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SUBJECT: Toxicological Assessment of ISS Air and Water Quality: April 17 – October 21, 2020 (Increment 63) Including HTV-9 and NG-14 Ingresses

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 63; four sets were collected for routine archive sampling on May 20, June 29, September 9, and October 19, 2020. Two samples were collected at ingress for HTV-9 (May 25, 2020) and NG-14 (October 5, 2020). Two samples were collected in the SpaceX Dragon-2 Demo-2 (Endeavor) vehicle on August 1 and 2, 2020. Additional samples were collected from May through July as a result of indications from the onboard Air Quality Monitor (AQM) that benzene was present in ISS air. The analysis of those samples and outcomes of that investigation are described in TOX-SW-2020-05, Benzene in ISS Air, April 13-August 2, 2020 (Increment 62-63). Additionally, four sets of formaldehyde badges were deployed during Increment 63. The badges were deployed in the US Lab and the Russian Service Module (SM) on May 20, June 29, September 9, and October 19, 2020. The May, June, and September 2020 formaldehyde badges were returned on Soyuz 62. The sample set from October 2020 was returned on Soyuz 63. A summary of the results from the Increment 63 samples is provided in Table 1.

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 Increment 63 samples were acceptable. The mean relative recoveries of the three surrogate standards from the mGSC samples returned on SpX-Demo 2, Soyuz 62, and SpX-21 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 1. Analytical summary of ISS air analyses (Increment 63)

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 Demo-2	US Lab	5/20/2020	130	4.3	0.4	17
SpaceX Demo-2	SM	5/20/2020	120	3.9	0.3	7
SpaceX Demo-2	HTV-9 Ingress	5/25/2020	100	3.5	0.5 (0.3)	--
SpaceX Demo-2	US Lab	6/29/2020	120	3.0	0.1	20
SpaceX Demo-2	JPM	6/29/2020	120	2.8	0.1	15[d]
SpaceX Demo-2	Demo-2	8/1/2020	120	2.8	0.1	--
SpaceX Demo-2	Demo-2	8/2/2020	100	1.4	0.3	--
Soyuz 62	US Lab	9/9/2020	150	2.9	0.1	15
Soyuz 62	Columbus	9/9/2020	130	2.7	0.1	9[d]
Soyuz 62	NG-14 Ingress	10/5/2020	26	3.2	0.5 (0.3)	--
SpaceX-21	US Lab	10/19/2020	200	3.2	0.1	18
SpaceX-21	SM	10/19/2020	190	3.3	0.1	11
Guideline			---	*<5*	*<1*[c]	*<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] T-value <1 used to evaluate routine monthly sampling; <3 used to evaluate first ingress.
[d] These formaldehyde samples were collected in the Russian SM.

Table 2. Average monthly concentrations (mg/m^3) of AQM target compounds

Compound	April Average	May Average	June Average	July Average ł	August Average ł	September Average ł	October Average ł	Increment Average
2-Propanol	MI	MI	MI	---	---	---	---	---
Acetone	0.2	0.18	0.19	---	---	---	---	---
Acrolein	ND	ND	ND	---	---	---	---	---
Benzene	TRACE*	MI	MI	---	---	---	---	---
1,2-Dichloroethane	ND	ND	ND	---	---	---	---	---
Decamethylcyclopentasiloxane#	ND	TRACE	TRACE	---	---	---	---	---
Hexanal	ND	ND	ND	---	---	---	---	---
Hexane	ND	ND	ND	---	---	---	---	---
m,p-Xylenes#	ND	ND	ND	---	---	---	---	---
Methanol	0.23	0.24	0.24	---	---	---	---	---
o-Xylene#	ND	ND	ND	---	---	---	---	---
Octamethylcylcotetrasiloxane#	ND	ND	ND	---	---	---	---	---
Toluene#	TRACE	ND	TRACE	---	---	---	---	---
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND
Acetaldehyde	TRACE	TRACE	TRACE	TRACE	TRACE	ND	ND	TRACE
Dichloromethane	ND	ND	ND	ND	ND	ND	ND	ND
Ethanol	4.3	2.2	1.3	4.3	3.7	2.9	2.4	3.0
Ethyl Acetate	ND	ND	TRACE	ND	ND	TRACE	ND	ND
Hexamethycyclotrisiloxane#	ND	ND	ND	---	---	---	---	---
n-Butanol	ND	ND	ND	ND	ND	ND	ND	ND
Trimethylsilanol	ND	ND	ND	ND	ND	ND	ND	ND

ND: Not detected; <MDL (Minimum Detection Limit)
TRACE: >MDL, <MQL (Minimum Quantification Limit)
MI: matrix interference
*: AQM1 began detecting benzene at trace levels on April 13, and measured levels increased into Increment 63. Later analysis using mGSC samples and CMS chip reader determined that this signal was due to an interfering compound.
--: Not analyzed.
ł AQM1 failed in late June and was not functional for the rest of Increment 63.

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 samples for this Increment that returned on SpX Demo-2, Soyuz 62, and SpX-21 confirmed air quality was acceptable. **T-values calculated using data from the routine archive samples (mGSC) met 180-d T-value guideline criteria (T < 1), indicating no concern for crew health.** Generally, the reported concentrations for the compounds detected during Increment 63 were similar to levels detected during recent Increments. The average, rounded T-value calculated from the nominal Increment 63 mGSC samples was 0.2 (Figure 1). As AQM1 failed in June and was inoperative for the rest of the Increment, no T-values could be calculated from AQM data.

