JSC TOXICOLOGY AND ENVIRONMENTAL CHEMISTRY GROUP

Shelley Chauvin, M.Sc.
Toxicology and Environmental Chemistry
NASA JSC/SK4
Houston, TX 77058

Memorandum Number
TOX-SC-2023-01

Voice: (281) 244-0584
Fax: (281) 483-3058
shelley.c.chauvin@nasa.gov

DATE: January 23, 2023

SUBJECT: Toxicological Assessment of ISS Air and Water Quality: April 17 – October 17, 2021 (Increment 65) Including SpX-22, MLM, NG-16 and SpX-23 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

Thirteen archive air samples were collected in mini grab sample containers (mGSCs) on ISS during Increment 65. Seven routine monitoring samples were collected on May 4, June 18, July 26 and September 6, 2021. Four sets of samples were planned for collection of routine monitoring. However, the scheduled July nominal sampling was reduced from two samples to one due to the limited number of mGSCs available onboard the ISS. Four ingress samples were collected during Increment 65: SpX-22 (June 5, 2021), MLM (July 30, 2021), NG-16 (August 12, 2021) and SpX-23 (August 30, 2021). Two contingency samples were collected due to odors within Node 3 on May 29 and September 9, 2021. Additionally, four sets of formaldehyde badges were deployed during Increment 65. The badges were deployed in the US Lab and the Russian Service Module (SM) on May 4, June 18, July 26, and September 6, 2021. All badges were returned on SpX-23. A summary of the results from the Increment 65 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 65 samples were acceptable. The mean relative recoveries of the three surrogate standards from the mGSC samples returned on SpX-22 and SpX-23 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.

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) Group's 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 that returned on SpX-22 and SpX-23 confirmed that air quality was acceptable during this Increment. **T-values calculated using data from 6 of the 7 routine archive samples (mGSC) met 180-d T-value guideline criteria (T< 1), indicating no concern for crew health.** As discussed below, the routine archive air sample collected in the US lab on July 18, 2021 did not meet the

guideline criterion, due to the presence of a fluorinated compound which raised the T-value above 4. However, that compound was not detected in any other air sample during the Increment, and thus we believe this to be an isolated event and not of concern for crew health.

Table 1. Analytical summary of ISS air analyses (Increment 65)

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-22	US Lab	5/4/2021	190	5.3	0.4	19
SpaceX-22	Columbus	5/4/2021	180	5.2	0.5	--
SpaceX-22	SM	5/4/2021	--	--	--	15
SpaceX-22	Node3 Contingency	5/29/2021	190	4.1	0.2	--
SpaceX-23	SpX-22 Ingress	6/5/2021	40	2.1	0.2 (0.1)	--
SpaceX-22	US Lab	6/18/2021	220	4.5	4.3	28
SpaceX-22	SM	6/18/2021	190	10.0	0.2	18
SpaceX-23	US Lab	7/26/2021	240	3.8	0.4	21
SpaceX-23	SM[d]	7/26/2021	--	--	--	18
SpaceX-23	MLM Ingress	7/30/2021	20	9.5	1.5 (0.7)	--
SpaceX-23	NG-16 Ingress	8/12/2021	50	2.4	0.4 (0.3)	--
SpaceX-23	SpX-23 Ingress	8/30/2021	30	1.6	0.2 (0.1)	--
SpaceX-23	US Lab	9/6/2021	220	3	0.2	32
SpaceX-23	SM	9/6/2021	--	--	--	15
SpaceX-23	JPM	9/6/2021	230	3.5	0.2	--
SpaceX-23	Node3 Contingency	9/9/2021	220	3.4	0.2	--
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.

--: No data

[c] T-value <1 used to evaluate routine monthly sampling; <3 used to evaluate first ingress.

[d] Scheduled collection of routine monitoring for July was reduced from two samples to one due to the limited number of mGSCs available onboard the ISS.

Table 2. Average monthly concentrations (mg/m^3) of AQM target compounds (Increment 65)

Compound	April Average	May Average	June Average	July Average	August Average	September Average	October Average	Increment Average
2-Propanol	0.22	0.36	0.38	0.26	0.24	0.24	0.26	0.28
Acetone	0.43	0.46	0.52	0.36	0.42	0.30	0.28	0.40
Acrolein	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	MI*	MI*	MI*	MI*	MI*	MI*	MI*	MI*
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND
Decamethylcyclopentasiloxane	ND	ND	ND	ND	ND	ND	ND	ND
Hexanal	ND	ND	ND	ND	ND	ND	ND	ND
Hexane	ND	ND	ND	ND	ND	ND	ND	ND
m,p-Xylenes	ND	ND	ND	ND	ND	ND	ND	ND
Methanol	0.62	0.28	0.19	0.34	0.35	0.4	0.34	0.36
o-Xylene	ND	ND	ND	ND	ND	ND	ND	ND
Octamethylcylcotetrasiloxane	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	TRACE	0.03	0.03	0.03	0.03	0.03	0.04	0.03
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND
Acetaldehyde	0.23	TRACE	0.21	TRACE	TRACE	TRACE	0.22	TRACE
Dichloromethane	ND	ND	ND	ND	ND	ND	ND	ND
Ethanol	5.9	5.9	7.0	4.7	4.9	3.0	5.2	5.2
Ethyl Acetate	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
Hexamethycyclotrisiloxane	ND	ND	ND	ND	ND	ND	ND	ND
n-Butanol	TRACE	0.05	0.05	0.06	0.05	0.04	ND	0.05
Trimethylsilanol	ND	ND	ND	ND	ND	ND	ND	ND

TRACE: >MDL, <MQL (Minimum Quantification Limit)

ND: Not detected; <MDL (Minimum Detection Limit)

MI: matrix interference

*: AQM1 continues to detect a compound in the benzene detection window; multiple analyses confirm that benzene is not present in ISS air, so benzene is reported as "matrix interference" for Increment 65.

The reported concentrations for the compounds detected during Increment 65 are generally similar to the previous Increment 64 and remain below levels of concern for crew health. The average, rounded T-value calculated from the nominal Increment 65 mGSC samples was 0.89 (Figure 1), nearly three times that of Increment 64 (0.29). This increase can be primarily attributed to the level of heptafluoro-butanoyl fluoride as measured within the June 18, 2021 sample collected from the US Lab. The concentration of heptafluoro-butanoyl fluoride was 0.34 mg/m^3, compared to levels <0.11 mg/m^3 for the rest of the Increment. Further, this compound has not previously been observed in the ISS atmosphere. The presence of this compound led to a remarkable increase in the T-value, as little data are available to assess its toxicity and set an appropriate SMAC. The concentration was thus compared with our default SMAC of 0.1 mg/m^3, resulting in a T-value of approximately 3.4 for that compound alone. Within the same sample, fluorotrimethysilane was also elevated above normal levels (0.087 mg/m^3). These results appear to be due to transient increases in the concentrations of these compounds, although no specific activity or source has been identified that explains these findings. Importantly, the measured levels of both compounds were below levels of concern for crew health and neither concentration remained elevated.

