JSC TOXICOLOGY AND ENVIRONMENTAL CHEMISTRY GROUP

E. Spencer Williams, PhD, DABT
Toxicology and Environmental Chemistry
NASA JSC/SK4
Houston, TX 77058

Memorandum Number
TOX-SW-2020-04

Voice: (281) 483-8921
Fax: (281) 483-3058
edward.s.williams@nasa.gov

DATE: November 10, 2020

SUBJECT: Toxicological Assessment of ISS Air and Water Quality: February 6 – April 17, 2020 (Increment 62) Including NG-13 and SpX-20 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

Six archive air samples were collected in mini grab sample containers (mGSCs) on ISS during Increment 62; two each on February 12 and March 31, 2020, as well as ingress samples for NG-13 (February 18, 2020) and SpX-20 (March 9, 2020). These samples were all returned on SpX-20. Additionally, two sets of formaldehyde badges were deployed during Increment 62. The badges were deployed in the US Lab and the Russian Service Module (SM) on February 12 and March 31, 2020. All Increment 62 formaldehyde badges were returned on Soyuz 61. A summary of the results from the Increment 62 samples is provided in Table 1.

Table 1. Analytical summary of ISS air analyses (Increment 62)

Return Flight	Sample Location	Sample Date	Freon 218 (mg/m^3)	Alcohols[a] (mg/m^3)	T-Value[b] (units)	Formaldehyde[c] ($\mu g/m^3$)
SpaceX-20	US Lab	2/12/2020	140	5.0	0.3	26
SpaceX-20	JPM	2/12/2020	150	4.8	0.3	16[e]
SpaceX-20	NG-13 ingress	2/18/2020	12	2.8	0.4 (0.2)	--
SpaceX-20	SpX-20 ingress	3/9/2020	37	2.0	0.2 (0.1)	--
SpaceX-20	US Lab	3/31/2020	130	4.8	0.3	27
SpaceX-20	Columbus	3/31/2020	110	4.2	0.1	<16[e]
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] All formaldehyde badges were returned on Soyuz 61S.
[d] T-value <1 used to evaluate routine monthly sampling; <3 used to evaluate first ingress
[e] These formaldehyde samples were collected in the Russian SM

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 62 samples were considered acceptable, but the pressure reading for the mGSC sample collected

in Columbus on March 31, 2020 was slightly low. Consequently, the reporting limits for this sample are higher than the other Increment 62 samples. The mean relative recoveries of the three surrogate standards from the mGSC samples returned on SpX-20 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	February Average	March Average	April Average	Increment Average
2-Propanol	MI	MI	MI	MI
Acetone	0.21	0.17	0.19	0.19
Acrolein	ND	TRACE	ND	ND
Benzene	ND	ND	TRACE*	ND
1,2-Dichloroethane	ND	ND	ND	ND
Decamethylcyclopentasiloxane#	ND	ND	ND	ND
Hexanal	ND	ND	ND	ND
Hexane	ND	ND	ND	ND
m,p-Xylenes#	ND	ND	ND	ND
Methanol	0.23	0.23	0.23	0.23
o-Xylene#	ND	ND	ND	ND
Octamethylcylcotetrasiloxane#	ND	ND	ND	ND
Toluene#	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND
Acetaldehyde	TRACE	TRACE	TRACE	TRACE
Dichloromethane	ND	ND	ND	ND
Ethanol	4.9	3.6	4.3	4.3
Ethyl Acetate	ND	ND	ND	ND
Hexamethycyclotrisiloxane#	ND	ND	ND	ND
n-Butanol	ND	ND	ND	ND
Trimethylsilanol	ND	ND	ND	ND

Obtained from prime unit
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.

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-20 confirmed air quality was acceptable. **T-values calculated using data from the routine samples (mGSC and AQM) 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 62 were similar to levels detected during recent Increments. The average, rounded T-value calculated from the nominal Increment 62 mGSC samples was 0.25 (Figure 1). The T-values calculated from GSC results (Figure 1; 0.25) and AQM (Figure 2; 0.22) were in close agreement during Increment 62.The increase in the T-value calculated from the AQM data relative to the previous Increment is due to acrolein and benzene being detected at trace levels. Neither compound was detected in any of the mGSCs collected during Increment 62.

