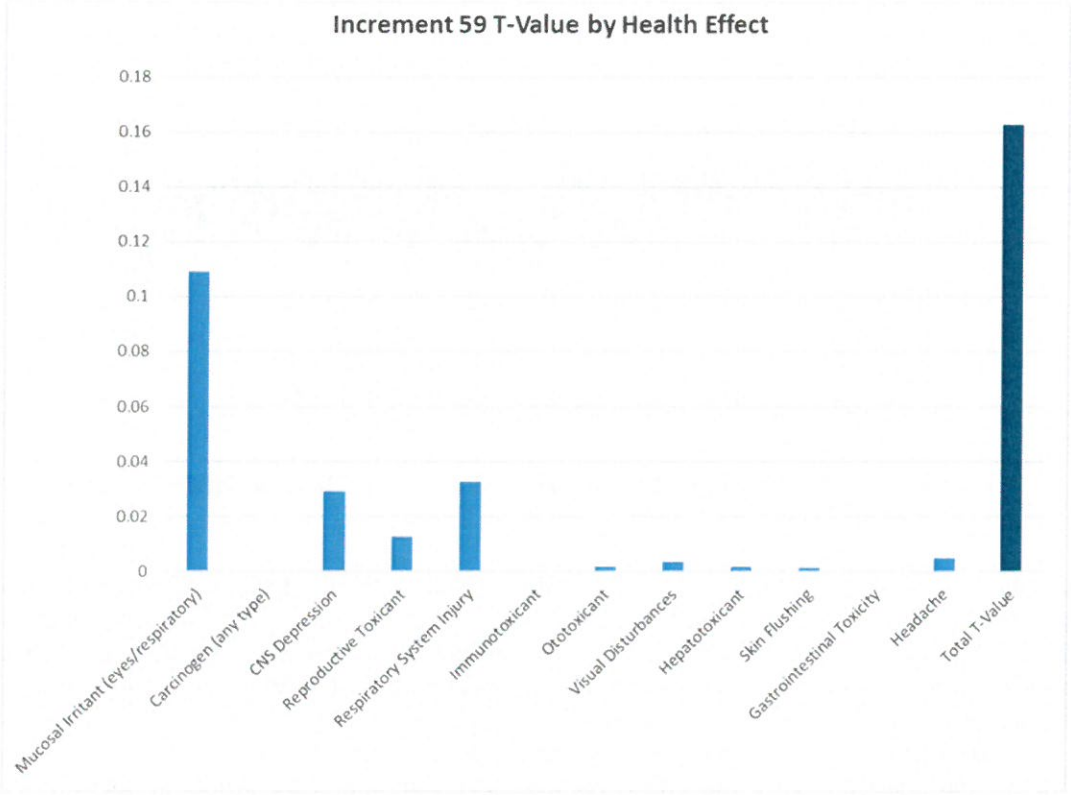

Figure 2. AQM-Derived T-Values by Health Effect for Increment 59

Generally, the reported concentrations for the compounds detected during Increment 59 are similar to levels detected during recent Increments. The concentration of 2-propanol measured on the AQMs in March 2019 is a notable exception. This issue is discussed in detail in TOX-SW-2019-03, Toxicological Assessment of Air Samples Collected During the SpaceX Dragon 2 Demo-1 Mission (March 3-7, 2019). Atmospheric concentrations of siloxanes (i.e., HMCTS, OMCTS) were similar to those observed during Increment 58 in the March and May samples but were markedly higher in June. This increase was not observed in AQM data from this period, which suggests this was due to a transient, isolated event. Levels of several analytes (DMCPS, trimethylsilanol, and n-butanol) fell in May on both AQM and mGSC samples. This could be associated with installation of combination charcoal/HEPA filters in Node 2 and Node 3 in April 2019.

The four mGSC samples from March and May 2019 contained a CO_2 concentration below the limit documented in Chit 14468, which requests that the 24 hour average concentration not exceed 3.0 mmHg (7300 mg/m^3) on the US segment. The reported CO_2 concentration from the sample collected in the JEM on June 10, 2019 slightly exceeded this limit at 3.3 mmHg (7700 mg/m^3). 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. However, the archive sample from JEM on June 10 is consistent with MCA readings above 3.0 mmHg in early to mid-June.