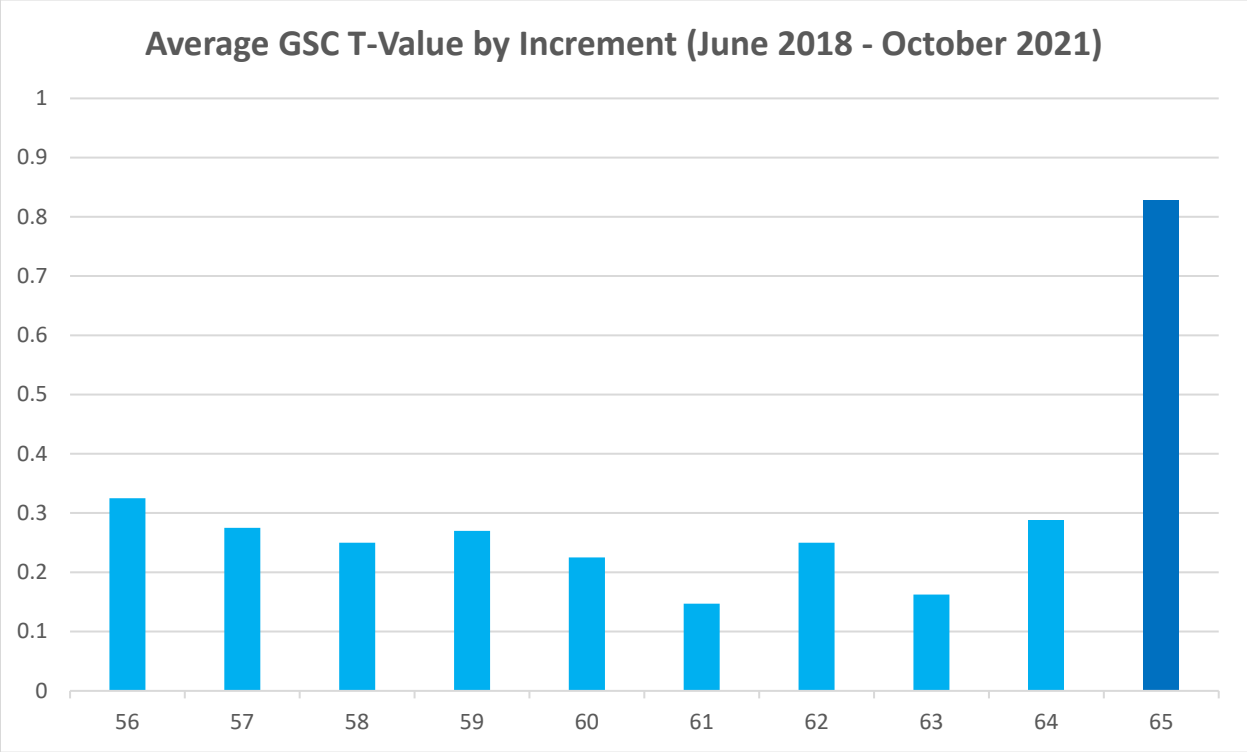

Figure 1. GSC-Derived T-values for Increments 56-65

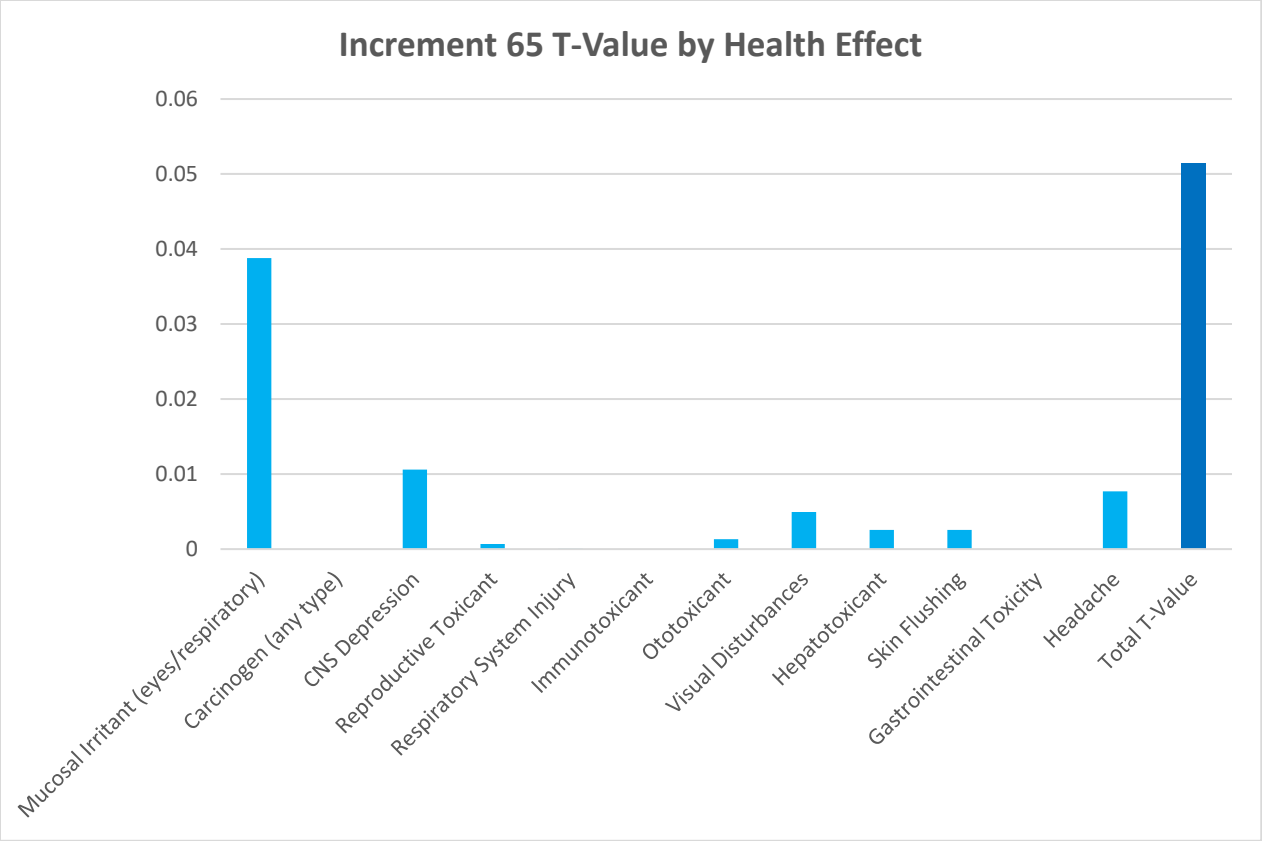

Figure 2. AQM-Derived T-Values by Health Effect for Increment 65

All of the 7 routine mGSC samples collected during Increment 65 contained a CO_2 concentration below the limit documented in Flight Note F091532D, which requests that the 24-hour average concentration not exceed a 24-hour average of 3.0 mmHg (7100 mg/m^3, 4000 ppm) on the US segment.

While mGSC CO_2 sampling provides a snapshot of the CO_2 concentration, real-time CO_2 data are available from a sensor in the Columbus module, 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 sensor throughout Increment 65. Limited CO_2 data collected by the Lab MCA during this period (data not shown) were consistent with the displayed Columbus sensor data below. Overall, CO_2 concentrations were well-controlled throughout the Increment (Figure 3). The ISS crew was comprised of 7 crew for most of the Increment, but 11 crew were briefly present in late April 2021 and 8 crew in early to mid-October.

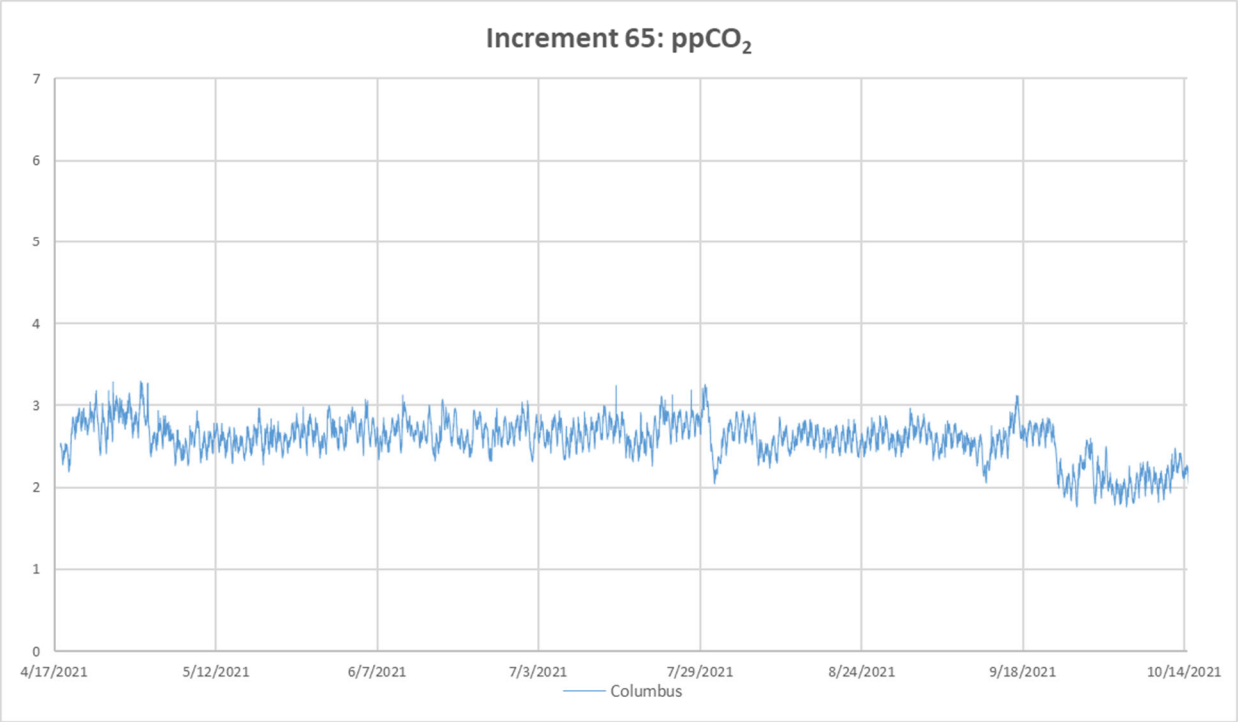

Figure 3. Environmental CO_2 Concentrations on ISS Increment 65 (mmHg)