Figure 1. GSC-Derived T-values for Increments 53- 62

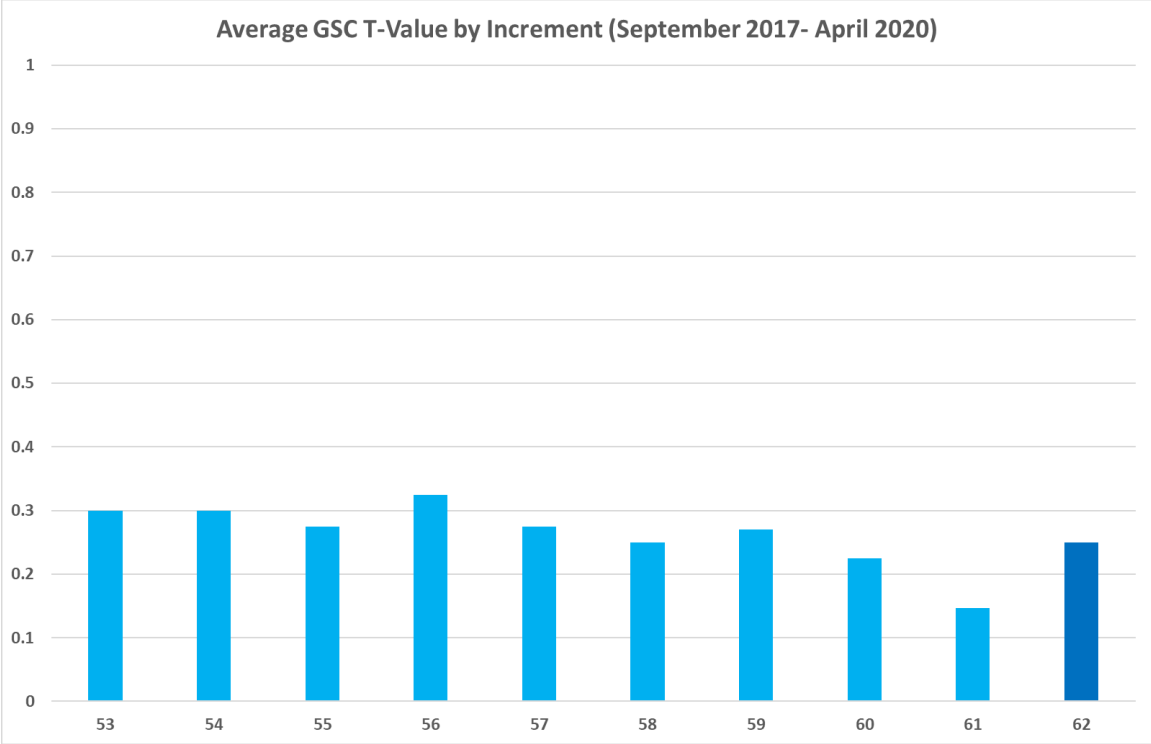
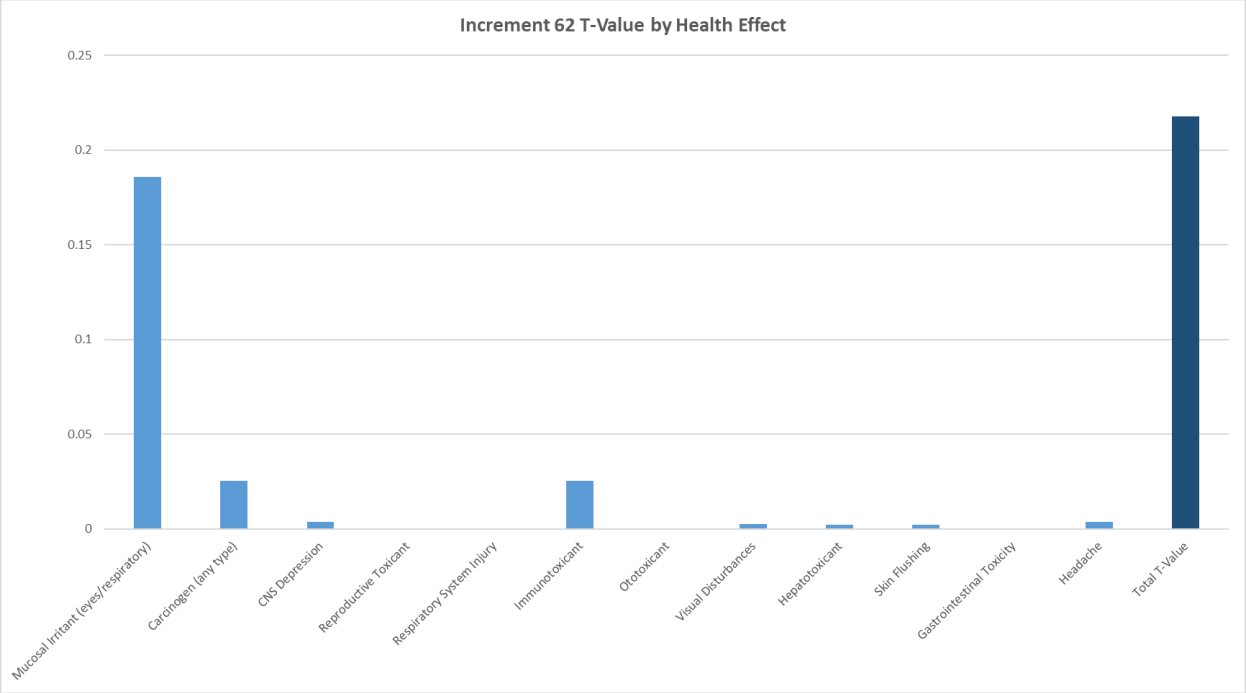