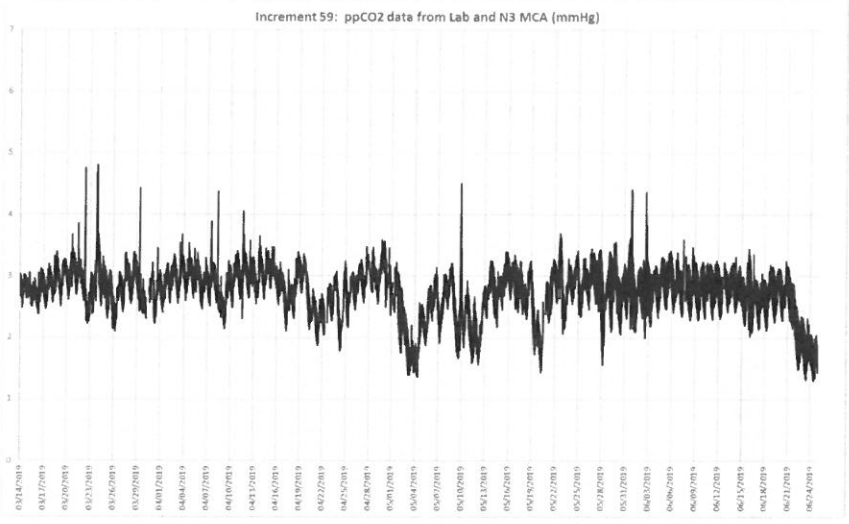

Figure 3. Environmental CO_2 Concentrations on ISS Increment 59 in mmHg

CO_2 data during March were obtained from both MCAs (Node 3 and the Lab), in alternating fashion. Data for April through June were obtained from the Node 3 MCA. Overall, CO_2 concentrations were well-controlled throughout the Increment (Figure 3). CO_2 levels have historically been maintained between 1.5 and 2 mmHg with 3-person crew and closer to the 3 mmHg limit with 6 crew. Excursions above 4 mmHg occurred as a result of EVA activity on March 22, March 29, and April 7, 2019. Additional excursions above 4 mmHg were observed on March 8, March 23, May 9, May 31, and June 2, 2019 during MetOx regeneration. On April 11, 2019, the MCA was exclusively sampling the airlock to monitor a breathing experiment involving the crew; the CO_2 concentration gradually rose above 4 mmHg and a LiOH canister was activated. Vozdukh on the Russian segment underwent repairs on April 15-19, and CO_2 levels

decreased following reactivation. Another downward trend was observed in late April following activation of the Thermal Amine Scrubber (TAS) technology demonstration. During May, the Carbon Dioxide Removal Assemblies (CDRAs) were deactivated for most of the month, as CO_2 levels were controlled using the TAS and the European Life Support Rack (LSR). The CDRA in the US Lab was activated on June 21, 2019, causing a drop in levels below 2 mmHg.

Alcohol values in the May and June 2019 routine archive samples returned on SpaceX-16 exceeded the guideline of <5 mg/m^3, which is intended to protect the water recovery system from risk of overloading. Total alcohol levels are primarily attributable to ethanol in the ISS atmosphere. Levels of total alcohols have been fluctuating over the last two Increments (58-59). Measured levels do not present a risk to crew health, but could adversely impact the lifetime of consumables in the water recovery system. This trend will continue to be monitored.

Three sets of passive formaldehyde badges were deployed on ISS during Increment 59 (on March 26, May 14, and June 10, 2019). Analytical and sampling issues created a data gap in formaldehyde monitoring that spanned from May until December 2018. Results from the Increment 59 badges deployed in March and May indicated that formaldehyde remains in the historical range observed on ISS, and concentrations were well below the SMAC of 120 µg/m^3 (Figure 4). As noted above, the badges deployed in June were not analyzed as they were from a lot that had previously been determined to be unreliable. The concentration in the SM ranged from 16-28 µg/m^3 and the range in the US Lab was 32-43 µg/m^3, similar to the ranges observed in Increment 58.

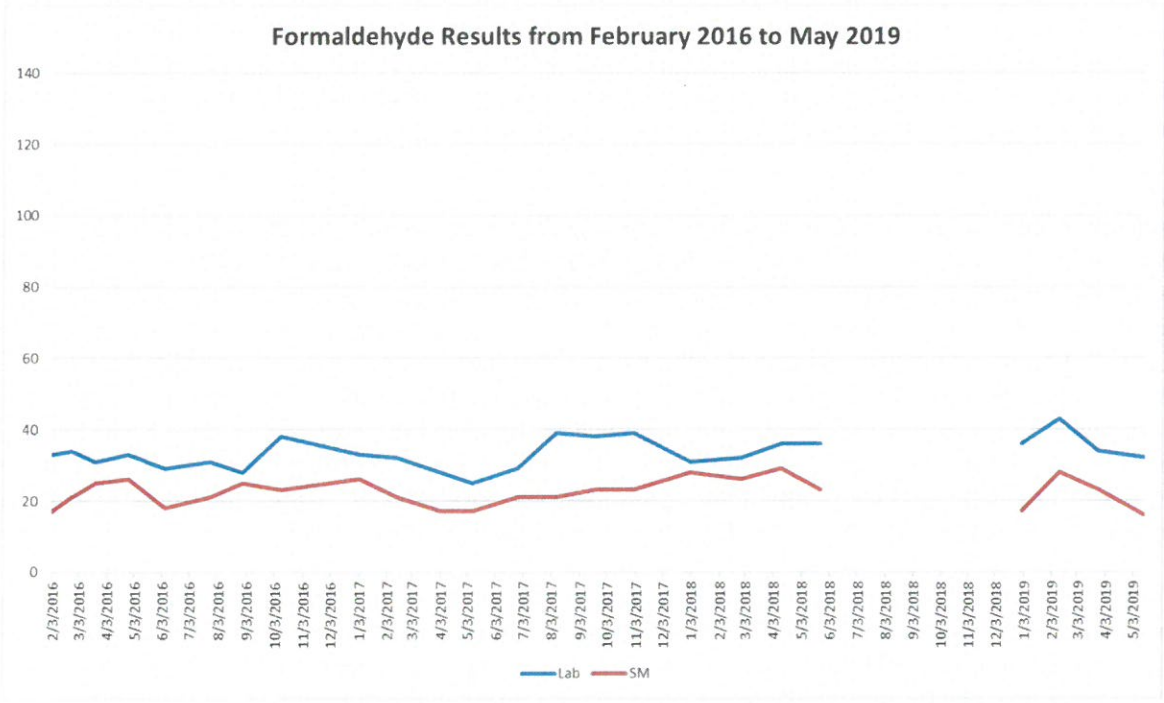

Figure 4. Trends in Formaldehyde (µg/m^3) in ISS Air from Passive Sampling of US Lab and Russian Service Module from February 2016 through May 2019