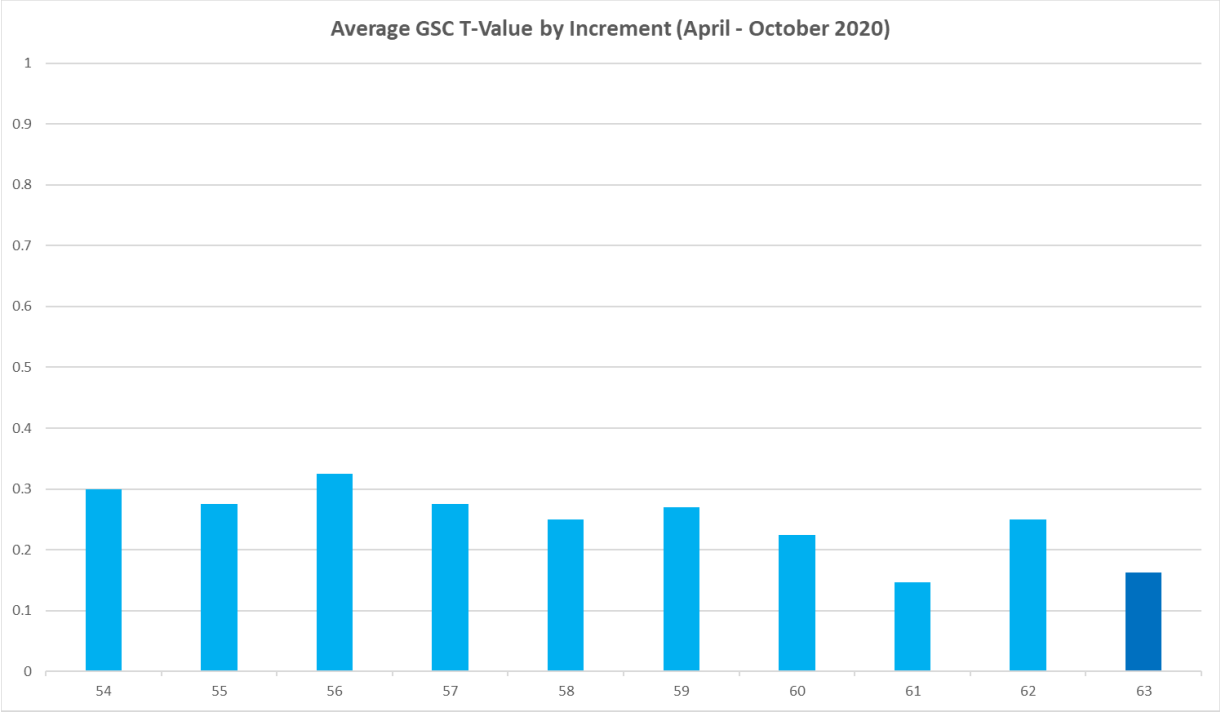

Figure 1. GSC-Derived T-values for Increments 54-63

All of the 8 routine mGSC samples collected during Increment 63 contained a CO_2 concentration below the limit documented in Flight Note F091532D, which requests that the 24-hour average concentration not exceed 3.1 mmHg (7300 mg/m^3) on the US segment. While mGSC CO_2 sampling provides a snap-shot of the CO_2 concentration, real-time CO_2 data are available from sensors in the Columbus module and SM, and intermittently from the Major Constituent Analyzer (MCA) (Figure 2). Concentrations measured by these sensors and 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. To preserve the longevity of the instrumentation, the MCAs were transitioned to intermittent operations starting in mid-February 2020. The MCAs are only activated during EVA activities, crew metabolic characterization, tech demo analysis, anomaly resolution, and when requested by crew surgeons.

CO_2 data were obtained from the Columbus and SM sensors throughout the Increment. Limited data were available from the Lab and Node 3 MCAs. Overall, CO_2 concentrations were well-controlled throughout the Increment (Figure 2). The ISS crew was comprised of 3 crew for much of Increment 63, with the

addition of 2 crew members from late May to early August during the SpaceX Demo-2 mission. CO_2 levels exceeded 4 mmHg in late June, early and mid-July, late August, and late October as a result of EVA activity and MetOx regeneration activities.