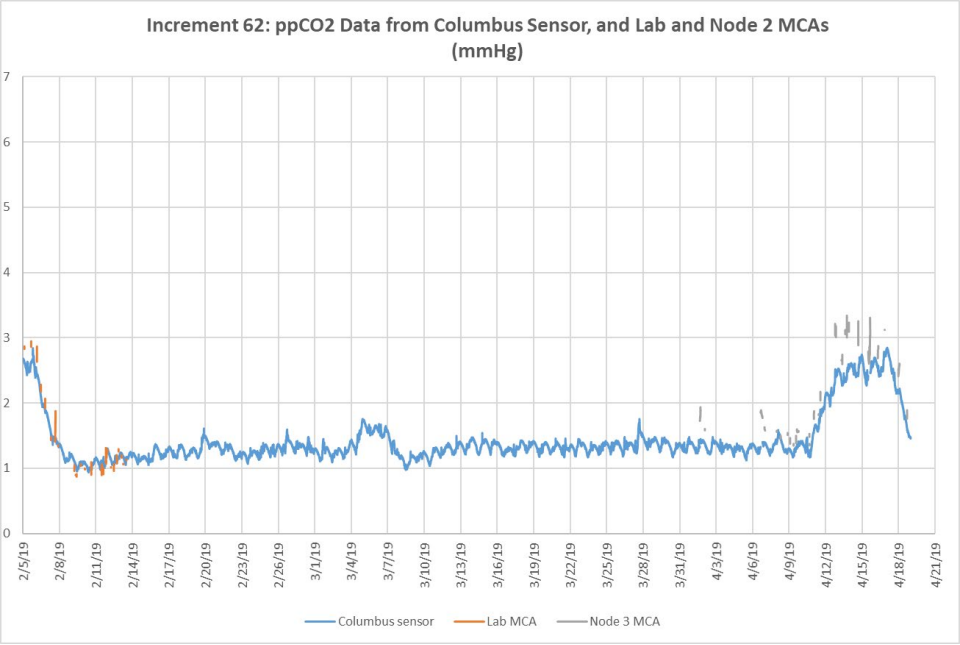
Figure 2. AQM-Derived T-Values by Health Effect for Increment 62



The last two AQM runs during Increment 62 occurred on April 13 and 16, 2020. The AQM registered the presence of benzene near the reporting limit in both runs. This observation continued into Increment 63. A complete discussion of this anomaly and the associated data will be summarized in a forthcoming report, Benzene in ISS Air April 13-August 2, 2020.

All four routine mGSC samples collected during Increment 62 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 is available from sensors in the Columbus module and SM, and intermittently from the Major Constituent Analyzer (MCA) (Figure 3). 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.

Figure 3. Environmental CO_2 Concentrations on ISS Increment 62 in mmHg



CO_2 data were obtained from the Columbus sensor throughout the Increment. Limited data were available from the Lab and Node 3 MCAs. To preserve the longevity of the instrumentation, the MCAs were transitioned to intermittent operations starting in mid-February. The MCAs are only activated during EVA activities, crew metabolic characterization, tech demo analysis, anomaly resolution, and when requested by crew surgeons. 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. The ISS crew was comprised of 3 crew from the beginning the Increment until the arrival of Soyuz 61 on April 12, 2020. The Node 3 MCA was activated in early April in advance of 6 crew operations. Based on the available data, CO_2 did not exceed 4 mmHg during Increment 62. No EVA activity occurred during this Increment.

Alcohol values in one of the six routine mGSC samples returned on SpaceX-20 fell at the upper limit of the guideline of <5 mg/m^3, which is intended to protect the water recovery system from risk of overloading. The majority of the total alcohol levels in the Increment 62 samples was attributable to ethanol (2.8-3.6 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 but could adversely impact the lifetime of consumables in the water recovery system.

Levels of octafluoropropane (Freon 218) rose in Increment 61, following a coolant leak from CKB during maintenance activities on October 9, 2019. Samples collected in August (Increment 60) and in October (Increment 61) had concentrations of octafluoropropane ranging from 21-26 mg/m^3. An increase in levels was observed in samples collected in November (146 mg/m^3 in the US Lab and 161 mg/m^3 in Columbus) and December (177 mg/m^3 in the US Lab and 85 mg/m^3 in the Russian SM). Concentrations of Freon 218 were similar in February and March (110-150 mg/m^3) to the range observed in November and December. These concentrations are well below levels of concern for crew health.

Two sets of passive formaldehyde badges were deployed on ISS during Increment 62 (February 12, March 31, 2020). Analytical results from 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 undetected to 16 µg/m^3, and in the US Lab the concentration ranged from 26-27 µg/m^3, slightly lower than levels observed in recent Increments.