WATER QUALITY

Two water samples were collected from the US Potable Water Dispenser (PWD) during Increment 59: ambient water on May 6 and hot water on June 5, 2019. Samples of Multifiltration (MF) bed effluent, Water Processor Assembly (WPA) wastewater, US condensate, and JEM condensate were also collected during the Increment. Complete data tables with results for all measured parameters are available upon request. A summary of select analytical results from the Increment 58 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 (Increment 59)

Return Mission	Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	Methyl Sulfone (mg/L)	Conductivity (µS/cm)	Total Iodine (mg/L)
SpaceX-17	MF Bed Effluent	4/15/2019	38.2	15	0.2	36	NA
SpaceX-17	WPA Wastewater	4/17/2019	45.0	15	0.4	152	NA
Soyuz-57	PWD Ambient	5/6/2019	1.21	3	0.2	1	< 0.05
SpaceX-17	US Condensate	5/14/2019	27.4	17	0.2	220	NA
SpaceX-17	JEM Condensate[a]	5/24/2019	99.7	40	0.1	250	NA
Soyuz-57	PWD Hot	6/5/2019	1.71	3	0.1	2	< 0.05

NA: not analyzed
[a] composite sample

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. Typically, archive water samples are also 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 June 2016 and June 2019 are shown in Figure 5. Dimethylsilane diol (DMSD) was the primary compound responsible for TOC in both potable water samples. The TOC concentration in the two potable samples were similar to those observed in Increment 57, and well below both the specification for the US segment (<3 mg/L) and the 100-day SWEG (5 mg/L) (Note: no samples of potable water were taken during Increment 58). **Based on results from analyses run on TOCA and from ground-based analysis, the water produced by the Water Processor Assembly (WPA) met the US potability requirement for TOC.**

Methyl sulfone was detected in the potable water samples at levels consistent with those observed in Increment 57 and well below the SWEG of 1,500 mg/L. Silicon was also detected in both samples at levels (0.8-1 mg/L) similar to the most recent results (0.9-1.1 mg/L in Increment 57). Essentially all of the measured silicon can be attributable to the presence of DMSD in the samples.

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 potable samples collected from the PWD was below the reporting limit (0.05 mg/L), indicating effective removal of iodine in water intended for consumption. For additional information regarding microbial analyses, see the Increment 59 post-flight report generated by the JSC Environmental Microbiology Laboratory.

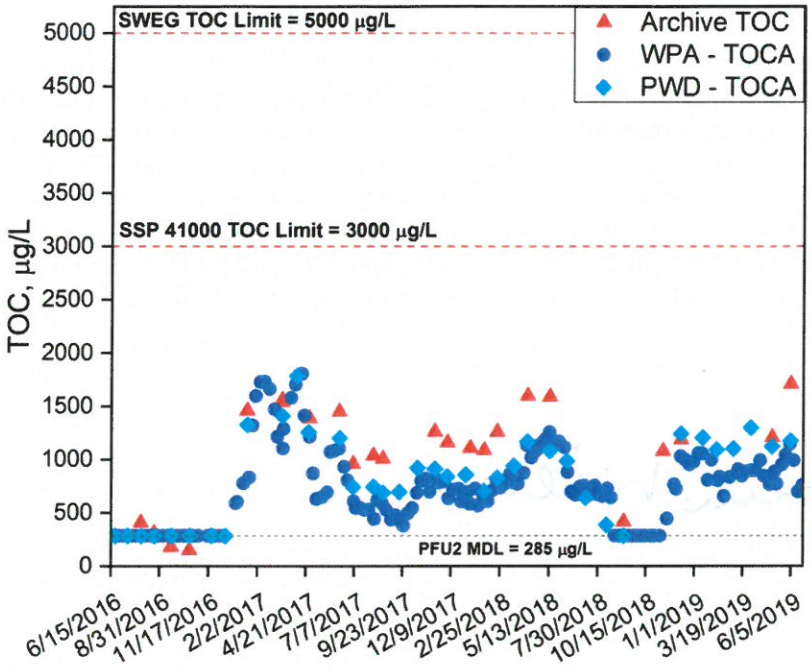

Figure 5. Total Organic Carbon (TOC) trending in US Potable Water

MF Bed Effluent

MF bed effluent was sampled on April 15, 2019 as part of an effort to identify the species responsible for the increasing conductivity at the MF Bed outlet. This sample was returned in a Ziploc bag that was wrapped in aluminum tape to minimize diffusion of CO_2 through the Teflon sample bag. The TOC concentration in this sample was 38.2 mg/L. The accountability for TOC in the MF bed effluent was >94.5%. Organic compounds present at concentrations greater than 0.5 mg/L in the sample include acetate (38.2 mg/L), DMSD (15 mg/L), ethanol (12.3 mg/L), propionate (8.5 mg/L), acetone (3.2 mg/L), methanol (2.9 mg/L), and isopropanol (2.9 mg/L), 1-propanol (0.5 mg/L), and 2-butanol (0.5 mg/L). Silicon was present at 4.6 mg/L, which is attributable to DMSD. Trace metals detected in this sample included zinc (67 µg/L), boron (18 µg/L), nickel (16 µg/L), and aluminum (6 µg/L). Ammonium, which is a used an indication that the MF Bed had reached end of life, was not detected in the sample.