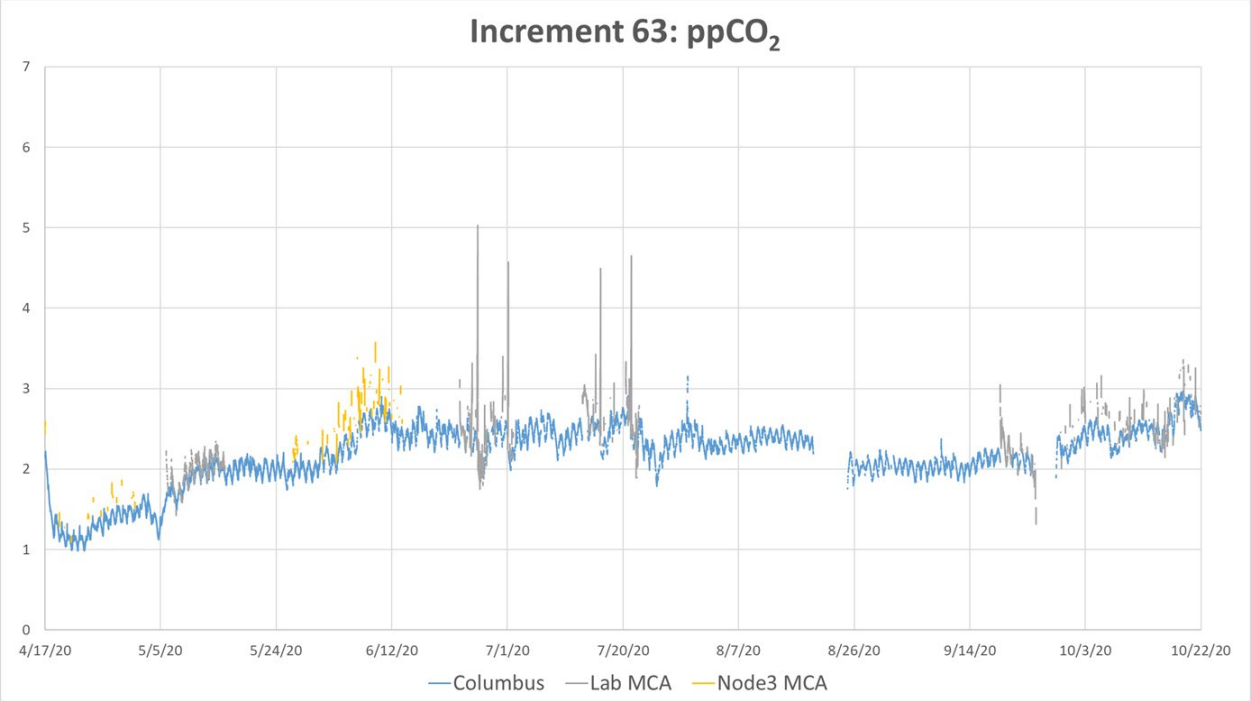

Figure 2. Environmental CO_2 Concentrations on ISS Increment 63 (mmHg)

Alcohol values in all eight routine mGSC samples returned on SpaceX Demo-2, SpaceX-21, and Soyuz 62 fell below the guideline of <5 mg/m^3, which is intended to protect the water recovery system from risk of overloading. Total alcohol levels generally ranged from 2.7-4.3 mg/m^3, slightly higher than the previous Increment. The majority of the total alcohol levels in the Increment 63 samples was attributable to ethanol (1.6-3.0 mg/m^3 across all samples). Levels of total alcohols continue to decrease over the last several Increments (7.2 mg/m^3 total alcohols measured in US Lab in late August 2019). Measured levels do not present a risk to crew health.

Levels of octafluoropropane (Freon 218) declined during the early part of the Increment (120-150 mg/m^3), but a slight increase was observed in the October 2020 samples (190-200 mg/m^3). Previous increases of octafluoropropane in ISS air have been associated with maintenance of CKB. However, no such activities are believed to have occurred during this Increment. These concentrations are well below levels of concern for crew health.

Four sets of passive formaldehyde badges were deployed on ISS during Increment 63 (May 22, June 30, September 9, and October 19, 2020). Results from analysis of these badges indicated that formaldehyde remains in the historical range observed on ISS, and concentrations are well below the SMAC of 120 µg/m^3 (Figure 3). The concentrations in the SM ranged from 7 to 20 µg/m^3, and in the US Lab the concentration ranged from 15-20 µg/m^3, slightly lower than levels observed in recent Increments.

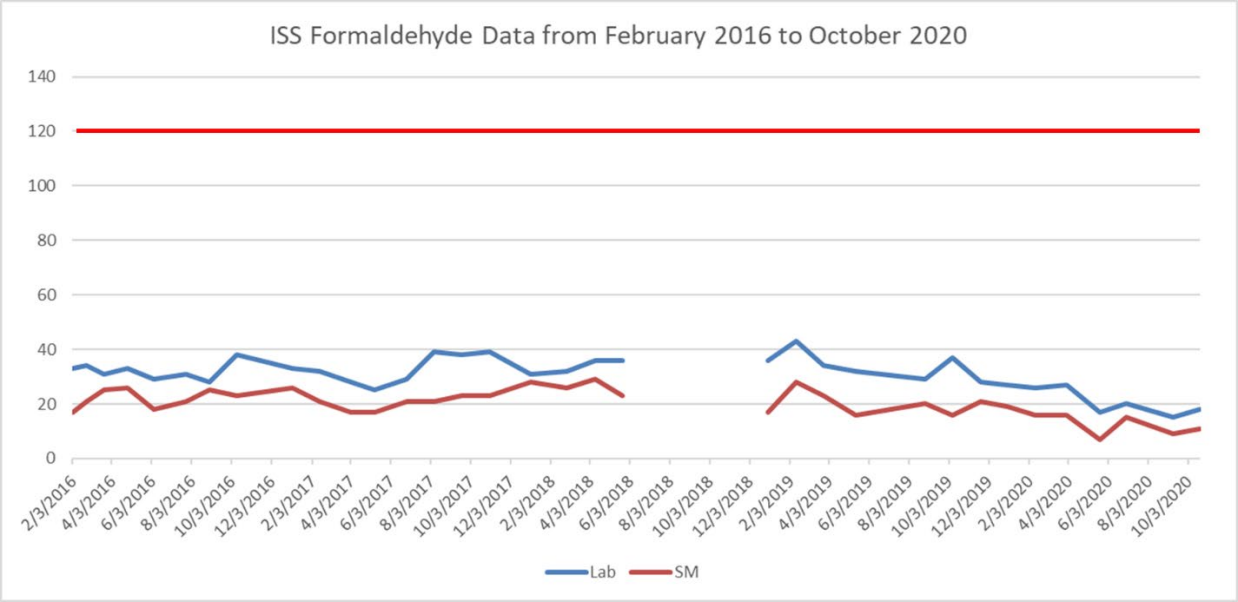

Figure 3: Formaldehyde Concentrations from February 2016 to October 2020

HTV-9 Ingress

An ingress sample was collected in HTV-9 on May 25, 2020, approximately 29 minutes after hatch opening. **Due to the extended period between hatch opening and sample collection, we would expect the atmosphere to have mixed with ISS and not to represent true concentrations at hatch opening.** The concentrations of CO_2 and octafluoropropane were slightly lower than was observed in the archive samples taken on May 20, 2020. The T-value for the HTV-9 ingress sample was 0.3, well below levels of concern for human health, and very similar to the T-values for the routine archive samples collected on May 20, 2020.