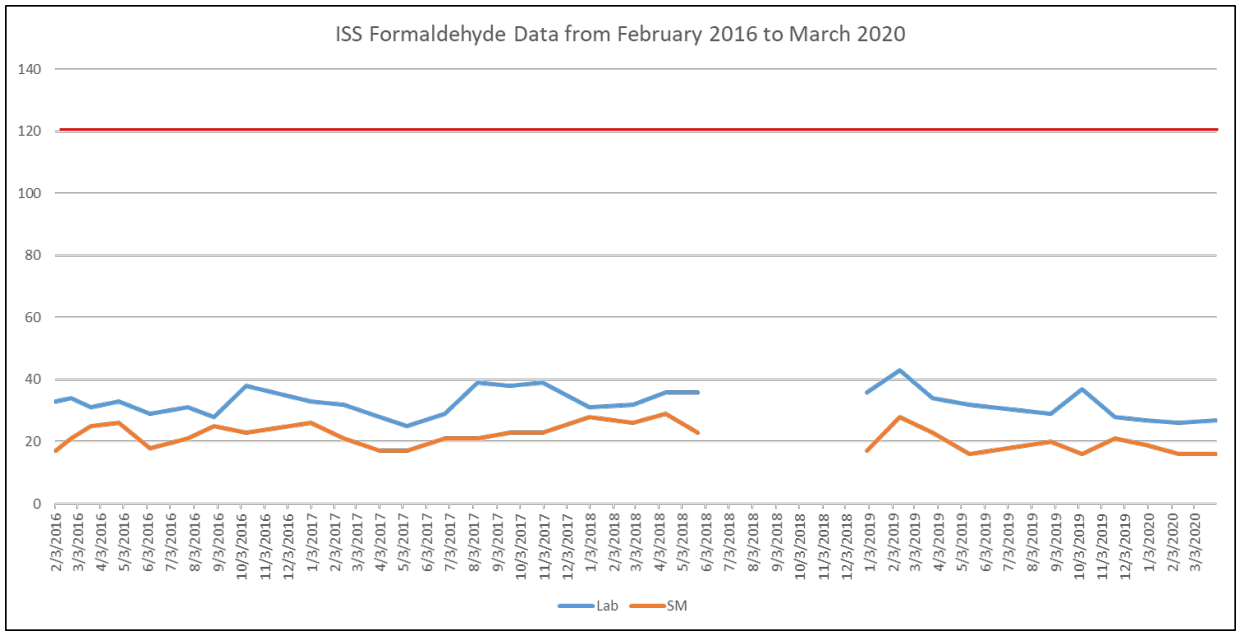


Figure 4: Formaldehyde Concentrations from February 2016 to March 2020

NG-13 Ingress

A sample was collected in an mGSC upon ingress into NG-13 on February 18, 2020, approximately 4 minutes after hatch opening. Levels of CO_2 in the ingress sample were 1500 mg/m^3 (0.6 mmHg), indicating that a relatively low level of mixing had occurred with ISS air before the sample was collected. This is further supported by the concentration of Freon 218 in this sample, which was 12 mg/m^3 compared to 140-150 mg/m^3 in samples collected in ISS in mid-February. **The calculated T-value for this ingress sample (0.2, excluding CO_2) is well below levels of concern for crew health.**

SpaceX-20 Ingress
An additional sample was collected in an mGSC upon ingress into SpaceX-20 on March 9, 2020, approximately 3 minutes after hatch opening. The octafluoropropane (Freon 218) concentration in the ingress sample was 37 mg/m^3, notably lower than the 140-150 mg/m^3 observed on ISS in mid-February. The carbon dioxide concentration in the ingress sample (1600 mg/m^3; 0.7 mmHg) also indicates a low level of mixing. **The measured T-value for this ingress (0.1, 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 62: a hot water sample on March 12 and an ambient water sample on April 8, 2020. A sample of WPA product water was also collected on March 23, 2020. In addition to the potable and product water samples, samples of WPA wastewater, MF bed effluent, and US condensate were collected during the Increment. All samples except the PWD ambient sample (Soyuz 61) were returned on SpaceX-20. A summary of select analytical results from the Increment 62 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 62)

Return Mission	Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	Methyl Sulfone (mg/L)	Conductivity (µS/cm)	Total Iodine (mg/L)
SpaceX-20	PWD Hot	3/12/2020	0.6	<1	0.05	1	<0.05
SpaceX-20	WPA Product Water	3/23/2020	0.3	<1	<0.05	2	2.42
Soyuz 61	PWD Ambient	4/8/2020	0.7	<1	0.05	1	<0.05
SpaceX-20	US Condensate	3/13/2020	10.40	3.9	<0.05	186	NA
SpaceX-20	MF Bed Effluent	4/1/2020	9.2	3.4	0.05	3	NA
SpaceX-20	WPA Wastewater	4/1/2020	27.50	6.9	0.2	169	NA