WPA Wastewater

A sample was collected from the WPA Wastewater ORU on April 17, 2019. The TOC concentration was 45 mg/L, which is close to the historical average of 44.0 mg/L. Organic compounds detected at or above 1 mg/L include DMSD (15 mg/L), benzyl alcohol (12.9 mg/L), propylene glycol (10.0 mg/L), methanol (4.9 mg/L), acetone (3.9 mg/L), monomethylsilanetriol (MMST; 1.4 mg/L), ibuprofen (1.3 mg/L), ethylene glycol (1.2 mg/L), and caprolactam (1.1 mg/L). The silicon concentration was 4.9 mg/L, all of which can be accounted for by the presence of DMSD. Zinc (2.0 mg/L) was the only metal present at or above 1.0 mg/L.

US Condensate

A sample of condensate from the US segment was collected on May 14, 2019. The TOC concentration in the sample was 27.4 mg/L, and accountability for TOC was 90.3%. Organic compounds detected at or above 1 mg/L include DMSD (17 mg/L), isopropanol (11.1 mg/L), ethanol (9.5 mg/L), propylene glycol (6.2 mg/L), acetone (5.5 mg/L), methanol (3.4 mg/L), and ethylene glycol (1.1 mg/L). Silicon was present

at a concentration of 5.4 mg/L, which is accounted for by DMSD. Of the metals analyzed, only zinc was detected at levels above 0.1 mg/L (1.0 mg/L).

JEM condensate

A sample of condensate from the JEM was collected on May 24, 2019. The TOC concentration in the sample was 99.7 mg/L, significantly higher than the concentration measured in the US condensate sample. Organic compounds detected at or above 1 mg/L include DMSD (40 mg/L), acetate (25 mg/L), ethanol (24 mg/L), formate (9.2 mg/L), propylene glycol (8.0 mg/L), isopropanol (7.4 mg/L), acetone (6.6 mg/L), lactate (5.7 mg/L), caprolactam (4.1 mg/L), methanol (4.1 mg/L), ethylene glycol (2.9 mg/L), benzyl alcohol (2.8 mg/L), benzoic acid (1.6 mg/L), urea (1.3 mg/L), and palmitic acid (1.1 mg/L). Silicon was present at a concentration of 12.5 mg/L, which is accounted for by DMSD. Nickel (0.4 mg/L), boron (0.2 mg/L), calcium (0.1 mg/L), and manganese (0.1 mg/L) were detected at levels above 0.1 mg/L.

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Enclosures

Table 1A: Analytical concentrations of compounds quantified in the mGSC returned on SpaceX-17

Table 1B: Analytical concentrations of compounds quantified in the mGSC returned on SpaceX-18

Table 2A: T-values corresponding to concentrations for routine mGSC samples returned on SpaceX-17, based on 180-day SMACs

Table 2B: T-values corresponding to concentrations for ingress air samples returned on SpaceX-17, based on 7-day and 180-day SMACs

Table 2C: T-values corresponding to concentrations for routine mGSC samples returned on SpaceX-18, based on 180-day SMACs

Table 3A: Analytical concentrations of compounds quantified in potable ambient and hot water samples returned on Soyuz 57

Table 3B: Analytical concentrations of compounds quantified in MF bed effluent, WPA wastewater, US condensate, and JEM condensate returned on SpaceX-17

TABLE 1A
ANALYTICAL RESULTS FOR SPACEX-17 RETURN SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)					
	AQ190285 SN 2086 LAB 3/26/2019 @ 16:10 GMT	**AQ190286 SN 2089 COL 3/26/2019 @ 16:10 GMT**	**AQ190287 SN 2096 NG-11 Ingress 4/19/2019 @ 16:09 GMT**	**AQ190288 SN 2095 Dragon Module2 Ingress 5/6/2019 @ 17:57 GMT**	**AQ190289 SN 2094 LAB 5/14/2019 @ 12:40 GMT**	**AQ190290 SN 2093 SM 5/14/2019 @ 12:45 GMT**
TARGET COMPOUNDS (TO-15) *						
1,1,1,2-Tetrafluoroethane (Norflurane)	TRACE	0.053	0.075	0.11	0.10	0.076
Perfluoro(2-methylpentane)	<0.10	<0.10	<0.10	1.9	<0.10	<0.10
Propene	<0.025	<0.025	<0.025	<0.025	0.060	0.057
Propane	<0.025	<0.025	TRACE	TRACE	<0.025	TRACE
Isobutane	TRACE	TRACE	0.48	0.17	0.030	0.032
Methanol	0.26	0.23	0.30	0.33	0.28	0.31
Acetaldehyde	0.19	0.19	0.10	0.082	0.14	0.12
Ethanol	3.5	3.7	1.0	1.2	3.1	2.9
Acetone	0.27	0.28	0.14	0.17	0.28	0.27
2-Propanol (Isopropanol)	0.17	0.22	0.74	1.3	2.1	1.6
Isoprene (2-Methyl-1,3-butadiene)	0.034	0.037	<0.025	<0.025	<0.025	<0.025
Methylene chloride (Dichloromethane)	<0.025	<0.025	<0.025	0.036	<0.025	<0.025
Carbon disulfide	<0.025	<0.025	<0.025	<0.025	<0.025	TRACE
1-Propanol	0.036	0.034	<0.025	0.027	TRACE	<0.025
Trimethylsilanol	0.11	0.14	0.028	0.028	0.037	TRACE
Ethyl acetate	TRACE	TRACE	<0.025	<0.025	<0.025	<0.025
1-Butanol	0.054	0.061	0.030	0.030	TRACE	0.033
m & p-Xylene	<0.050	<0.050	<0.050	0.070	<0.050	<0.050
o-Xylene	<0.050	<0.050	<0.050	TRACE	<0.050	TRACE
Decamethylcyclopentasiloxane (DMCPS)	0.38	0.45	<0.175	<0.175	<0.175	<0.175
Octafluoropropane (Perfluoropropane)	34	34	6.6	3.8	28	27
SPECIAL INTEREST COMPOUNDS #						
Hexamethylcyclotrisiloxane	0.25	0.27	<0.20	<0.20	<0.20	<0.20
NON-TARGET COMPOUNDS **						
Sulfur hexafluoride	0.073	<0.050	<0.050	<0.050	<0.050	<0.050
TOTAL ALCOHOLS PLUS ACETONE	**4.3**	**4.5**	**2.2**	**3.0**	**5.8**	**5.1**
TARGET COMPOUNDS (GC) *						
Methane	27	26	7.8	21	50	51
Carbon dioxide	6900	6800	7000	3900	5900	6600
Hydrogen	4.6	4.5	1.2	2.3	4.6	4.8
Carbon monoxide	0.56	0.61	3.6	5.4	0.67	0.63