Alcohol values for three of the routine mGSC samples returned on SpX-22 exceeded the ECLS guideline of <5 mg/m^3, but all other samples were below. The sample collected on June 18, 2021 in the SM reported total alcohols at 10 mg/m^3. The increase is attributable to ethanol (9.4 mg/m^3). The samples collected on May 4, 2021 reported total alcohols at 5.3 mg/m^3 (US Lab) and 5.2 mg/m^3 (Columbus). As expected, the samples collected in May contained increased levels of ethanol in the US Lab (4.1 mg/m^3) and Columbus (4.0 mg/m^3). The cause of increased ethanol levels in these samples is unknown, but levels in the US Lab decreased to 2.6 mg/m^3 in July. For the other samples collected, total alcohol levels generally ranged from 2.1-4.5 mg/m^3, slightly elevated than the previous Increment. For most samples across the Increment, total alcohol levels were largely attributable to ethanol. Measured levels do not present a risk to crew health.

As compared to the previous Increment 64, levels of octafluoropropane (Freon 218) increased, ranging from 180-240 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 65 (May 4, June 18, July 26, and September 6, 2021). 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 4). The concentrations in the SM ranged from 13 to 23 µg/m^3, and in the US Lab the concentration ranged from 17-33 µg/m^3, slightly higher than levels observed in Increment 64 (12-24 mg/m^3).

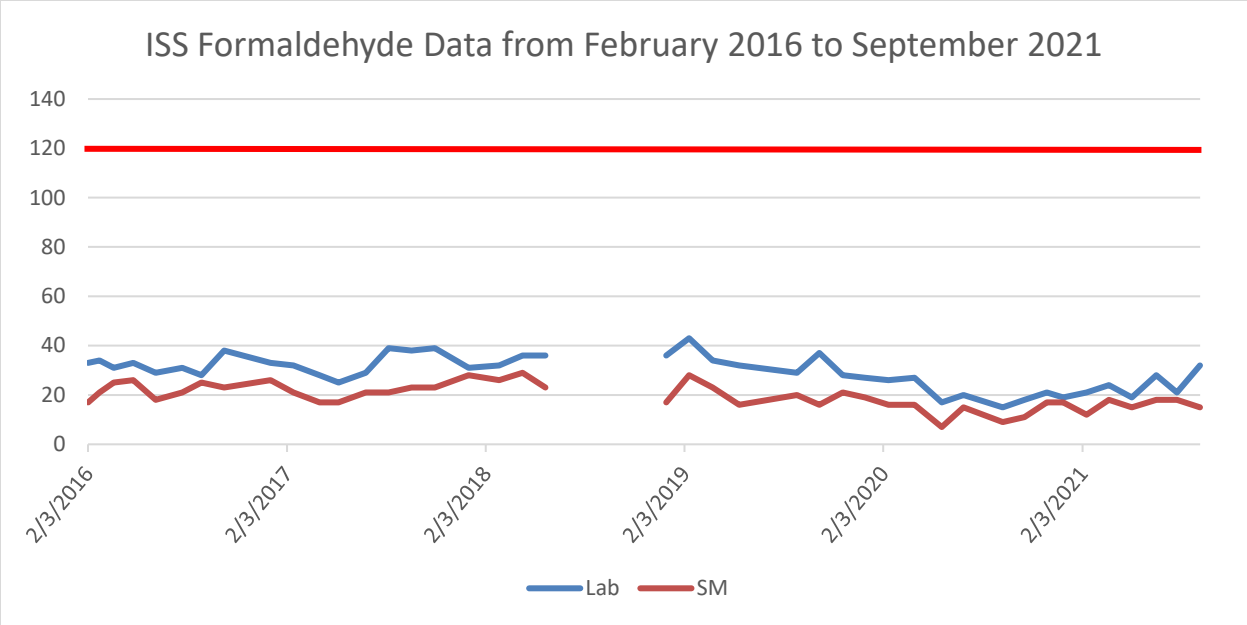

Figure 4: Formaldehyde Concentrations from February 2016 to September 2021

SpX-22 Ingress
An ingress sample was collected for SpX-22 on June 5, 2021, approximately 3 minutes after hatch opening. The octafluoropropane (Freon 218) concentration was 40 mg/m^3 for the ingress sample, much lower than the concentrations observed in the late-May (190 mg/m^3) and mid-June (220 mg/m^3) archive samples suggesting limited atmospheric mixing occurred prior to sample collection. However, the CO_2 level in the ingress sample was 1.8 mmHg (4300 mg/m^3), only slightly lower than the CO_2 level in the ISS atmosphere. The measured T-value for the SpX-22 ingress sample was 0.1 (excluding CO_2); well below levels of concern for human health.

MLM Ingress
An ingress sample was collected for MLM on July 30, 2021, approximately 11 minutes after hatch opening. The octafluoropropane (Freon 218) concentration in the ingress sample was on the order of 10% of those observed during nominal ISS sampling in late July and early September, indicating less than full mixing. However, the CO_2 concentration was approximately half of the levels observed in routine samples. The measured T-value for this ingress was 0.7 compared to 7-d SMAC values (excluding CO_2), which is well below our target level of 3 or less for ingress samples. The primary contributors were carbon monoxide, HMCTS, TMS, 1,2-dichloroethane, and o-xylene.

NG-16 Ingress
An ingress sample was collected for NG-16 on August 12, 2021, approximately 4 minutes after hatch opening. The octafluoropropane (Freon 218) and CO_2 concentrations in the ingress sample were markedly lower those observed during nominal ISS sampling in late July and early September, indicating less than full mixing. The measured T-value for this ingress was 0.3 (excluding CO_2), which is well below levels of concern for crew health.

SpX-23 Ingress
An ingress sample was collected for SpX-23 on August 30, 2021, approximately 5 minutes after hatch opening. The octafluoropropane (Freon 218) level in the ingress sample was 30 mg/m^3, compared to 220-

230 mg/m^3 detected in routine samples collected a week later, suggesting minimal mixing. However, the CO_2 level in the ingress sample was 1.6 mmHg (3800 mg/m^3), only slightly lower than the CO_2 level in the ISS atmosphere. The measured T-value for this ingress was 0.1 (excluding CO_2), which is well below levels of concern for crew health.

Node 3 Contingency Samples
Two contingency mGSC samples were collected within Node 3 during Increment 65 on May 29, 2021 and September 9, 2021. The May contingency sample was collected due to odor detection from the Brine Processor Assembly (BPA). The September sample was collected for a burning odor detected in the Service Module. No unusual compounds were detected in these samples, and no changes in compounds often detected in ISS air were observed, and thus no source for the reported odors could be determined. The measured T-value for both contingency samples was 0.2, indicating this was a habitability concern rather than a direct crew health concern.