NA: not analyzed

Toxicological Evaluation of ISS Water Quality

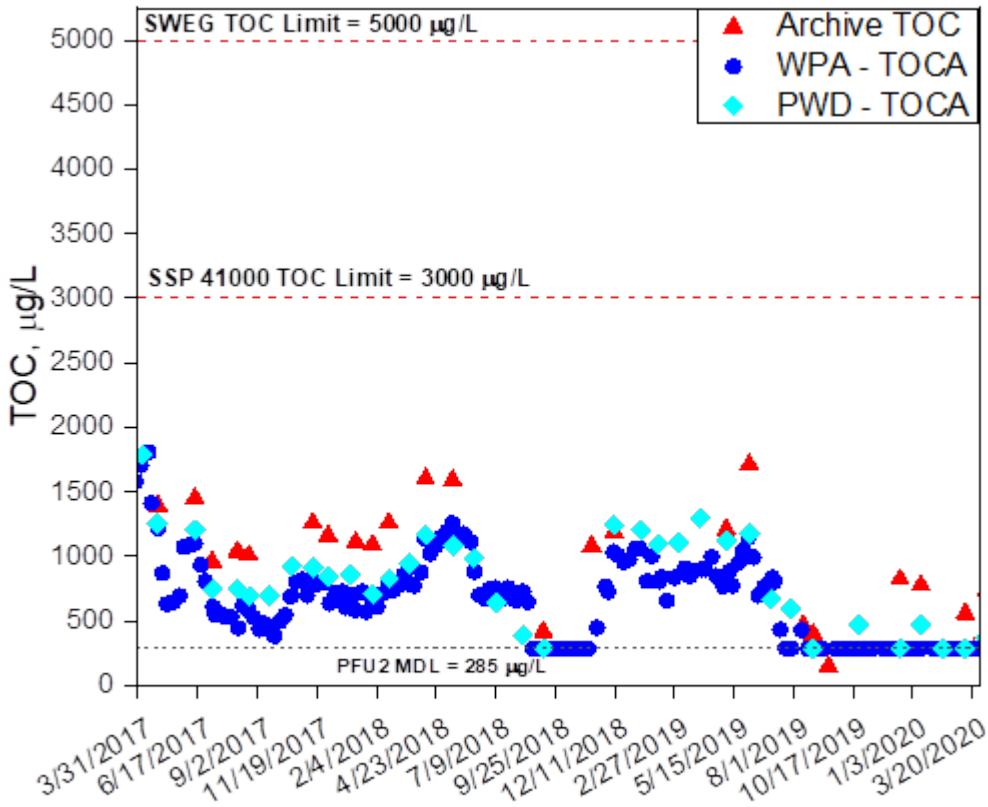
Routine water quality monitoring is performed in-flight using the total organic carbon analyzer (TOCA). Results from these analyses provide a general indication of overall water quality. Typically, archive water samples are also collected during each Increment and returned for comprehensive analysis 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 March 2017 and March 2020 are shown in Figure 5. The TOC concentrations in the two potable samples and product water fell markedly from those observed in Increment 61 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 remained below 1 mg/L in the potable water samples. **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 61 (~0.05 mg/L), well below the SWEG of 1,500 mg/L. Silicon was detected in both samples (0.16-0.21 mg/L) at levels slightly lower than what was measured in the Increment 61 samples, consistent with the downward trend in DMSD levels over that period.

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 62 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. The iodine concentration in the WPA product water samples was 1.74 mg/L, which is in the expected range of 1-4 mg/L. Aside from a slightly higher level of nickel (0.8 mg/L), the concentrations of all other parameters measured in the product water were similar to levels found in the potable water samples.

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



US Condensate

A sample of condensate from the US segment was collected on March 13, 2020. The TOC concentration in the sample was 10.4 mg/L, the lowest concentration observed in the US segment. Organic compounds detected at or above 1 mg/L included only DMSD (3.9 mg/L) and acetone (2.2 mg/L). The organic carbon recovery was 25.6%, markedly lower than in recent Increments. Neither ethanol nor isopropanol were detected in this sample, which likely contributed to the low TOC as these compounds often account for a large portion of TOC in condensate samples. The silicon concentration was 1.5 mg/L, which can be

accounted for by the presence of DMSD. Trace amounts of aluminum, boron, chromium, nickel, and silver were also detected.

MF Bed Effluent
A sample of MF bed effluent was collected on April 1, 2020. The TOC concentration was 9.24 mg/L. Organic compounds present in concentrations greater than 0.5 mg/L include ethanol (7.8 mg/L), methanol (4.8 mg/L), DMSD (3.4 mg/L), acetone (3.0 mg/L), and isopropanol (2.4 mg/L). The organic carbon accountability was >100%. Silicon was present at 1.1 mg/L, which is attributable to the presence of DMSD. Metals present in the sample included zinc (0.15 mg/L), nickel (0.06 mg/L), and boron (0.02 mg/L), along with trace amounts of aluminum, calcium, and phosphate.

US Wastewater
A sample of wastewater was collected on April 1, 2020. The TOC concentration was 27.5 mg/L, which is higher than what was observed in the Increment 61 sample, but lower than the historical average of 41.4 mg/L. Organic compounds detected at or above 1 mg/L include acetone (7.0 mg/L), DMSD (6.9 mg/L), and methanol (4.2 mg/L). Organic carbon accountability was only 34%, likely due to the low levels of ethanol and isopropanol in the sample. The silicon concentration was 2.8 mg/L, which is mostly attributable to DMSD (2.1 mg/L). Zinc (1.1 mg/L) was the only metal present at levels above 0.1 mg/L. Ammonium was present at a concentration of 23 mg/L, which is higher than the historical average of 17.3 mg/L.