* 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; concentrations are estimates only.

< : Value is less than the laboratory reporting limit.

TRACE: Amount detected is sufficient for compound identification only.

TABLE 1B
ANALYTICAL RESULTS FOR SPACEX-18 RETURN AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)	
	AQ190523 S/N 2091 Lab 6/10/2019 @ 12:15	**AQ190524 S/N 2090 JEM 6/10/2019 @ 12:15**
TARGET COMPOUNDS (TO-15) *		
1,1,1,2-Tetrafluoroethane (Norflurane)	0.094	0.075
Propene	0.31	0.23
Propane	TRACE	TRACE
Carbonyl sulfide (Carbon oxide sulfide)	<0.025	TRACE
Chloromethane	0.040	0.033
Isobutane	0.031	TRACE
Methanol	0.39	0.32
Acetaldehyde	0.11	0.091
2-Methyl-1-propene	TRACE	TRACE
Ethanol	3.2	3.2
Acetone	0.36	0.27
2-Propanol (Isopropanol)	2.7	2.7
Acrylonitrile	TRACE	TRACE
Carbon disulfide	<0.025	TRACE
1-Propanol	TRACE	TRACE
Trimethylsilanol	0.033	0.032
1-Butanol	0.027	0.026
Octamethylcyclotetrasiloxane (OMCTS)	0.31	0.24
Decamethylcyclopentasiloxane (DMCPS)	0.27	0.25
Octafluoropropane (Perfluoropropane)	29	28
SPECIAL INTEREST COMPOUNDS #		
Hexamethylcyclotrisiloxane (HMCTS)	1.3	0.91
NON-TARGET COMPOUNDS **		
Freon 22	0.55	0.40
TOTAL ALCOHOLS PLUS ACETONE	6.7	6.5
TARGET COMPOUNDS (GC) *		
Methane	52	52
Carbon dioxide	7200	7700
Hydrogen	5.0	5.1
Carbon monoxide	1.1	0.96

* 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; concentrations are estimates only.

< : Value is less than the laboratory reporting limit.

TRACE: Amount detected is sufficient for compound identification only.

TABLE 2A
T-VALUES FOR SPACEX-17 RETURN SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)			
	AQ190285 SN 2086 LAB 3/26/2019 @ 16:10 GMT	**AQ190286 SN 2089 COL 3/26/2019 @ 16:10 GMT**	**AQ190289 SN 2094 LAB 5/14/2019 @ 12:40 GMT**	**AQ190290 SN 2093 SM 5/14/2019 @ 12:45 GMT**
TARGET COMPOUNDS (TO-15)				
1,1,1,2-Tetrafluoroethane (Norflurane)	0.000	0.000	0.000	0.000
Propene	ND	ND	0.000	0.000
Propane	ND	ND	ND	0.000
Isobutane	0.000	0.000	0.000	0.000
Methanol	0.003	0.003	0.003	0.003
Acetaldehyde	0.047	0.047	0.035	0.030
Ethanol	0.002	0.002	0.002	0.001
Acetone	0.005	0.005	0.005	0.005
2-Propanol (Isopropanol)	0.001	0.001	0.014	0.010
Isoprene (2-Methyl-1,3-butadiene)	0.011	0.012	ND	ND
Carbon disulfide	ND	ND	ND	0.011
1-Propanol	0.000	0.000	0.000	ND
Trimethylsilanol	0.028	0.034	0.009	0.003
Ethyl acetate	0.000	0.000	ND	ND
1-Butanol	0.001	0.002	0.000	0.001
o-Xylene	ND	ND	ND	0.001
Decamethylcyclopentasiloxane	0.026	0.030	ND	ND
Octafluoropropane (Perfluoropropane)	0.000	0.000	0.000	0.000
SPECIAL INTEREST COMPOUNDS				
Hexamethylcyclotrisiloxane	0.027	0.030	ND	ND
NON-TARGET COMPOUNDS				
Sulfur hexafluoride	0.000	ND	ND	ND
TARGET COMPOUNDS (GC)				
Methane	0.008	0.007	0.014	0.015
Hydrogen	0.014	0.013	0.014	0.014
Carbon monoxide	0.033	0.036	0.039	0.037
TOTAL T-VALUE	**0.2**	**0.2**	**0.1**	**0.1**