SpaceX Demo-2 Mission Samples

mGSC samples were collected in the SpaceX Demo-2 (Dragon) vehicle on August 1, 2020 (while it was still docked to ISS) and 8 minutes before splashdown on August 2, 2020. The docked sample contained 7800 mg/m^3 CO_2 (3.3 mmHg), slightly higher than the limit specified in Flight Note F091532D, but the sample collected prior to splashdown contained only 2300 mg/m^3 CO_2 (0.97 mmHg), indicating that the CO_2 removal systems on the vehicle were working well. The level of total alcohols also dropped between the two samples (2.8 to 1.4 mg/m^3), attributable mostly to a reduction in ethanol concentration from 1.9 to 0.9 mg/m^3.

NG-14 Ingress

An additional sample was collected in an mGSC upon ingress into NG-14 on October 5, 2020, approximately 2 minutes after hatch opening. The octafluoropropane (Freon 218) concentration in the ingress sample was 26 mg/m^3, notably lower than the 130-150 mg/m^3 observed on ISS in mid-September. The carbon dioxide concentration in the ingress sample (2200 mg/m^3; 0.9 mmHg) also indicates a low level of mixing. **The measured T-value for this ingress (0.3, excluding CO_2) is well below levels of concern for crew health.**

WATER QUALITY

Two samples were collected from the US Potable Water Dispenser (PWD) during Increment 63: a hot water sample on September 2 and an ambient water sample on September 23, 2020. A summary of select analytical results from the Increment 63 samples is provided in Table 3. Complete data tables with results for all measured parameters are available upon request. 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 63)

Return Mission	Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	Methyl Sulfone (mg/L)	Conductivity (µS/cm)	Total Iodine (mg/L)
Soyuz 62	PWD Hot	9/2/2020	1.23	<1	0.1	2	<0.05
Soyuz 62	PWD Ambient	9/23/2020	0.452	<1	<0.02	<1	<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. 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 October 2018 and October 2020 are shown in Figure 4. The TOC concentrations in the two potable samples continued to be low and were well below both the specification for the US segment (<3 mg/L) and the 100-day SWEG (5 mg/L). A slight increase was noted in a single reading in September 2020, but the cause is unknown. The DMSD concentrations remained below 1 mg/L in the potable water samples. Methyl sulfone was detected in one of the two the potable water samples at levels well below the SWEG of 1,500 mg/L. Silicon was detected in both samples (0.21-0.23 mg/L). **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.**

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 63 post-flight report generated by the JSC Environmental Microbiology Laboratory. The main difference between potable water and WPA product water is the presence of iodine.

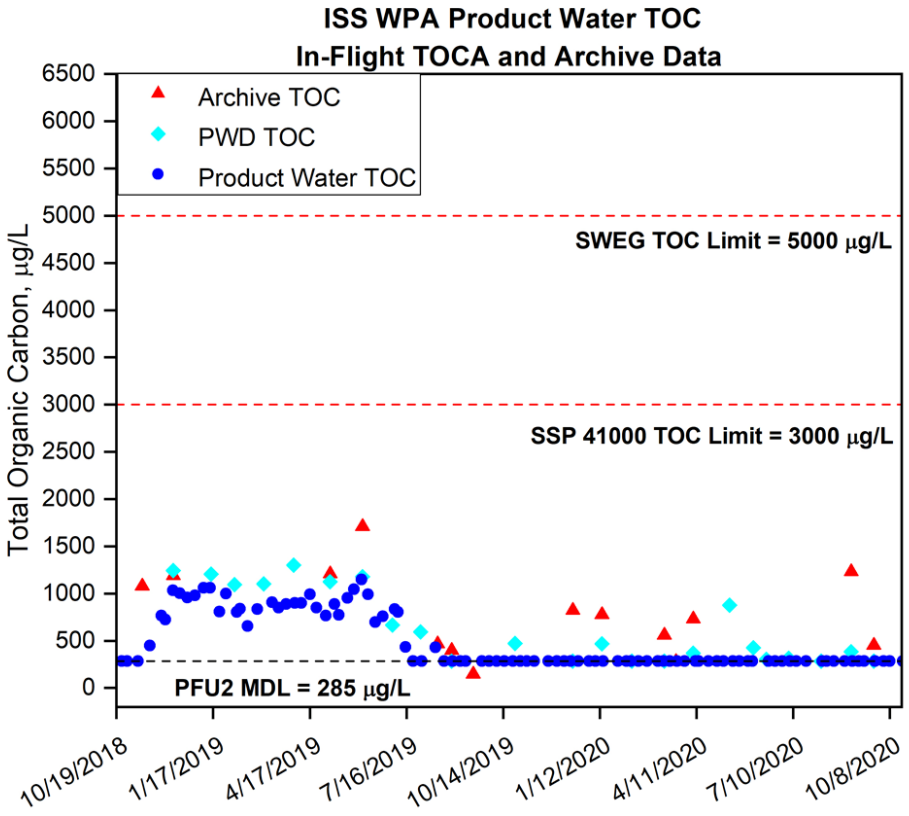

Figure 4. Total Organic Carbon (TOC) trending in US Potable Water

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Enclosures

Table 1A: Analytical concentrations of compounds quantified in routine archive and HTV-9 ingress mGSCs returned on SpaceX Demo-2