E. Spencer Williams, PhD DABT
NASA Toxicologist

Edward Williams
Digitally signed by Edward Williams
Date: 2020.11.16 14:22:27 -06'00'

Valerie E. Ryder, PhD DABT
NASA Toxicologist

Valerie Ryder
Digitally signed by Valerie Ryder
Date: 2020.11.16 14:34:51 -06'00'

Enclosures
Table 1: Analytical concentrations of compounds quantified in the mGSC samples returned on SpaceX-20
Table 2A: T-values corresponding to concentrations for routine mGSC samples returned on SpaceX-20, based on 180-day SMACs
Table 2B: T-values corresponding to concentrations for NG-13 and SpaceX-20 ingress air samples, based on 7-day and 180-day SMACs
Table 3A: Analytical concentrations of compounds quantified in potable ambient, potable hot, and product water samples returned on SpaceX-20 and Soyuz 61
Table 3B: Analytical concentrations of compounds quantified in US wastewater, US condensate, and MF bed effluent returned on SpaceX-20

TABLE 1
ANALYTICAL RESULTS FOR SPACEX-20 RETURN AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)					
	AQ200380 S/N 2047 LAB 2/12/20 @ 14:54	**AQ200381 S/N 2052 JPM 2/12/20 @ 14:55**	**AQ200382 S/N 2057 NG-13 INGRESS 2/18/20 @ 16:23**	**AQ200383 S/N 2053 SpX-20 INGRESS 3/9/20 @ 18:07**	**AQ200384 S/N 2051 LAB 3/31/20 @ 18:21**	**AQ200385 S/N 2048 COLUMBUS 3/31/20 @ 18:19**
TARGET COMPOUNDS (TO-15) *						
1,1,1,2-Tetrafluoroethane (Norflurane)	0.093	0.10	<0.050	0.28	0.11	<0.18
Propene	0.10	0.10	TRACE	0.059	0.053	TRACE
Propane	<0.025	<0.025	<0.025	0.041	<0.025	<0.050
Carbonyl sulfide (Carbon oxide sulfide)	<0.025	<0.025	0.038	<0.025	<0.025	<0.075
Isobutane	<0.025	<0.025	0.15	<0.025	<0.025	<0.075
Methanol	0.34	0.35	0.15	0.30	0.35	0.35
Acetaldehyde	0.14	0.14	0.26	0.14	0.18	0.19
2-Methyl-1-propene	<0.025	<0.025	0.12	<0.025	<0.025	<0.075
Ethanol	3.6	3.4	1.2	1.1	3.6	2.8
Acetone	0.24	0.25	0.29	0.13	0.21	0.38
Propanal (Propionaldehyde)	<0.025	<0.025	0.042	<0.025	<0.025	<0.075
2-Propanol (Isopropanol)	0.76	0.71	1.1	0.43	0.61	0.68
Isoprene (2-Methyl-1,3-butadiene)	<0.025	<0.025	<0.025	<0.025	TRACE	<0.075
Acrylonitrile	TRACE	TRACE	<0.025	<0.025	TRACE	<0.075
2-Methyl-2-propanol	<0.025	<0.025	TRACE	<0.025	<0.025	<0.075
Methyl acetate	<0.025	<0.025	0.055	<0.025	<0.025	<0.075
Methylene chloride (Dichloromethane)	TRACE	<0.025	0.71	0.15	0.037	<0.10
Carbon disulfide	<0.025	<0.025	TRACE	<0.025	<0.025	<0.10
1-Propanol	0.039	0.046	0.029	<0.025	0.041	<0.075
Trimethylsilanol	<0.025	0.040	0.28	0.047	TRACE	<0.10
Butanal (Butyraldehyde)	<0.025	<0.025	TRACE	<0.025	<0.025	<0.075
2-Butanone (Methyl ethyl ketone)	<0.025	<0.025	0.093	TRACE	<0.025	<0.075
Ethyl acetate	<0.025	<0.025	0.070	<0.025	<0.025	<0.10
1-Butanol	<0.025	<0.025	0.054	0.027	<0.025	<0.075
Toluene	<0.025	<0.025	0.034	<0.025	<0.025	<0.10
Hexanal	<0.025	<0.025	0.025	<0.025	<0.025	<0.12
Octafluoropropane (Perfluoropropane)	140	150	12	37	130	110
SPECIAL INTEREST COMPOUND #						
Hexamethylcyclotrisiloxane (HMCTS)	<0.20	<0.20	1.1	<0.20	<0.20	<0.75
NON-TARGET COMPOUNDS **						
All Non-Target Compounds were below their reporting limit						
TOTAL ALCOHOLS PLUS ACETONE	**5.0**	**4.8**	**2.8**	**2.0**	**4.8**	**4.2**
TARGET COMPOUNDS (GC) *						
Methane	48	49	4.5	8.7	26	24
Carbon dioxide	2700	2700	1500	1600	3500	3000
Hydrogen	3.4	3.5	0.32	0.90	3.5	2.9
Carbon monoxide	0.63	0.69	0.83	1.3	0.39	<1.4