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 2B
T-VALUES FOR SPACEX-17 RETURN INGRESS SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (7- & 180-d)			
	7-d SMAC	180-d SMAC	7-d SMAC	180-d SMAC
	AQ190287 SN 2096 NG-11 Ingress 4/19/2019 @ 16:09 GMT	AQ190287 SN 2096 NG-11 Ingress 4/19/2019 @ 16:09 GMT	AQ190288 SN 2095 Dragon Module2 Ingress 5/6/2019 @ 17:57 GMT	AQ190288 SN 2095 Dragon Module2 Ingress 5/6/2019 @ 17:57 GMT
TARGET COMPOUNDS (TO-15)				
1,1,1,2-Tetrafluoroethane (Norflurane)	0.000	0.000	0.000	0.000
Perfluoro(2-methylpentane)	ND	ND	0.000	0.000
Propane	0.000	0.000	0.000	0.000
Isobutane	0.003	0.003	0.001	0.001
Methanol	0.003	0.003	0.004	0.004
Acetaldehyde	0.026	0.026	0.020	0.020
Ethanol	0.001	0.001	0.001	0.001
Acetone	0.003	0.003	0.003	0.003
2-Propanol (Isopropanol)	0.005	0.005	0.009	0.009
Methylene chloride (Dichloromethane)	ND	ND	0.001	0.004
1-Propanol	ND	ND	0.000	0.000
Trimethylsilanol	0.007	0.007	0.007	0.007
1-Butanol	0.000	0.001	0.000	0.001
m & p-Xylene	ND	ND	0.001	0.002
o-Xylene	ND	ND	0.000	0.001
Octafluoropropane (Perfluoropropane)	0.000	0.000	0.000	0.000
SPECIAL INTEREST COMPOUNDS				
Compound was below its laboratory reporting limit				
NON-TARGET COMPOUNDS				
All Non-Target compounds were below their reporting limit				
TARGET COMPOUNDS (GC)				
Methane	0.002	0.002	0.006	0.006
Hydrogen	0.003	0.003	0.007	0.007
Carbon monoxide	0.057	0.210	0.086	0.319
TOTAL T-VALUE	**0.1**	**0.3**	**0.1**	**0.4**

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-18 RETURN AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)	
	AQ190523 S/N 2091 Lab 6/10/2019 @ 12:15	AQ190524 S/N 2090 JEM 6/10/2019 @ 12:15
TARGET COMPOUNDS (TO-15)		
1,1,1,2-Tetrafluoroethane (Norflurane)	0.000	0.000
Propene	0.001	0.001
Propane	0.000	0.000
Carbonyl sulfide (Carbon oxide sulfide)	ND	0.001
Chloromethane	0.022	0.018
Isobutane	0.000	0.000
Methanol	0.015	0.012
Acetaldehyde	0.028	0.023
2-Methyl-1-propene	0.001	0.001
Ethanol	0.002	0.002
Acetone	0.007	0.005
2-Propanol (Isopropanol)	0.018	0.018
Acrylonitrile	0.179	0.179
Carbon disulfide	ND	0.011
1-Propanol	0.000	0.000
Trimethylsilanol	0.008	0.008
1-Butanol	0.001	0.001
Octamethylcyclotetrasiloxane (OMCTS)	0.026	0.020
Decamethylcyclopentasiloxane (DMCPS)	0.018	0.016
Octafluoropropane (Perfluoropropane)	0.000	0.000
SPECIAL INTEREST COMPOUNDS		
Hexamethylcyclotrisiloxane (HMCTS)	0.141	0.101
NON-TARGET COMPOUNDS		
Freon 22	0.000	0.000
TARGET COMPOUNDS (GC)		
Methane	0.008	0.002
Hydrogen	0.008	0.002
Carbon monoxide	0.032	0.081
TOTAL T-VALUE	**0.51**	**0.50**

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 3A: Analytical concentrations of compounds quantified in potable ambient and hot water samples returned on Soyuz 57

Increment					59	
Mission					Soyuz 57	
Sample Location			Potable Water		WPA PWD Ambient	WPA PWD Hot
Sample Description		Test	Maximum Contaminant	Maximum Contaminant	Potable water	Potable water
Sample Date		Conducted	Level	Level	5/6/2019	6/5/2019
Analysis/Sample ID	Units	by	(MCL)	Source	WQ190286	WQ190287
Physical Characteristics						
Conductivity	µS/cm	U.S.			1	2
pH	pH units	U.S.	4.5-8.5	41000	5.51	5.61
Minerals ICPMS						
Calcium	mg/L	U.S.	30	41000	0.02	0.02
Potassium	mg/L	U.S.	340	41000	< 0.01	0.03
Sodium	mg/L	U.S.			0.02	0.03
Trace Metals ICPMS						
Aluminum	µg/L	U.S.			3	3
Barium	µg/L	U.S.	10,000	SWEG&41000	< 1	1
Molybdenum	µg/L	U.S.			< 1	12
Nickel	µg/L	U.S.	300	SWEG&41000	2	5
Zinc	µg/L	U.S.	2,000	SWEG&41000	17	21
Silicon ICPMS						
Silicon	µg/L	U.S.			800	991
Total Organic Carbon-Sievers						
Total Inorganic Carbon (TIC)	mg/L	U.S.			0.8	0.8
Total Organic Carbon (TOC)	mg/L	U.S.		SWEG / 41000	1.2	1.7
Semi-volatile Organics-Targets						
Methyl sulfone	µg/L	U.S.	1,500,000	**interim SWEG (06-2017)**	192	140
Silanols LCRI (Semi-Quantitative-NIST traceable standard not available)						
Dimethylsilanediol (DMSD)	µg/L	U.S.	35,000	SWEG	2,600	3,200
Organic Carbon Recovery	percent	U.S.			60.00	50.82
Unaccounted Organic Carbon	mg/L	U.S.			0.48	0.84

Comments: None.