WATER QUALITY
In total, eight samples were collected from the US Segment during Increment 65 and returned on SpX-22 and SpX-23. Four of these were potable water samples collected from the US Potable Water Dispenser (PWD): two hot water samples (June 14 and September 20, 2021) and two ambient water samples (June 30 and September 1, 2021). Samples of US condensate (June 18 and September 6, 2021) and wastewater (June 16 and September 6, 2021) were also collected during Increment 65. These samples were returned to ground for analysis on SpX-22 and SpX-23. A summary of select analytical results from the Increment 65 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 3A. Analytical Summary of ISS Water Analyses for CHeCS Samples (Increment 65)

Return Mission	Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	Methyl Sulfone (mg/L)	Conductivity (µS/cm)	Total Iodine (mg/L)
SpX-22	PWD Hot	6/14/2921	0.311	<1	0.111	1	<0.05
SpX-22	PWD Ambient	6/30/2021	0.252	<1	0.109	1	<0.05
SpX-23	PWD Ambient	9/1/2021	0.615	1.6	0.100	<1	<0.05
SpX-23	PWD Hot	9/20/2021	0.8	1.2	0.121	<1	<0.05

Table 3B. Analytical Summary of ISS Water Analyses for ECLS Samples (Increment 65)

Return Mission	Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	Methyl Sulfone (mg/L)	Conductivity (µS/cm)	Total Iodine (mg/L)
SpX-22	WPA Wastewater	6/16/2021	42.5	13.0	0.108	156	NA
SpX-22	US Condensate	6/18/2021	114	28.0	0.085	350	NA
SpX-23	WPA Wastewater	9/6/2021	17.4	11.0	0.134	138	NA
SpX-23	US Condensate	9/6/2021	79.4	17.0	0.464	290	NA

NA: not analyzed

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 April 2021 and October 2021 are shown in Figure 5. The TOC concentrations in the four 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).

The DMSD concentrations were above the 1 mg/L reporting limit in the two potable water samples (1.6 and 1.2 mg/L) from September 2021 and are similar to the average concentration seen in Increment 64. Methyl sulfone was detected in all potable water samples at levels well below the SWEG of 1,500 mg/L. Silicon was detected in all four samples (0.08, 0.12, 0.52, and 0.55 mg/L) which remain below the historical average. Based on these results, the water produced by the Water Processor Assembly (WPA) met all US potability requirements.

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. The main difference between potable water and WPA product water is the presence of iodine. For additional information regarding microbial analyses, see the Increment 65 post-flight report generated by the JSC Environmental Microbiology Laboratory.

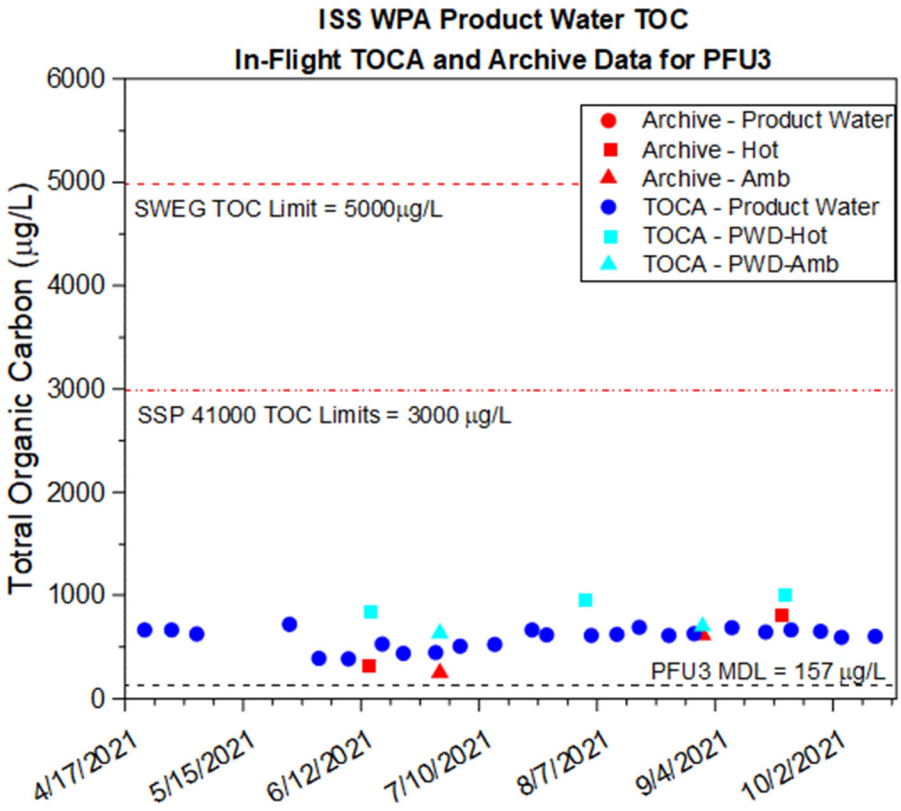

Figure 5. Total Organic Carbon (TOC) trending in US Potable Water for PFU3.

Condensate

The condensate samples collected on June 18 and September 6, 2021 contained a TOC level of 114 mg/L and 79.4 mg/L respectively, which is below the historical average (152 mg/L). Organic compounds detected at or above 1 mg/L include 2-propanol (1.2 mg/L), benzoic acid (1.5 and 2.0 mg/L), ethylene glycol (2.8 and 7.5 mg/L), acetone (3.1 and 4.0 mg/L), formate (3.1 mg/L), benzyl alcohol (5.0 and 6.0 mg/L), methanol (5.9 and 6.8 mg/L), dimethylsilanediol (DMSD, 17 and 28 mg/L), ethanol (14.0 and 29.0 mg/L), propylene glycol (40.1 and 66.6 mg/l), and acetate (43.7 and 46.2 mg/L). Silicon was present at 10.6 mg/L in June and 6.7 mg/L in September. Both measurements are below the historic average (13.3 mg/L) and can mostly be accounted for by the presence of DMSD (28 mg/L in June and 17 mg/L in September). Zinc was the only metal detected above 0.1 mg/L in both June and September samples. However, nickel was also detected above 0.1 mg/L within the June sample at 0.2 mg/L. Within both samples, trace amounts of aluminum, boron, chromium, copper, and silver were also present. In addition, the June sample showed trace amounts of manganese, strontium and vanadium; while the September sample indicated a trace amount of nickel. Trace amounts of calcium, magnesium, phosphate, sodium, and fluoride were present in both the June and September samples. Potassium was present in in trace amounts within the June sample only. Ammonium was present at a concentration of 45.3 mg/L in June and 40.3 in September, both which are slightly above the historical average of 37 mg/L. 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 samples, collected on June 16 and September 6, 2021, contained a TOC level of 42.5 mg/L and 17.4 mg/L respectively (historical average of 40.94 mg/L). The DMSD concentration for each sample was 13 mg/L in June and 11 mg/L in September. These measurements, while higher than the previous

wastewater sample (7.9 mg/L) collected during Increment 64, both are lower than the historic average of 15.3 mg/L. Silicon was present in both samples at 4.9 mg/L in June and 3.5 mg/L in September, which can be mostly accounted for by the presence of DMSD (11 mg/L and 13 mg/L Si). Zinc (2.9 mg/L in June and 2.0 mg/L in September) was the only metal detected above 0.1 mg/L in both June and September samples. However, nickel was also detected above 0.1 mg/L within the June sample at 0.12 mg/L. Traces of other metals were also present in both June and September samples, including aluminum, boron, chromium, copper, manganese, nickel, and silver. A trace amount of vanadium was noted for the June sample only. For both June and September samples, trace amounts of calcium, magnesium, phosphate, potassium, sodium and fluoride were also present. Ammonium was present at a concentration of 19.8 mg/L for June and 21.1 mg/L for September, with both measurements higher than the historical average (17.4 mg/L). As with the condensate samples, all compounds of toxicological interest were effectively cleaned from the samples by the WRS.