* 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-20 RETURN AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)			
	AQ200380 S/N 2047 LAB 2/12/20 @ 14:54	**AQ200381 S/N 2052 JPM 2/12/20 @ 14:55**	**AQ200384 S/N 2051 LAB 3/31/20 @ 18:21**	**AQ200385 S/N 2048 COLUMBUS 3/31/20 @ 18:19**
TARGET COMPOUNDS (TO-15)				
1,1,1,2-Tetrafluoroethane (Norflurane)	0.000	0.000	0.000	ND
Propene	0.000	0.000	0.000	0.000
Methanol	0.013	0.014	0.014	0.013
Acetaldehyde	0.036	0.035	0.045	0.047
Ethanol	0.002	0.002	0.002	0.001
Acetone	0.005	0.005	0.004	0.007
2-Propanol (Isopropanol)	0.005	0.005	0.004	0.005
Isoprene (2-Methyl-1,3-butadiene)	ND	ND	0.004	ND
Acrylonitrile	0.179	0.179	0.179	ND
Methylene chloride (Dichloromethane)	0.001	ND	0.004	ND
1-Propanol	0.001	0.001	0.001	ND
Trimethylsilanol	ND	0.010	0.003	ND
Octafluoropropane (Perfluoropropane)	0.002	0.002	0.002	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	0.014	0.014	0.008	0.007
Hydrogen	0.010	0.010	0.010	0.008
Carbon monoxide	0.037	0.040	0.023	ND
TOTAL T-VALUE	**0.3**	**0.3**	**0.3**	**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-20 RETURN INGRESS SAMPLES

CHEMICAL CONTAMINANT	T-VALUES (7-d & 180-d SMAC)			
	7-d SMAC	180-d SMAC	7-d SMAC	180-d SMAC
	AQ200382 S/N 2057 NG-13 INGRESS 2/18/20 @ 16:23	AQ200382 S/N 2057 NG-13 INGRESS 2/18/20 @ 16:23	AQ200383 S/N 2053 SpX-20 INGRESS 3/9/20 @ 18:07	AQ200383 S/N 2053 SpX-20 INGRESS 3/9/20 @ 18:07
TARGET COMPOUNDS (TO-15)				
1,1,1,2-Tetrafluoroethane (Norflurane)	ND	ND	0.000	0.000
Propene	0.000	0.000	0.000	0.000
Propane	ND	ND	0.000	0.000
Carbonyl sulfide (Carbon oxide sulfide)	0.000	0.002	ND	ND
Isobutane	0.001	0.001	ND	ND
Methanol	0.006	0.006	0.012	0.012
Acetaldehyde	0.065	0.065	0.034	0.034
2-Methyl-1-propene	0.001	0.005	ND	ND
Ethanol	0.001	0.001	0.001	0.001
Acetone	0.006	0.006	0.002	0.002
Propanal (Propionaldehyde)	0.003	0.003	ND	ND
2-Propanol (Isopropanol)	0.007	0.007	0.003	0.003
2-Methyl-2-propanol	0.000	0.000	ND	ND
Methyl acetate	0.001	0.001	ND	ND
Methylene chloride (Dichloromethane)	0.014	0.071	0.003	0.015
Carbon disulfide	0.011	0.011	ND	ND
1-Propanol	0.000	0.000	ND	ND
Trimethylsilanol	0.070	0.070	0.012	0.012
Butanal (Butyraldehyde)	0.001	0.001	ND	ND
2-Butanone (Methyl ethyl ketone)	0.003	0.003	0.000	0.000
Ethyl acetate	0.000	0.000	ND	ND
1-Butanol	0.001	0.001	0.000	0.001
Toluene	0.002	0.002	ND	ND
Hexanal	0.001	0.001	ND	ND
Octafluoropropane (Perfluoropropane)	0.000	0.000	0.000	0.000
SPECIAL INTEREST COMPOUND				
Hexamethylcyclotrisiloxane (HMCTS)	0.012	ND	ND	ND
NON-TARGET COMPOUNDS				
All Non-Target Compounds were below their reporting limit				
TARGET COMPOUNDS (GC)				
Methane	0.001	0.001	0.003	0.003
Hydrogen	0.001	0.001	0.003	0.003
Carbon monoxide	0.013	0.049	0.021	0.077
TOTAL T-VALUE	**0.2**	**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.