Data Qualifiers: WQ190286 & -287 Zinc - Possible high bias.

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable
#previously identified as bis(2-Chloroisopropyl) ether

Table 3B: Analytical concentrations of compounds quantified in MF bed effluent, WPA wastewater, US condensate, and JEM condensate returned on SpaceX-17

Increment					59			
Mission					SpaceX-17			
Sample Location			Potable Water		WPA MF Bed #2 ORU S/N 00017	WPA Wastewater ORU	WPA Condensate Sample Port	JAXA CHX
Sample Description					MF Bed Effluent	WPA Wastewater	US Condensate	JEM Condensate (Composite)
Sample Date			Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	4/15/2019	4/17/2019	5/14/2019	5/24/2019
Analysis/Sample ID	Units	Test Conducted by			WQ190257	WQ190258	WQ190259	WQ190260
Physical Characteristics								
Conductivity	µS/cm	U.S.			36	152	220	250
pH	pH units	U.S.	4.5-8.5	41000	5.08	7.42	7.65	7.65
Anions IC								
Fluoride	mg/L	U.S.			< 0.1	0.3	0.2	< 0.1
Cations IC								
Ammonium (as N)	mg/L	U.S.	1	SWEG&41000	< 0.25	20.8	28.7	35.5
Minerals ICPMS								
Calcium	mg/L	U.S.	30	41000	0.04	0.05	0.05	0.11
Potassium	mg/L	U.S.	340	41000	0.02	0.03	0.01	< 0.01
Sodium	mg/L	U.S.			< 0.01	0.02	< 0.01	< 0.01
Trace Metals ICPMS								
Aluminum	µg/L	U.S.			6	< 10	< 10	< 10
Boron	µg/L	U.S.			18	21	71	222
Manganese	µg/L	U.S.	300	SWEG&41000	< 1	< 10	< 10	120
Nickel	µg/L	U.S.	300	SWEG&41000	16	37	47	383
Silver	µg/L	U.S.	400	SWEG&41000	< 1	< 10	10	< 10
Zinc	µg/L	U.S.	2,000	SWEG&41000	67	2,020	1,030	< 10
Silicon ICPMS								
Silicon	µg/L	U.S.			4,570	4,870	5,420	12,500
Total Organic Carbon-Sievers & Total Organic Carbon-OI								
Total Inorganic Carbon (TIC)	mg/L	U.S.			1.2	15.9	23.6	18.0
Total Organic Carbon (TOC)	mg/L	U.S.		SWEG / 41000	38.2	45.0	27.4	99.7
Volatile Organics-Targets								
2-Butanone (Methyl ethyl ketone)	µg/L	U.S.	54,000	SWEG	395	276	< 50	< 50
Volatile Organics-Special Interest Compounds (Semi-quantitative)								
Trimethylsilanol	µg/L	U.S.			not found	180	not found	not found
Semi-volatile Organics-Targets								
Benzothiazole	µg/L	U.S.			< 20	75	< 50	21
bis-(2-Ethylhexyl)adipate	µg/L	U.S.	400	EPA	< 20	< 50	< 50	53
Decamethylcyclopentasiloxane (DMCPS)	µg/L	U.S.			< 20	< 50	< 50	876
Dodecamethylcyclohexasiloxane	µg/L	U.S.			< 20	< 50	< 50	322
Methyl sulfone	µg/L	U.S.	1,500,000	**interim SWEG (06-2017)**	157	418	197	86
N-n-Butylbenzenesulfonamide	µg/L	U.S.			< 20	71	73	79
Tris(2-Chloroethyl)phosphate	µg/L	U.S.			< 20	< 50	< 50	130
Acid Extractables-EPA 625 List GCMS								
4-Methylphenol (p-Cresol)	µg/L	U.S.			< 20	180	< 50	< 20
Benzoic acid	µg/L	U.S.			< 100	462	< 250	1,620
Phenol	µg/L	U.S.	4,000	SWEG	< 20	88	< 50	207

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable
#previously identified as bis(2-Chloroisopropyl) ether