Shelley C. Chauvin, MSc
Toxicologist

Shelley Chauvin (affiliate)
Digitally signed by Shelley Chauvin (affiliate)
Date: 2023.02.02 09:41:12 -06'00'

E. Spencer Williams, PhD DABT
NASA Toxicologist

Edward Williams
Digitally signed by Edward Williams
Date: 2023.02.02 09:09:21 -06'00'

Valerie E. Ryder, PhD DABT
NASA Toxicologist

Valerie Ryder
Digitally signed by Valerie Ryder
Date: 2023.02.02 09:28:00 -06'00'

Enclosures
Table 1A: Analytical concentrations of compounds quantified in mGSCs collected in and returned on SpaceX-22
Table 1B: Analytical concentrations of compounds quantified in routine archive, SpaceX-22, MLM, NG-16, and SpaceX-23 ingresses mGSCs returned on SpaceX-23.
Table 2A: T-values corresponding to concentrations for routine archive mGSC samples returned on SpaceX-22, based on 180-day SMACs
Table 2B: T-values corresponding to concentrations for routine archive mGSC samples returned on SpaceX-23, based on 180-day SMACs
Table 2C: T-values corresponding to concentrations for SpaceX-22, MLM, NG-16, and SpaceX-23 ingresses air samples returned on SpaceX-23, based on 7-day and 180-day SMACs
Table 3A: Analytical concentrations of compounds quantified in potable ambient and potable water samples returned on SpaceX-22 and SpaceX-23.
Table 3B: Analytical concentrations of compounds quantified in US wastewater and US condensate returned on SpaceX-22 and SpaceX-23

TABLE 1A
ANALYTICAL RESULTS FOR SPACEX-22 RETURN NOMINAL SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/m^3)				
	AQ210614 SN2028 Lab 05/04/21 16:36	**AQ210615 SN2025 Columbus 05/04/21 16:30**	**AQ210616 SN2037 Node 3 Contingency 05/29/21 17:40**	**AQ210617 SN2029 Lab 06/18/21 09:02**	**AQ210618 SN2030 SM 06/18/21 09:10**
TARGET COMPOUNDS (TO-15) *					
1,1,1,2-Tetrafluoroethane	0.17	0.16	0.13	0.13	0.14
Isobutane	0.28	0.34	0.36	0.56	0.51
Methanol	0.42	0.46	0.37	0.38	0.37
Acetaldehyde	0.23	0.24	0.21	0.20	0.23
2-Methyl-1-propene	0.017	0.017	<0.014	0.021	0.019
Ethanol	4.1	4.0	3.2	3.4	9.4
Acetone	0.37	0.40	0.29	0.40	0.38
2-Propanol (Isopropanol)	0.28	0.31	0.21	0.30	0.24
Isoprene (2-Methyl-1,3-butadiene)	0.038	0.041	0.030	0.044	0.046
Acrylonitrile	0.016	0.016	<0.013	0.014	<0.013
1-Propanol	0.025	0.026	0.016	0.023	0.024
Trimethylsilanol	0.039	0.071	0.030	0.056	0.046
Ethyl acetate	0.024	0.024	<0.022	0.026	0.028
1-Butanol	0.033	0.037	0.028	0.042	0.040
Octafluoropropane (Perfluoropropane)	190	180	190	220	190
SPECIAL INTEREST COMPOUNDS #					
The Special Interest Compound was below its reporting limit					
NON-TARGET COMPOUNDS **					
Fluorotrimethylsilane	<0.045	<0.045	<0.045	0.087	<0.045
Heptafluoro-butanoyl fluoride	<0.11	<0.11	<0.11	0.34	<0.11
TOTAL ALCOHOLS PLUS ACETONE	**5.3**	**5.2**	**4.1**	**4.5**	**10**
TARGET COMPOUNDS (GC) *					
Methane	47	48	32	31	32
Carbon dioxide	6200	6400	5600	6000	6500
Hydrogen	9.8	10	7.3	6.3	6.2
Carbon monoxide	0.92	0.99	0.64	0.73	0.61

* Quantified using a multi-point calibration

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

< : Value is less than the laboratory reporting limit.

TABLE 1B
ANALYTICAL RESULTS FOR SPACEX-23 RETURN AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/m^3)							
	AQ210897 SN2036 SpX-22 Ingress 6/5/21 11:18	AQ210899 SN2039 Lab 7/26/21 13:00	AQ210900 SN2031 MLM Ingress 7/30/21 18:00	AQ210901 SN2042 NG-16 Ingress 8/12/21 17:05	AQ210902 SN2032 SpX-23 Ingress 8/30/21 16:40	AQ210903 SN2084 Lab 9/6/21 12:24	AQ210904 SN2107 JPM 9/6/21 12:25	AQ210905 SN2096 Contingency Node 3 9/9/21 7:25
TARGET COMPOUNDS (TO-15) *								
1,1,1,2-Tetrafluoroethane	0.26	0.14	<0.042	<0.042	3.1	0.15	0.17	0.18
Perfluoro(2-methylpentane)	<0.083	<0.083	<0.083	3.8	<0.083	<0.083	<0.083	<0.083
Propene	<0.010	0.011	0.22	<0.010	<0.010	<0.010	<0.010	0.053
Propane	<0.011	<0.011	0.066	<0.011	0.018	<0.011	0.017	0.20
Carbonyl sulfide (Carbon oxide sulfide)	<0.015	<0.015	0.24	0.039	<0.015	<0.015	<0.015	<0.015
Chloromethane	<0.012	<0.012	0.024	<0.012	<0.012	<0.012	<0.012	<0.012
Isobutane	0.12	0.47	0.083	0.40	0.17	0.37	0.42	0.37
Methanol	0.26	0.41	0.21	0.16	0.22	0.34	0.37	0.33
Acetaldehyde	0.11	0.18	0.21	0.17	0.062	0.14	0.16	0.16
2-Methyl-1-propene	<0.014	0.018	0.079	0.11	<0.014	<0.014	0.014	0.023
Butane	<0.014	<0.014	0.032	0.016	0.19	<0.014	0.026	<0.014
Chloroethane	<0.016	<0.016	<0.016	<0.016	0.078	<0.016	<0.016	<0.016
Ethanol	1.0	2.6	6.4	0.76	0.61	1.9	2.1	2.3
Freon 11 (Trichlorofluoromethane)	<0.034	<0.034	0.12	<0.034	<0.034	<0.034	<0.034	<0.034
Acetone	0.29	0.40	1.2	0.44	0.15	0.33	0.40	0.35
Propanal (Propionaldehyde)	<0.014	<0.014	<0.014	0.029	<0.014	<0.014	<0.014	<0.014
Pentane	<0.018	<0.018	0.032	0.087	<0.018	<0.018	0.088	<0.018
2-Propanol (Isopropanol)	0.50	0.30	1.0	0.87	0.55	0.34	0.55	0.33
Isoprene (2-Methyl-1,3-butadiene)	<0.017	0.048	<0.017	<0.017	<0.017	0.037	0.045	0.038
Acrylonitrile	<0.013	0.017	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013
2-Methyl-2-propanol	<0.018	<0.018	0.085	0.024	<0.018	<0.018	<0.018	<0.018
Methylene chloride (Dichloromethane)	0.044	<0.021	<0.021	0.16	0.024	<0.021	<0.021	<0.021
Carbon disulfide	<0.019	<0.019	<0.019	0.029	<0.019	<0.019	<0.019	<0.019
1-Propanol	0.023	0.038	<0.015	0.072	<0.015	0.031	0.041	0.030
Trimethylsilanol	0.18	0.075	0.68	0.49	0.070	0.078	0.14	0.061
Butanal (Butyraldehyde)	<0.018	<0.018	0.050	<0.018	<0.018	<0.018	<0.018	<0.018
2-Butanone (Methyl ethyl ketone)	0.019	<0.018	0.28	0.059	<0.018	<0.018	<0.018	<0.018
Hexane	<0.021	<0.021	0.056	<0.021	<0.021	<0.021	<0.021	<0.021
Ethyl acetate	<0.022	0.037	0.98	0.082	<0.022	0.029	0.033	0.031
1,2-Dichloroethane	<0.024	<0.024	0.22	0.030	<0.024	<0.024	<0.024	<0.024
1-Butanol	0.034	0.068	0.53	0.051	0.022	0.072	0.084	0.072
2-Methylhexane	<0.025	<0.025	0.60	0.035	<0.025	<0.025	<0.025	<0.025
2,3-Dimethylpentane	<0.025	<0.025	0.41	0.043	<0.025	<0.025	<0.025	<0.025
3-Methylhexane	<0.025	<0.025	1.0	0.074	<0.025	<0.025	<0.025	<0.025
n-Heptane	<0.025	<0.025	0.44	<0.025	<0.025	<0.025	<0.025	<0.025
Toluene	0.029	<0.023	0.66	0.042	<0.023	<0.023	<0.023	<0.023
Hexanal	<0.025	<0.025	<0.025	0.031	<0.025	<0.025	<0.025	<0.025
Butyl acetate	<0.029	<0.029	0.053	<0.029	<0.029	<0.029	<0.029	<0.029
Ethylbenzene	<0.026	<0.026	0.045	<0.026	<0.026	<0.026	<0.026	<0.026
m & p-Xylene	<0.052	<0.052	0.097	<0.052	<0.052	<0.052	<0.052	<0.052
Heptanal	<0.028	<0.028	0.029	<0.028	<0.028	<0.028	<0.028	<0.028
o-Xylene	<0.026	<0.026	5.0	<0.026	<0.026	<0.026	<0.026	<0.026
Cyclohexanone	<0.024	<0.024	0.032	<0.024	<0.024	<0.024	<0.024	<0.024
Octamethylcyclotetrasiloxane (OMCTS)	<0.12	<0.12	0.21	<0.12	<0.12	<0.12	<0.12	<0.12
Octafluoropropane (Perfluoropropane)	40	240	20	50	30	220	230	220
SPECIAL INTEREST COMPOUNDS #								
Hexamethylcyclotrisiloxane (HMCTS)	<0.18	<0.18	2.3	0.45	<0.18	<0.18	<0.18	<0.18
NON-TARGET COMPOUNDS **								
1,1-Dichloro-1-fluoroethane (Freon 141)	<0.057	<0.057	2.1	<0.057	<0.057	<0.057	<0.057	<0.057
2-Methyl-1-propanol	<0.036	<0.036	1.6	<0.036	<0.036	<0.036	<0.036	<0.036
3.3-Dimethylpentane	<0.049	<0.049	0.098	<0.049	<0.049	<0.049	<0.049	<0.049
3-Ethyl pentane	<0.049	<0.049	0.087	<0.049	<0.049	<0.049	<0.049	<0.049
Dodecane	<0.084	<0.084	<0.084	0.19	<0.084	<0.084	<0.084	<0.084
C12-Alkane	<0.084	<0.084	<0.084	0.12	<0.084	<0.084	<0.084	<0.084
C12-Alkane	<0.084	<0.084	<0.084	0.094	<0.084	<0.084	<0.084	<0.084
TOTAL ALCOHOLS PLUS ACETONE	**2.1**	**3.8**	**9.5**	**2.4**	**1.6**	**3.0**	**3.5**	**3.4**
TARGET COMPOUNDS (GC) *								
Methane	5.8	44	5.5	7.9	6.0	40	39	41
Carbon dioxide	4300	5900	3000	1700	3800	5400	6100	5300
Hydrogen	1.4	6.6	0.70	1.5	1.7	7.5	7.4	7.9
Carbon monoxide	0.98	0.62	5.0	0.74	1.7	0.72	0.71	0.84