Table 1B: Analytical concentrations of compounds quantified in mGSCs collected in and returned on SpaceX Demo-2

Table 1C: Analytical concentrations of compounds quantified in routine archive and NG-14 ingress mGSCs returned on Soyuz 62

Table 1D: Analytical concentrations of compounds quantified in routine archive mGSCs returned on SpaceX-21

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

Table 2B: T-values corresponding to concentrations for HTV-9 ingress air sample returned on SpaceX Demo-2, based on 7-day and 180-day SMACs

Table 2C: T-values corresponding to concentrations for mGSC samples collected in and returned on SpaceX Demo-2, based on 180-day SMACs

Table 2D: T-values corresponding to concentrations for routine archive mGSC samples returned on Soyuz 62, based on 180-day SMACs

Table 2E: T-values corresponding to concentrations for NG-14 ingress air sample returned on Soyuz 62, based on 7-day and 180-day SMACs

Table 2F: T-values corresponding to concentrations for routine archive mGSC samples returned on SpaceX-21, based on 180-day SMACs

Table 3: Analytical concentrations of compounds quantified in potable ambient, potable hot, and product water samples returned on SpaceX-20 and Soyuz 61

TABLE 1A
ANALYTICAL RESULTS FOR SPACEX-DEMO 2 RETURN SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M3)				
	AQ200612 **SN 2074** **Lab Center** **05/20/20 @ 14:40 GMT**	**AQ200613** **SN 2076** **SM Center** **05/20/20 @ 14:45 GMT**	**AQ200614** **SN 2080** **HTV-9 Ingress** **05/25/20 @ 19:53 GMT**	**AQ200619** **SN 2070** **Lab** **06/29/20 @ 09:35 GMT**	**AQ200620** **SN 2071** **JPM** **06/29/20 @ 9:40 GMT**
TARGET COMPOUNDS (TO-15) *					
1,1,1,2-Tetrafluoroethane (Norflurane)	0.086	0.087	0.051	0.055	0.052
Isobutane	<0.025	<0.025	<0.025	0.031	0.038
Methanol	0.34	0.33	0.32	0.29	0.29
Acetaldehyde	0.15	0.16	0.16	0.095	0.11
2-Methyl-1-propene	TRACE	TRACE	0.026	<0.025	<0.025
Ethanol	3.0	2.6	2.1	2.1	1.9
Acetone	0.25	0.28	0.22	0.17	0.16
2-Propanol (Isopropanol)	0.61	0.61	0.84	0.43	0.44
Isoprene (2-Methyl-1,3-butadiene)	0.026	0.031	TRACE	<0.025	TRACE
Acrylonitrile	TRACE	TRACE	TRACE	<0.025	<0.025
Methyl acetate	<0.025	<0.025	TRACE	<0.025	<0.025
Methylene chloride (Dichloromethane)	TRACE	TRACE	0.19	<0.025	<0.025
1-Propanol	0.045	0.043	0.037	TRACE	0.029
Trimethylsilanol	0.031	0.031	0.74	<0.025	0.059
2-Butanone (Methyl ethyl ketone)	<0.025	<0.025	TRACE	<0.025	<0.025
Ethyl acetate	<0.025	TRACE	TRACE	<0.025	<0.025
1-Butanol	<0.025	TRACE	TRACE	<0.025	<0.025
Decamethylcyclopentasiloxane (DMCPS)	1.1	0.48	<0.18	<0.18	<0.18
Octafluoropropane (Perfluoropropane)	130	120	100	120	120
SPECIAL INTEREST COMPOUND #					
Hexamethylcyclotrisiloxane (HMCTS)	<0.20	<0.20	<0.20	<0.20	<0.20
NON-TARGET COMPOUNDS **					
All Non-Target Compounds were below their reporting limit					
TOTAL ALCOHOLS PLUS ACETONE	**4.3**	**3.9**	**3.5**	**3.0**	**2.8**
TARGET COMPOUNDS (GC) *					
Methane	16	16	9.3	22	22
Carbon dioxide	5300	5800	4600	6000	6100
Hydrogen	3.3	3.4	1.5	1.7	1.7
Carbon monoxide	0.64	0.65	0.77	0.71	0.69

* 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-DEMO 2 RETURN DRAGON SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)	
	AQ200640 SN 2087 Dragon Prehatch Closure 08/01/20 @ 21:20	**AQ200641 SN 2088 Dragon Reentry 08/02/20 @ 13:40**
TARGET COMPOUNDS (TO-15) *		
1,1,1,2-Tetrafluoroethane (Norflurane)	0.076	0.12
Chloromethane	<0.025	0.029
Isobutane	0.060	0.073
Methanol	0.43	0.20
Acetaldehyde	0.098	0.027
Ethanol	1.9	0.89
Acetonitrile	<0.025	TRACE
Acetone	0.12	0.098
2-Propanol (Isopropanol)	0.32	0.21
1-Propanol	TRACE	<0.025
Trimethylsilanol	0.040	<0.025
Octafluoropropane (Perfluoropropane)	120	100
SPECIAL INTEREST COMPOUND #		
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	**2.8**	**1.4**
TARGET COMPOUNDS (GC) *		
Methane	30	81
Carbon dioxide	7800	2300
Hydrogen	4.4	9.8
Carbon monoxide	0.84	3.0