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

Increment					62		
Mission					SpaceX-20	Soyuz 61	SpaceX-20
Sample Location			Potable Water Maximum		WPA PWD Hot	WPA PWD Ambient	Potable Bus
Sample Description		Test	Contaminant	Maximum Contaminant	Potable Water	Potable water	WPA Product Water
Sample Date		Conducted	Level	Level	3/12/2020	4/8/2020	3/23/2020
Analysis/Sample ID	Units	by	(MCL)	Source	WQ200153	WQ200171	WQ200154
Physical Characteristics							
Conductivity	µS/cm	U.S.			1	1	2
pH	pH units	U.S.	4.5-8.5	41000	5.47	5.62	5.36
Iodine LCV							
Iodide	mg/L	U.S.			< 0.05	< 0.05	0.68
Iodine	mg/L	U.S.	1.0-4.0	41000 (residual iodine - product water only)	< 0.05	< 0.05	1.74
Total I	mg/L	U.S.	6/0.2	41000 (tl I max/tl I at pt of consumption)	< 0.05	< 0.05	2.42
Minerals ICPMS							
Calcium	mg/L	U.S.	30	41000	< 0.01	0.02	< 0.01
Phosphate (as P)	mg/L	U.S.			0.01	< 0.01	0.02
Trace Metals ICPMS							
Aluminum	µg/L	U.S.			2	2	< 1
Barium	µg/L	U.S.	10,000	SWEG&41000	< 1	1	< 1
Copper	µg/L	U.S.	1,000	41000	< 1	1	1
Nickel	µg/L	U.S.	300	SWEG&41000	1	2	77
Zinc	µg/L	U.S.	2,000	SWEG&41000	< 1	< 1	1
Silicon ICPMS							
Silicon	µg/L	U.S.			156	205	148
Total Organic Carbon-Sievers & OI							
Total Inorganic Carbon (TIC)	mg/L	U.S.			0.414	0.999	0.368
Total Organic Carbon (TOC)	mg/L	U.S.	5 / 3	SWEG / 41000	0.558	0.733	0.280
Semi-volatile Organics-Targets							
Methyl sulfone	µg/L	U.S.	1,500,000	**interim SWEG (06-2017)**	45	52	< 50
Organic Carbon Recovery	percent	U.S.			1.97	1.77	0.00
Unaccounted Organic Carbon	mg/L	U.S.			0.55	0.72	0.28

Comments: None

Table 3B: Analytical concentrations of compounds quantified in US wastewater, US condensate, and MF bed effluent returned on SpaceX-20

Increment					62		
Mission					SpaceX-20		
Sample Location			Potable Water Maximum		WPA MF Bed #2 ORU S/N 00021	WPA Wastewater ORU	WPA Condensate Sample Port
Sample Description		Test	Contaminant	Maximum Contaminant	MF Bed Effluent	WPA Wastewater	US Condensate
Sample Date		Conducted	Level	Level	4/1/2020	4/1/2020	3/13/2020
Analysis/Sample ID	Units	by	(MCL)	Source	WQ200155	WQ200156	WQ200157
Physical Characteristics							
Conductivity	µS/cm	U.S.			3	169	186
pH	pH units	U.S.	4.5-8.5	41000	5.27	7.22	7.69
Anions IC							
Fluoride	mg/L	U.S.			< 0.1	0.2	< 0.1
Phosphate (as P)	mg/L	U.S.			< 0.1	0.5	< 0.1
Cations IC							
Ammonium (as N)	mg/L	U.S.	1	SWEG&41000	< 0.25	23.0	25.2
Minerals ICPMS							
Calcium	mg/L	U.S.	30	41000	0.02	0.05	0.11
Magnesium	mg/L	U.S.	50	41000	< 0.01	< 0.01	0.07
Phosphate (as P)	mg/L	U.S.			0.01	0.63	0.02
Potassium	mg/L	U.S.	340	41000	< 0.01	0.26	< 0.01
Sodium	mg/L	U.S.			< 0.01	0.22	0.07
Trace Metals ICPMS							
Aluminum	µg/L	U.S.			2	3	3
Boron	µg/L	U.S.			22	23	27
Chromium	µg/L	U.S.	230	41000	< 1	60	2
Copper	µg/L	U.S.	1,000	41000	< 1	2	< 10
Nickel	µg/L	U.S.	300	SWEG&41000	59	90	14
Silver	µg/L	U.S.	400	SWEG&41000	< 1	5	5
Zinc	µg/L	U.S.	2,000	SWEG&41000	150	1,060	329
Silicon ICPMS							
Silicon	µg/L	U.S.			1,100	2,760	1,540
Total Organic Carbon-Sievers & OI							
Total Inorganic Carbon (TIC)	mg/L	U.S.			1.59	17.8	18.1
Total Organic Carbon (TOC)	mg/L	U.S.	5 / 3	SWEG / 41000	9.24	27.5	10.4
Semi-volatile Organics-Targets							
Benzothiazole	µg/L	U.S.			< 20	53	< 50
Methyl sulfone	µg/L	U.S.	1,500,000	**interim SWEG (06-2017)**	52	238	< 50
Base and Neutral Extractables-EPA 625 List GCMS							
Semi-volatile Organics-Special Interest Compounds (Semi-quantitative)							
Ibuprofen	µg/L	U.S.			not found	930	not found
N,N-Dimethyl acetamide	µg/L	U.S.			not found	370	not found
N,N-Dimethylformamide	µg/L	U.S.			not found	750	not found
Alcohols & Acetone GCMS							
2-Propanol (Isopropanol)	µg/L	U.S.			2,430	424	496
Acetone	µg/L	U.S.	15000	SWEG	3,000	7,000	2,170
Ethanol	µg/L	U.S.			7,800	< 400	< 400
Methanol	µg/L	U.S.	40,000	SWEG	4,760	4,170	< 400
Silanols LCRI (Semi-Quantitative-NIST traceable standard not available)							
Dimethylsilanediol (DMSD)	µg/L	U.S.	35,000	SWEG	3,400	6,900	3,900
Organic Carbon Recovery	percent	U.S.			108.96	33.92	25.57
Unaccounted Organic Carbon	mg/L	U.S.			0.00	18.17	7.74

Comments: None