* 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.

TABLE 2A
T-VALUES FOR SPACEX-22 RETURN NOMINAL GSC SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)				
	AQ210614 SN2028 Lab 05/04/21 16:36	**AQ210615 SN2025 Columbus 05/04/21 16:30**	**AQ210616 SN2037 Node 3 Contingency 05/29/21 17:40**	**AQ210617 SN2029 Lab 06/18/21 09:02**	**AQ210618 SN2030 SM 06/18/21 09:10**
TARGET COMPOUNDS (TO-15)					
1,1,1,2-Tetrafluoroethane	0.000	0.000	0.000	0.000	0.000
Isobutane	0.001	0.002	0.002	0.003	0.003
Methanol	0.016	0.018	0.014	0.015	0.014
Acetaldehyde	0.058	0.060	0.051	0.051	0.057
2-Methyl-1-propene	0.001	0.001	ND	0.001	0.001
Ethanol	0.002	0.002	0.002	0.002	0.005
Acetone	0.007	0.008	0.006	0.008	0.007
2-Propanol (Isopropanol)	0.002	0.002	0.001	0.002	0.002
Isoprene (2-Methyl-1,3-butadiene)	0.013	0.014	0.010	0.015	0.015
Acrylonitrile	0.228	0.225	ND	0.196	ND
1-Propanol	0.000	0.000	0.000	0.000	0.000
Trimethylsilanol	0.010	0.018	0.007	0.014	0.012
Ethyl acetate	0.000	0.000	ND	0.000	0.000
1-Butanol	0.001	0.001	0.001	0.001	0.001
Octafluoropropane (Perfluoropropane)	0.002	0.002	0.002	0.003	0.002
SPECIAL INTEREST COMPOUNDS					
The Special Interest Compound was below its reporting limit					
NON-TARGET COMPOUNDS					
Fluorotrimethylsilane	ND	ND	ND	0.038	ND
Heptafluoro-butanoyl fluoride	ND	ND	ND	3.449	ND
C12-Alkane	ND	ND	ND	ND	ND
Undecane	ND	ND	ND	ND	ND
C12-Alkane	ND	ND	ND	ND	ND
C12-Alkane	ND	ND	ND	ND	ND
TARGET COMPOUNDS (GC)					
Methane	0.014	0.014	0.009	0.009	0.009
Hydrogen	0.029	0.029	0.021	0.019	0.018
Carbon monoxide	0.054	0.058	0.038	0.043	0.036
TOTAL T-VALUE	**0.4**	**0.5**	**0.2**	**3.9**	**0.2**

ND : Value is less than the laboratory reporting limit.
Note: Number of decimal places in T-Values do not represent significant figures of measurements.
The following non-target compound interim 180-day SMACs were used in the T-value calculations for SpX-22 return only:
Heptafluoro-butanoyl fluoride: 0.1 mg/3
C12 Alkane: 19.2 mg/m3

TABLE 2B
T-VALUES FOR SPACEX-23 RETURN AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)			
	AQ210899 SN2039 Lab 7/26/21 13:00	**AQ210903 SN2084 Lab 9/6/21 12:24**	**AQ210904 SN2107 JPM 9/6/21 12:25**	**AQ210905 SN2096 Contingency Node 3 9/9/21 7:25**
TARGET COMPOUNDS (TO-15)				
1,1,1,2-Tetrafluoroethane	0.000	0.000	0.000	0.000
Propene	0.000	ND	ND	0.000
Propane	ND	ND	0.000	0.000
Isobutane	0.002	0.002	0.002	0.002
Methanol	0.016	0.013	0.014	0.013
Acetaldehyde	0.045	0.036	0.039	0.039
2-Methyl-1-propene	0.001	ND	0.001	0.001
Butane	ND	ND	0.000	ND
Ethanol	0.001	0.001	0.001	0.001
Acetone	0.008	0.006	0.008	0.007
Pentane	ND	ND	0.010	ND
2-Propanol (Isopropanol)	0.002	0.002	0.004	0.002
Isoprene (2-Methyl-1,3-butadiene)	0.016	0.012	0.015	0.013
Acrylonitrile	0.240	ND	ND	ND
1-Propanol	0.001	0.000	0.001	0.000
Trimethylsilanol	0.019	0.020	0.036	0.015
Ethyl acetate	0.000	0.000	0.000	0.000
1-Butanol	0.002	0.002	0.002	0.002
Octafluoropropane (Perfluoropropane)	0.003	0.003	0.003	0.003
SPECIAL INTEREST COMPOUNDS				
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	0.013	0.011	0.011	0.012
Hydrogen	0.019	0.022	0.022	0.023
Carbon monoxide	0.037	0.042	0.042	0.049
TOTAL T-VALUE	**0.4**	**0.2**	**0.2**	**0.2**