* 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 1C
ANALYTICAL RESULTS FOR SOYUZ 62 RETURN SAMPLES CONDENSED

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)		
	AQ200877 SN2085 LAB Center 09/09/20 @ 13:45	**AQ200878 SN2077 COLUMBUS 09/09/20 @ 13:45**	**AQ200879 SN2078 NG-14 Ingress 10/5/20 @ 17:04**
TARGET COMPOUNDS (TO-15) *			
1,1,1,2-Tetrafluoroethane (Norflurane)	0.091	0.088	0.23
Propane	<0.025	<0.025	TRACE
Carbonyl sulfide (Carbon oxide sulfide)	<0.025	<0.025	0.051
Isobutane	TRACE	TRACE	0.18
Methanol	0.38	0.30	0.17
Acetaldehyde	0.13	0.12	0.26
2-Methyl-1-propene	<0.025	<0.025	0.19
Ethanol	1.7	1.6	0.64
Acetone	0.23	0.23	0.35
Propanal (Propionaldehyde)	<0.025	<0.025	0.031
2-Propanol (Isopropanol)	0.56	0.54	1.9
Isoprene (2-Methyl-1,3-butadiene)	TRACE	TRACE	<0.025
2-Methyl-2-propanol	<0.025	<0.025	TRACE
Methyl acetate	<0.025	<0.025	TRACE
Methylene chloride (Dichloromethane)	<0.025	TRACE	0.24
1-Propanol	TRACE	TRACE	0.030
Trimethylsilanol	0.031	0.060	0.52
2-Butanone (Methyl ethyl ketone)	<0.025	<0.025	0.095
Ethyl acetate	<0.025	TRACE	0.051
1-Butanol	TRACE	0.028	0.11
Toluene	<0.025	<0.025	0.057
Octafluoropropane (Perfluoropropane)	150	130	26
SPECIAL INTEREST COMPOUND #			
Hexamethylcyclotrisiloxane (HMCTS)	<0.20	<0.20	0.72
NON-TARGET COMPOUNDS **			
1,1,1,3,3-Pentafluoropropane	<0.075	<0.075	1.8
Fluorotrimethylsilane	<0.050	<0.050	0.21
TOTAL ALCOHOLS PLUS ACETONE	**2.9**	**2.7**	**3.2**
TARGET COMPOUNDS (GC) *			
Methane	29	29	5.1
Carbon dioxide	4700	4700	2200
Hydrogen	3.7	3.7	0.82
Carbon monoxide	0.55	0.49	1.0

* 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 1D
ANALYTICAL RESULTS FOR SPACEX-21 RETURN AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)	
	AQ210086 S/N 2005 LAB 10/19/20 @ 13:59	**AQ210087 S/N 2004 SM 10/19/20 @ 15:04**
TARGET COMPOUNDS (TO-15) *		
1,1,1,2-Tetrafluoroethane (Norflurane)	0.079	0.084
Methanol	0.27	0.28
Acetaldehyde	0.11	0.12
Ethanol	2.1	2.3
Acetone	0.25	0.28
2-Propanol (Isopropanol)	0.53	0.46
Isoprene (2-Methyl-1,3-butadiene)	0.025	0.029
1-Propanol	0.026	0.034
Trimethylsilanol	0.048	0.038
Ethyl acetate	0.022	0.025
1-Butanol	0.024	0.035
Octafluoropropane (Perfluoropropane)	200	190
SPECIAL INTEREST COMPOUND		
The Special Interest Compound was below its reporting limit.		
NON-TARGET COMPOUNDS		
The Non-Target Compound was below its reporting limit.		
TOTAL ALCOHOLS PLUS ACETONE	**3.2**	**3.3**
TARGET COMPOUNDS (GC) *		
Methane	34	34
Carbon dioxide	7200	7200
Hydrogen	4.6	4.7
Carbon monoxide	0.82	0.83

* Quantified using a multi-point calibration

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

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)			
	AQ200612 **SN 2074** **Lab Center** **05/20/20 @ 14:40 GMT**	**AQ200613** **SN 2076** **SM Center** **05/20/20 @ 14:45 GMT**	**AQ200619** **SN 2070** **Lab** **06/29/20 @ 09:35 GMT**	**AQ200620** **SN 2071** **JPM** **06/29/20 @ 9:40 GMT**
TARGET COMPOUNDS (TO-15)				
1,1,1,2-Tetrafluoroethane (Norflurane)	0.000	0.000	0.000	0.000
Isobutane	ND	ND	0.000	0.000
Methanol	0.013	0.013	0.011	0.011
Acetaldehyde	0.038	0.040	0.024	0.027
2-Methyl-1-propene	0.001	0.001	ND	ND
Ethanol	0.002	0.001	0.001	0.001
Acetone	0.005	0.005	0.003	0.003
2-Propanol (Isopropanol)	0.004	0.004	0.003	0.003
Isoprene (2-Methyl-1,3-butadiene)	0.009	0.010	ND	0.004
Acrylonitrile	0.179	0.179	ND	ND
Methylene chloride (Dichloromethane)	0.001	0.001	ND	ND
1-Propanol	0.001	0.001	0.000	0.000
Trimethylsilanol	0.008	0.008	ND	0.015
Ethyl acetate	ND	0.000	ND	ND
1-Butanol	ND	0.000	ND	ND
Decamethylcyclopentasiloxane (DMCPS)	0.076	0.032	ND	ND
Octafluoropropane (Perfluoropropane)	0.002	0.001	0.001	0.001
SPECIAL INTEREST COMPOUND				
The Special Interest Compound was below its reporting limit				
NON-TARGET COMPOUNDS				
The Non-Target Compounds were below their reporting limits				
TARGET COMPOUNDS (GC)				
Methane	0.005	0.005	0.006	0.006
Hydrogen	0.010	0.010	0.005	0.005
Carbon monoxide	0.038	0.038	0.042	0.041
TOTAL T-VALUE	**0.4**	**0.3**	**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-DEMO 2 RETURN INGRESS SAMPLE CONDENSED