Increment					59			
Mission					SpaceX-17			
Sample Location			Potable Water		WPA MF Bed #2 ORU S/N 00017	WPA Wastewater ORU	WPA Condensate Sample Port	JAXA CHX
Sample Description				Maximum Contaminant Level Source	MF Bed Effluent	WPA Wastewater	US Condensate	JEM Condensate (Composite)
Sample Date			Maximum Contaminant Level (MCL)		4/15/2019	4/17/2019	5/14/2019	5/24/2019
Analysis/Sample ID	Units	Test Conducted by			WQ190257	WQ190258	WQ190259	WQ190260
Base and Neutral Extractables-EPA 625 List GCMS								
Benzyl alcohol	µg/L	U.S.			31	12,900	< 50	2,750
bis-(2-Ethylhexyl)phthalate	µg/L	U.S.	20,000/6	SWEG/EPA	< 20	< 50	< 50	239
Butylbenzylphthlate	µg/L	U.S.			< 20	< 50	< 50	44
Di-n-butylphthalate	µg/L	U.S.	40,000	SWEG	< 20	152	151	63
Diethylphthalate	µg/L	U.S.			< 20	821	224	886
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.			not found	not found	not found	110
1-Methyl-2-pyrrolidinone	µg/L	U.S.			not found	< 200	not found	260
2-(2-Butoxyethoxy)ethanol	µg/L	U.S.			not found	< 100	not found	730
2-Butoxyethanol	µg/L	U.S.			not found	130	not found	85
2-Ethoxyethanol	µg/L	U.S.			130	390	not found	not found
2-Ethyl-1-hexanol	µg/L	U.S.			not found	170	not found	75
2-Ethylhexanoic acid	µg/L	U.S.			not found	120	not found	390
2-Phenoxyethanol	µg/L	U.S.			not found	not found	not found	590
Benzaldehyde	µg/L	U.S.			not found	330	not found	60
Butylated hydroxyanisole (BHA)	µg/L	U.S.			not found	130	not found	not found
Caffeine	µg/L	U.S.			not found	not found	not found	26
Ibuprofen	µg/L	U.S.			not found	1,300	not found	not found
Monomethyl phthalate	µg/L	U.S.			not found	79	46	< 10
N,N-Diethylformamide	µg/L	U.S.			not found	< 50	not found	24
N,N-Dimethyl acetamide	µg/L	U.S.			340	510	not found	290
N,N-Dimethylformamide	µg/L	U.S.			300	760	660	330
Neomenthol	µg/L	U.S.			not found	66	< 50	not found
Nonanoic acid	µg/L	U.S.			not found	not found	not found	800
Palmitic acid	µg/L	U.S.			not found	not found	not found	1,100
Phenethyl alcohol	µg/L	U.S.			not found	not found	not found	19
Tributyl phosphate	µg/L	U.S.			not found	65	not found	37
Triethyl phosphate	µg/L	U.S.			not found	not found	not found	30
Alcohols & Acetone GCMS								
1-Propanol	µg/L	U.S.			492	< 400	< 400	< 400
2-Butanol	µg/L	U.S.			456	< 400	< 400	< 400
2-Propanol (Isopropanol)	µg/L	U.S.			2,870	< 400	11,100	7,390
Acetone	µg/L	U.S.	15000	SWEG	3,240	3,920	5,510	6,620
Ethanol	µg/L	U.S.			12,300	< 400	9,450	24,000
Methanol	µg/L	U.S.	40,000	SWEG	2,880	4,870	3,370	4,140
Glycols GCMS								
1,2-Ethanediol (Ethylene glycol)	µg/L	U.S.	4000	SWEG	< 1000	1,200	1,140	2,910
1,2-Propanediol (Propylene glycol)	µg/L	U.S.	1,700,000	SWEG	< 1000	9,970	6,160	7,950
Silanols LCRI (Semi-Quantitative-NIST traceable standard not available)								
Dimethylsilanediol (DMSD)	µg/L	U.S.	35,000	SWEG	15,000	15,000	17,000	40,000
Monomethylsilanetriol (MMST)	µg/L	U.S.	110,000	SWEG	< 1000	1,400	< 1000	< 1000
Carboxylates IC								

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable
#previously identified as bis(2-Chloroisopropyl) ether

Increment					59			
Mission					SpaceX-17			
Sample Location			Potable Water		WPA MF Bed #2 ORU S/N 00017	WPA Wastewater ORU	WPA Condensate Sample Port	JAXA CHX
Sample Description				Maximum Contaminant Level Source	MF Bed Effluent	WPA Wastewater	US Condensate	JEM Condensate (Composite)
Sample Date		Test Conducted by	Maximum Contaminant Level (MCL)		4/15/2019	4/17/2019	5/14/2019	5/24/2019
Analysis/Sample ID	Units				WQ190257	WQ190258	WQ190259	WQ190260
Acetate	µg/L	U.S.			38,200	< 500	< 500	25,100
Formate	µg/L	U.S.	2,500,000	SWEG	< 500	< 500	< 500	9,150
Lactate	µg/L	U.S.			< 500	< 500	< 500	5,660
Propionate	µg/L	U.S.			8,450	< 500	< 500	633
Aldehydes GCMS								
Formaldehyde (Methanal)	µg/L	U.S.	12,000	SWEG	< 10	< 10	< 20	278
Non-volatile Organics LC								
Caprolactam	µg/L	U.S.	100,000	SWEG	< 500	1,050	< 500	4,100
Urea	µg/L	U.S.			< 800	< 800	< 800	1,280
Organic Carbon Recovery	percent	U.S.			94.51	63.24	90.30	64.27
Unaccounted Organic Carbon	mg/L	U.S.			2.10	16.54	2.66	35.62

Comments: WQ190260: Composite sample - Collected from 5/22/19 to 5/24/19

Data Qualifiers: WQ190257: Possible high bias - N,N-Dimethylformamide; Possible low bias - Propionate (MS Rec. 60%)
WQ190258: Possible high bias - N,N-Dimethylformamide
WQ190259: Possible high bias - N,N-Dimethylformamide; Possible low bias -DMSD (MS Rec. 72%)
WQ190260: Possible high bias - N,N-Dimethylformamide; Possible low bias -DMSD (MS Rec. 59%)

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable
#previously identified as bis(2-Chloroisopropyl) ether