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-23 RETURN INGRESS SAMPLES

CHEMICAL CONTAMINANT	T-VALUE							
	7-day	180-day	7-day	180-day	7-day	180-day	7-day	180-day
	AQ210897 SN2036 SpX-22 Ingress 6/5/21 11:18	AQ210897 SN2036 SpX-22 Ingress 6/5/21 11:18	AQ210900 SN2031 MLM Ingress 7/30/21 18:00	AQ210900 SN2031 MLM Ingress 7/30/21 18:00	AQ210901 SN2042 NG-16 Ingress 8/12/21 17:05	AQ210901 SN2042 NG-16 Ingress 8/12/21 17:05	AQ210902 SN2032 SpX-23 Ingress 8/30/21 16:40	AQ210902 SN2032 SpX-23 Ingress 8/30/21 16:40
TARGET COMPOUNDS (TO-15)								
1,1,1,2-Tetrafluoroethane	0.000	0.000	ND	ND	ND	ND	0.000	0.000
Perfluoro(2-methylpentane)	ND	ND	ND	ND	0.000	0.000	ND	ND
Propene	ND	ND	0.000	0.001	ND	ND	ND	ND
Propane	ND	ND	0.000	0.000	ND	ND	0.000	0.000
Carbonyl sulfide (Carbon oxide sulfide)	ND	ND	0.003	0.012	0.000	0.002	ND	ND
Chloromethane	ND	ND	0.001	0.013	ND	ND	ND	ND
Isobutane	0.001	0.001	0.000	0.000	0.002	0.002	0.001	0.001
Methanol	0.010	0.010	0.008	0.008	0.006	0.006	0.009	0.009
Acetaldehyde	0.028	0.028	0.054	0.054	0.044	0.044	0.015	0.015
2-Methyl-1-propene	ND	ND	0.001	0.003	0.001	0.005	ND	ND
Butane	ND	ND	0.000	0.000	0.000	0.000	0.000	0.000
Chloroethane	ND	ND	ND	ND	ND	ND	0.000	0.000
Ethanol	0.001	0.001	0.003	0.003	0.000	0.000	0.000	0.000
Freon 11 (Trichlorofluoromethane)	ND	ND	0.000	0.000	ND	ND	ND	ND
Acetone	0.006	0.006	0.023	0.023	0.008	0.008	0.003	0.003
Propanal (Propionaldehyde)	ND	ND	ND	ND	0.002	0.002	ND	ND
Pentane	ND	ND	0.000	0.004	0.000	0.010	ND	ND
2-Propanol (Isopropanol)	0.003	0.003	0.007	0.007	0.006	0.006	0.004	0.004
2-Methyl-2-propanol	ND	ND	0.001	0.001	0.000	0.000	ND	ND
Methylene chloride (Dichloromethane)	0.001	0.004	ND	ND	0.003	0.016	0.000	0.002
Carbon disulfide	ND	ND	ND	ND	0.027	0.027	ND	ND
1-Propanol	0.000	0.000	ND	ND	0.001	0.001	ND	ND
Trimethylsilanol	0.046	0.046	0.169	0.169	0.123	0.123	0.018	0.018
Butanal (Butyraldehyde)	ND	ND	0.003	0.003	ND	ND	ND	ND
2-Butanone (Methyl ethyl ketone)	0.001	0.001	0.009	0.009	0.002	0.002	ND	ND
Hexane	ND	ND	0.007	0.007	ND	ND	ND	ND
Ethyl acetate	ND	ND	0.004	0.004	0.000	0.000	ND	ND
1,2-Dichloroethane	ND	ND	0.136	0.136	0.019	0.019	ND	ND
1-Butanol	0.000	0.001	0.007	0.013	0.001	0.001	0.000	0.001
2-Methylhexane	ND	ND	0.002	0.049	0.000	0.003	ND	ND
2,3-Dimethylpentane	ND	ND	0.002	0.033	0.000	0.003	ND	ND
3-Methylhexane	ND	ND	0.004	0.085	0.000	0.006	ND	ND
n-Heptane	ND	ND	0.002	0.037	ND	ND	ND	ND
Toluene	0.002	0.002	0.044	0.044	0.003	0.003	ND	ND
Hexanal	ND	ND	ND	ND	0.002	0.002	ND	ND
Butyl acetate	ND	ND	0.000	0.000	ND	ND	ND	ND
Ethylbenzene	ND	ND	0.000	0.001	ND	ND	ND	ND
m & p-Xylene	ND	ND	0.001	0.003	ND	ND	ND	ND
Heptanal	ND	ND	0.001	0.001	ND	ND	ND	ND
o-Xylene	ND	ND	0.069	0.136	ND	ND	ND	ND
Cyclohexanone	ND	ND	0.003	0.003	ND	ND	ND	ND
Octamethylcyclotetrasiloxane (OMCTS)	ND	ND	0.001	0.018	ND	ND	ND	ND
Octafluoropropane (Perfluoropropane)	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000
SPECIAL INTEREST COMPOUNDS								
Hexamethylcyclotrisiloxane (HMCTS)	ND	ND	0.026	0.255	0.005	0.050	ND	ND
NON-TARGET COMPOUNDS								
1,1-Dichloro-1-fluoroethane (Freon 141)	ND	ND	0.004	0.004	ND	ND	ND	ND
2-Methyl-1-propanol	ND	ND	0.055	0.055	ND	ND	ND	ND
3.3-Dimethylpentane	ND	ND	0.000	0.008	ND	ND	ND	ND
3-Ethyl pentane	ND	ND	0.000	0.007	ND	ND	ND	ND
Dodecane	ND	ND	ND	ND	0.000	0.009	ND	ND
C12-Alkane	ND	ND	ND	ND	0.000	0.006	ND	ND
C12-Alkane	ND	ND	ND	ND	0.000	0.004	ND	ND
TARGET COMPOUNDS (GC)								
Methane	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Hydrogen	0.004	0.004	0.002	0.002	0.004	0.004	0.005	0.005
Carbon monoxide	0.016	0.058	0.079	0.294	0.012	0.044	0.025	0.093
TOTAL T-VALUE	**0.1**	**0.2**	**0.7**	**1.5**	**0.3**	**0.4**	**0.1**	**0.2**

ND : Value is less than the laboratory reporting limit.
Note: Number of decimal places in T-Values do not represent significant figures of measurements.
The following non-target compound interim 7-day and 180-day SMACs were used in the T-Value calculation for SpX-23 return only:
1,1-Dichloro-1-fluoroethane (Freon 141): 478 mg/m3 (7d and 180d)
2-Methyl-1-propanol: 30 mg/m3 (7-d and 180-d)
Dodecane: 418 mg/m3 (7-d) and 21 mg/m3 (180-d)
C12 Alkane: 417 mg/m3 (7-d) and 21 mg/m3 (180-d)

Table 3A: Analytical concentrations of compounds quantified in potable ambient and potable water samples returned on SpaceX-22 and SpaceX-23

Increment				65			
Mission				SpaceX-22		SpaceX-23	
Sample Location				WPA PWD Hot	WPA PWD Ambient	WPA PWD Ambient	WPA PWD Hot
Sample Description	Test Conducted by	Potable Water Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Potable Water	Potable Water	Potable Water	Potable Water
Sample Date Analysis/Sample ID				6/14/2021 **WQ210256**	6/30/2021 **WQ210257**	9/1/2021 **WQ210402**	9/20/2021 **WQ210403**
Physical Characteristics							
Conductivity	U.S.			1	1	< 1	< 1
pH	U.S.	4.5-8.5	41000	5.48	5.50	5.55	5.60
Minerals ICPMS							
Calcium	U.S.	30	41000	< 0.01	0.01	0.01	0.02
Magnesium	U.S.	50	41000	< 0.01	< 0.01	0.01	0.01
Potassium	U.S.	340	41000	< 0.01	< 0.01	< 0.01	0.02
Sodium	U.S.			< 0.01	< 0.01	< 0.01	0.02
Trace Metals ICPMS							
Aluminum	U.S.			2	1	9	15
Nickel	U.S.	300	SWEG&41000	2	4	1	2
Vanadium	U.S.			2	2	< 1	< 1
Silicon ICPMS							
Silicon	U.S.			82	118	517	554
Total Organic Carbon-Sievers							
Total Inorganic Carbon (TIC)	U.S.			0.660	0.630	0.666	0.645
Total Organic Carbon (TOC)	U.S.	5 / 3	SWEG / 41000	0.311	0.252	0.615	0.800
Semi-volatile Organics-Targets							
Methyl sulfone	U.S.	1,500,000	interim SWEG (06-2017)	111	109	100	121
Silanols LCRI (Semi-Quantitative-NIST traceable standard not available)							
Dimethylsilanediol (DMSD)	U.S.	35,000	SWEG	< 1000	< 1000	1,600	1,200
Organic Carbon Recovery	U.S.			9.00	11.11	71.87	42.88
Unaccounted Organic Carbon	U.S.			0.28	0.22	0.17	0.46

Comments: None

Data Qualifiers: Possible low bias: WQ210256, -257,-258 & -259 trans-1,3-Dichloropropene