CHEMICAL CONTAMINANT	T-VALUES (7-d & 180-d SMAC)	
	7-d SMAC	180-d SMAC
	AQ200614 SN 2080 HTV-9 Ingress 05/25/20 @ 19:53 GMT	AQ200614 SN 2080 HTV-9 Ingress 05/25/20 @ 19:53 GMT
TARGET COMPOUNDS (TO-15)		
1,1,1,2-Tetrafluoroethane (Norflurane)	0.000	0.000
Propane	ND	ND
Carbonyl sulfide (Carbon oxide sulfide)	ND	ND
Freon 12 (Dichlorodifluoromethane)	ND	ND
Methanol	0.012	0.012
Acetaldehyde	0.041	0.041
2-Methyl-1-propene	0.000	0.001
Ethanol	0.001	0.001
Acetone	0.004	0.004
2-Propanol (Isopropanol)	0.006	0.006
Isoprene (2-Methyl-1,3-butadiene)	0.002	0.004
Acrylonitrile	0.031	0.179
2-Methyl-2-propanol	ND	ND
Methyl acetate	0.000	0.000
Methylene chloride (Dichloromethane)	0.004	0.019
Carbon disulfide	ND	ND
1-Propanol	0.000	0.000
Trimethylsilanol	0.185	0.185
Butanal (Butyraldehyde)	ND	ND
2-Butanone (Methyl ethyl ketone)	0.000	0.000
Hexane	ND	ND
Ethyl acetate	0.000	0.000
1-Butanol	0.000	0.000
2-Methylhexane	ND	ND
2,3-Dimethylpentane	ND	ND
3-Methylhexane	ND	ND
Pentanal	ND	ND
n-Heptane	ND	ND
Toluene	ND	ND
Octane	ND	ND
Hexanal	ND	ND
Butyl acetate	ND	ND
Ethylbenzene	ND	ND
m & p-Xylene	ND	ND
Heptanal	ND	ND
o-Xylene	ND	ND
Cyclohexanone	ND	ND
Decamethylcyclopentasiloxane (DMCPS)	ND	ND
Octafluoropropane (Perfluoropropane)	0.001	0.001
SPECIAL INTEREST COMPOUNDS		
Hexamethylcyclotrisiloxane (HMCTS)	ND	ND
NON-TARGET COMPOUNDS		
2,4-dimethylpentane	ND	ND
2-methyl-1-propanol	ND	ND
methylcyclopentane	ND	ND
3,3-dimethylpentane	ND	ND
3-Ethylpentane	ND	ND
1,2-dimethylcyclopentane	ND	ND
Methylcyclohexane	ND	ND
2-Pinene	ND	ND
TARGET COMPOUNDS (GC)		
Methane	0.003	0.003
Hydrogen	0.005	0.005
Carbon monoxide	0.012	0.045
TOTAL T-VALUE	**0.3**	**0.5**

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-DEMO 2 RETURN DRAGON SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)	
	AQ200640 SN 2087 Dragon Prehatch Closure 08/01/20 @ 21:20	**AQ200641 SN 2088 Dragon Reentry 08/02/20 @ 13:40**
TARGET COMPOUNDS (TO-15)		
1,1,1,2-Tetrafluoroethane (Norflurane)	0.000	0.000
Chloromethane	ND	0.016
Isobutane	0.000	0.000
Methanol	0.017	0.008
Acetaldehyde	0.024	0.007
Ethanol	0.001	0.000
Acetonitrile	ND	0.001
Acetone	0.002	0.002
2-Propanol (Isopropanol)	0.002	0.001
1-Propanol	0.000	ND
Trimethylsilanol	0.010	ND
Octafluoropropane (Perfluoropropane)	0.001	0.001
SPECIAL INTEREST COMPOUND		
The Special Interest Compound was below its reporting limit		
NON-TARGET COMPOUNDS		
All Non-Target Compounds were below their reporting limit		
TARGET COMPOUNDS (GC)		
Methane	0.009	0.023
Hydrogen	0.013	0.029
Carbon monoxide	0.050	0.178
TOTAL T-VALUE	**0.1**	**0.3**

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 2D
T-VALUES FOR SOYUZ 62 RETURN SAMPLES CONDENSED

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)	
	AQ200877 SN2085 LAB Center 09/09/20 @ 13:45	**AQ200878 SN2077 COLUMBUS 09/09/20 @ 13:45**
TARGET COMPOUNDS (TO-15)		
1,1,1,2-Tetrafluoroethane (Norflurane)	0.000	0.000
Isobutane	0.000	0.000
Methanol	0.015	0.012
Acetaldehyde	0.031	0.031
Ethanol	0.001	0.001
Acetone	0.004	0.004
2-Propanol (Isopropanol)	0.004	0.004
Isoprene (2-Methyl-1,3-butadiene)	0.004	0.004
Methylene chloride (Dichloromethane)	ND	0.001
1-Propanol	0.000	0.000
Trimethylsilanol	0.008	0.015
Ethyl acetate	ND	0.000
1-Butanol	0.000	0.001
Octafluoropropane (Perfluoropropane)	0.002	0.002
SPECIAL INTEREST COMPOUND		
The Special Interest Compound (HMCTS) was below its reporting limit		
NON-TARGET COMPOUNDS		
All Non-Target Compounds were below their reporting limit		
TARGET COMPOUNDS (GC)		
Methane	0.008	0.008
Hydrogen	0.011	0.011
Carbon monoxide	0.032	0.029
TOTAL T-VALUE	**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 2E
T-VALUES FOR SOYUZ 62 RETURN INGRESS SAMPLE CONDENSED

CHEMICAL CONTAMINANT	T-VALUE	
	7-d SMAC	180-d SMAC
	AQ200879 SN2078 NG-14 Ingress 10/5/20 @ 17:04	AQ200879 SN2078 NG-14 Ingress 10/5/20 @ 17:04
TARGET COMPOUNDS (TO-15)		
1,1,1,2-Tetrafluoroethane (Norflurane)	0.000	0.000
Propane	0.000	0.000
Carbonyl sulfide (Carbon oxide sulfide)	0.001	0.003
Isobutane	0.001	0.001
Methanol	0.007	0.007
Acetaldehyde	0.066	0.066
2-Methyl-1-propene	0.002	0.008
Ethanol	0.000	0.000
Acetone	0.007	0.007
Propanal (Propionaldehyde)	0.003	0.003
2-Propanol (Isopropanol)	0.013	0.013
2-Methyl-2-propanol	0.000	0.000
Methyl acetate	0.000	0.000
Methylene chloride (Dichloromethane)	0.005	0.024
1-Propanol	0.000	0.000
Trimethylsilanol	0.131	0.131
2-Butanone (Methyl ethyl ketone)	0.003	0.003
Ethyl acetate	0.000	0.000
1-Butanol	0.001	0.003
Toluene	0.004	0.004
Octafluoropropane (Perfluoropropane)	0.000	0.000
SPECIAL INTEREST COMPOUNDS		
Hexamethylcyclotrisiloxane (HMCTS)	0.008	0.080
NON-TARGET COMPOUNDS		
1,1,1,3,3-Pentafluoropropane	0.002	0.013
Fluorotrimethylsilane	0.055	0.092
TARGET COMPOUNDS (GC)		
Methane	0.001	0.001
Hydrogen	0.002	0.002
Carbon monoxide	0.016	0.060
TOTAL T-VALUE	**0.3**	**0.5**

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 2F
T-VALUES FOR SPACEX-21 RETURN AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)	
	AQ210086 S/N 2005 LAB 10/19/20 @ 13:59	**AQ210087 S/N 2004 SM 10/19/20 @ 15:04**
TARGET COMPOUNDS (TO-15)		
1,1,1,2-Tetrafluoroethane (Norflurane)	0.000	0.000
Methanol	0.011	0.011
Acetaldehyde	0.028	0.030
Ethanol	0.001	0.001
Acetone	0.005	0.005
2-Propanol (Isopropanol)	0.004	0.003
Isoprene (2-Methyl-1,3-butadiene)	0.008	0.010
1-Propanol	0.000	0.000
Trimethylsilanol	0.012	0.009
Ethyl acetate	0.000	0.000
1-Butanol	0.001	0.001
Octafluoropropane (Perfluoropropane)	0.002	0.002
SPECIAL INTEREST COMPOUND		
The Special Interest Compound was below its reporting limit.		
NON-TARGET COMPOUNDS		
The Non-Target Compound was its reporting limit.		
TARGET COMPOUNDS (GC)		
Methane	0.010	0.010
Hydrogen	0.014	0.014
Carbon monoxide	0.048	0.049
TOTAL T-VALUE	**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 3: Analytical concentrations of compounds quantified in potable ambient and potable hot water samples returned on Soyuz 62

Increment					63	
Mission					Soyuz 62	
Sample Location			Potable Water Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	WPA PWD Hot	WPA PWD Ambient
Sample Description		Test Conducted by			Potable water	Potable water
Sample Date					9/2/2020	9/23/2020
Analysis/Sample ID	Units				WQ200423	WQ200424
Physical Characteristics						
Conductivity	µS/cm	U.S.			2	< 1
pH	pH units	U.S.	4.5-8.5	41000	5.64	5.68
Minerals ICPMS						
Calcium	mg/L	U.S.	30	41000	0.02	0.01
Potassium	mg/L	U.S.	340	41000	0.02	< 0.01
Sodium	mg/L	U.S.			0.02	< 0.01
Trace Metals ICPMS						
Aluminum	µg/L	U.S.			2	2
Nickel	µg/L	U.S.	300	SWEG&41000	7	5
Silicon ICPMS						
Silicon	µg/L	U.S.			212	235
Total Organic Carbon-Sievers						
Total Inorganic Carbon (TIC)	mg/L	U.S.			0.819	0.895
Total Organic Carbon (TOC)	mg/L	U.S.	5 / 3	SWEG / 41000	1.23	0.452
Volatile Organics-Targets						
Semi-volatile Organics-Targets						
Methyl sulfone	µg/L	U.S.	1,500,000	**interim SWEG (06-2017)**	105	< 20
Organic Carbon Recovery	percent	U.S.			2.2	0.0
Unaccounted Organic Carbon	mg/L	U.S.			1.2	0.45

Comments: None.