Possible high bias: WQ210258 & -259 2-Ethoxyethanol; Matrix inteferences: WQ210258 & -259 Ethanol (MS rec. 65%) & Methanol (MS rec. 136%)

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 US wastewater and US condensate returned on SpaceX-22 and SpaceX-23

Increment				65			
Mission				SpaceX-22		SpaceX-23	
Sample Location				WPA Wastewater ORU	WPA Condensate Sample Port	WPA Wastewater ORU	WPA Condensate Sample Port
Sample Description				WPA Wastewater	US Condensate	WPA Wastewater	US Condensate
Sample Date				6/16/2021	6/18/2021	9/6/2021	9/6/2021
Analysis/Sample ID	Test Conducted by	Potable Water Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	WQ210258	WQ210259	WQ210404	WQ210405
Physical Characteristics							
Conductivity	U.S.			156	350	138	290
pH	U.S.	4.5-8.5	41000	7.65	7.67	7.45	7.68
Anions IC							
Fluoride	U.S.			0.3	0.3	0.4	0.2
Cations IC							
Ammonium (as N)	U.S.	1	SWEG&41000	19.8	45.3	21.1	40.3
Minerals ICPMS							
Calcium	U.S.	30	41000	0.19	0.22	0.12	0.19
Magnesium	U.S.	50	41000	0.07	0.06	0.03	0.06
Phosphate (as P)	U.S.			0.08	0.02	0.56	0.03
Potassium	U.S.	340	41000	0.10	0.04	0.33	< 0.01
Sodium	U.S.			0.13	0.08	0.37	0.07
Trace Metals ICPMS							
Aluminum	U.S.			4	6	6	6
Boron	U.S.			21	36	20	34
Chromium	U.S.	230	41000	13	1	67	2
Copper	U.S.	1,000	41000	2	10	1	2
Manganese	U.S.	300	SWEG&41000	8	13	2	< 1
Nickel	U.S.	300	SWEG&41000	123	162	69	60
Silver	U.S.	400	SWEG&41000	3	6	3	6
Strontium	U.S.			< 1	1	< 1	< 1
Vanadium	U.S.			2	1	< 1	< 1
Zinc	U.S.	2,000	SWEG&41000	2,940	592	1,990	670
Silicon ICPMS							
Silicon	U.S.			4,890	10,600	3,500	6,720
Total Organic Carbon-Sievers							
Total Inorganic Carbon (TIC)	U.S.			16.4	24.1	16.8	22.8
Total Organic Carbon (TOC)	U.S.	5 / 3	SWEG / 41000	42.5	114	17.4	79.4
Volatile Organics-Targets							
2-Butanone (Methyl ethyl ketone)	U.S.	54,000	SWEG	438	< 25	< 50	< 50
Acetone	U.S.	15,000	SWEG	See Alcohols	See Alcohols	< 50	See Alcohols
Volatile Organics-Special Interest Compounds (Semi-quantitative)							
Acetaldehyde	U.S.			not found	460	not found	not found
Trimethylsilanol	U.S.			67	110	75	140
Semi-volatile Organics-Targets							
Benzothiazole	U.S.			43	23	45	148
bis-(2-Ethylhexyl)adipate	U.S.	400	EPA	48	27	< 20	< 100
Decamethylcyclopentasiloxane (DMCPS)	U.S.			28	19	29	130
Dodecamethylcyclohexasiloxane	U.S.			32	< 10	34	156
Methyl sulfone	U.S.	1,500,000	interim SWEG (06-2017)	108	85	134	464
N-n-Butylbenzenesulfonamide	U.S.			41	< 10	< 20	< 100
Tris(2-Chloroethyl)phosphate	U.S.			57	30	< 20	< 100
Acid Extractables-EPA 625 List GCMS							
4-Methylphenol (p-Cresol)	U.S.			277	< 10	< 20	< 100
Benzoic acid	U.S.			77	1,520	< 40	1,990
Phenol	U.S.	4,000	SWEG	92	57	< 20	< 100
Base and Neutral Extractables-EPA 625 List GCMS							
Benzyl alcohol	U.S.			823	5,990	< 20	5,080
bis-(2-Ethylhexyl)phthalate	U.S.	20,000/6	SWEG/EPA	182	138	< 20	< 100
Diethylphthalate	U.S.			143	231	103	287
Di-n-butylphthalate	U.S.	40,000	SWEG	25	15	< 20	< 100
Semi-volatile Organics-Special Interest Compounds (Semi-quantitative)							
1-Methyl-2-pyrrolidinone	U.S.			120	170	not found	< 400
2-(2-Butoxyethoxy)ethanol	U.S.			110	not found	not found	not found
2-Butoxyethanol	U.S.			54	56	not found	not found
2-Ethoxyethanol	U.S.			170	170	not found	720
2-Ethylhexanoic acid	U.S.			not found	100	not found	250
2-Phenoxyethanol	U.S.			23	270	not found	170
2-Phenyl-2-propanol	U.S.			46	69	not found	not found
Benzaldehyde	U.S.			< 20	64	not found	not found
Dipropylene glycol methyl ether	U.S.			120	not found	not found	not found
Heptanoic acid	U.S.			not found	69	not found	not found
Hexanoic acid (Caprolate)	U.S.			not found	210	not found	not found
Ibuprofen	U.S.			410	180	480	not found
N,N-Diethylformamide	U.S.			< 20	13	not found	not found
N,N-Dimethyl acetamide	U.S.			< 80	120	< 40	280
N,N-Dimethylformamide	U.S.			300	200	not found	1,400
Neomenthol	U.S.			39	not found	40	not found
Nonanoic acid	U.S.			not found	72	not found	not found
Palmitic acid	U.S.			600	300	not found	not found

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 US wastewater and US condensate returned on SpaceX-22 and SpaceX-23

Increment				65			
Mission				SpaceX-22		SpaceX-23	
Sample Location		Potable Water Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	WPA Wastewater ORU	WPA Condensate Sample Port	WPA Wastewater ORU	WPA Condensate Sample Port
Sample Description				WPA Wastewater	US Condensate	WPA Wastewater	US Condensate
Sample Date	Test Conducted by			6/16/2021	6/18/2021	9/6/2021	9/6/2021
Analysis/Sample ID				**WQ210258**	**WQ210259**	**WQ210404**	**WQ210405**
Phenethyl alcohol	U.S.			not found	15	not found	not found
Tributyl phosphate	U.S.			13	8	not found	not found
Triethyl phosphate	U.S.			< 10	20	not found	not found
Alcohols & Acetone GCMS							
2-Propanol (Isopropanol)	U.S.			506	1,240	< 400	< 800
Acetone	U.S.	15,000	SWEG	10,900	3,100	See Volatiles	3,990
Ethanol	U.S.			10,500	29,000	< 400	13,600
Methanol	U.S.	40,000	SWEG	6,440	6,780	4,960	5,880
Glycols GCMS							
1,2-Ethanediol (Ethylene glycol)	U.S.	4000	SWEG	1,240	2,760	1,110	7,540
1,2-Propanediol (Propylene glycol)	U.S.	1,700,000	SWEG	5,870	40,100	1,700	66,600
Silanols LCRI (Semi-Quantitative-NIST traceable standard not available)							
Dimethylsilanediol (DMSD)	U.S.	35,000	SWEG	13,000	28,000	11,000	17,000
Carboxylates IC							
Acetate	U.S.			< 500	46,200	< 500	43,700
Formate	U.S.	2,500,000	SWEG	< 500	3,110	< 500	< 500
Propionate	U.S.			< 500	760	< 500	< 500
Aldehydes GCMS							
Formaldehyde (Methanal)	U.S.	12,000	SWEG	< 10	530	< 10	112
Non-volatile Organics LC							
Caprolactam	U.S.	100,000	SWEG	< 500	789	< 500	< 500
Organic Carbon Recovery	U.S.			57.96	67.02	37.51	95.48
Unaccounted Organic Carbon	U.S.			17.85	37.45	10.88	3.59

Comments: None

Data Qualifiers: Possible low bias: WQ210256, -257,-258 & -259 trans-1,3-Dichloropropene

Possible high bias: WQ210258 & -259 2-Ethoxyethanol; Matrix inteferences: WQ210258 & -259 Ethanol (MS rec. 65%) & Methanol (MS rec. 136%)

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