JSC TOXICOLOGY AND ENVIRONMENTAL CHEMISTRY GROUP

Amelia Romoser, PhD, DABT
Toxicology and Environmental Chemistry
NASA JSC/SK4
Houston, TX 77058

Memorandum Number
TOX-AR-2017-01

Voice: (281) 483-3223
Fax: (281) 483-3058
amelia.a.romoser@nasa.gov

DATE: January 9, 2017

SUBJECT: Toxicological Assessment of ISS Air and Water Quality: March 1, 2016 –June 18, 2016 (Increment 47), Including Ingress Reports for BEAM/OA-6/SpX-8, and Node 3 Investigation

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

AIR QUALITY

Ten archive air samples were collected in mini grab sample containers (mGSCs) on ISS during Increment 47 and were returned on SpX-8, Soyuz 45 (45S), and SpX-9. Five mGSCs were collected as routine monthly samples for April and June in the US Laboratory (Lab) and either the Russian Service Module (SM) or the Japanese Pressurized Module (JPM). March nominal samples were collected at the end of February and are discussed in the Increment 46 memorandum (TOX-AR-2016-02). Two additional samples were collected in Node 3 on 4/26/2016 and 5/3/2016 as part of an investigation into the relationship between siloxanes in the ISS atmosphere and dimethylsilanediol (DMSD) in humidity condensate. Three ingress samples were also collected during first ingress of OA-6, SpX-8, and the Bigelow Expandable Activity Module (BEAM).

Table 1. Summary of ISS air analyses

Return Flight	Sample Location	Sample Date	NMVOCs[a] (mg/m³)	Freon 218 (mg/m³)	Alcohols[b] (mg/m³)	T-Value[c] (units)	CO_2 (mg/m³)	Formaldehyde (µg/m³)[f]
SpX-8	LAB	3/21/2016	9.1	82	8.6	0.2	6400	31 (45S) [g]
SpX-8	SM	3/21/2016	8.7	79	8.2	0.2	6800	25 (45S) [g]
SpX-8	OA-6 Ingress	3/27/2016	20	9.0	4.6	2.1 (1.6)	1600	--
SpX-8	SpX-8 Ingress	4/11/2016	1.7	5.6	1.6	0.2 (0.1)	700	--
SpX-8	Lab	4/26/2016	15	76	15	0.3	6100	33 (45S)
45S	SM	4/26/2016	--	--	--	--	--	26 (45S)
SpX-8	Node 3 Invest.	4/26/2016	9.1	74	8.7	0.2	6300	--
SpX-8	Node 3 Invest.	5/3/2016	6.8	79	6.4	0.2	6200	--
SpX-9	LAB	6/6/2016	6.9	87	6.3	0.3	6500	29 (47S) [g]
47S	SM	6/6/2016	--	--	--	--	--	18 (47S) [g]
SpX-9	JPM	6/6/2016	5.8	90	5.2	0.3	6400	--
45 S	Beam Ingress	6/6/2016	4.1	4.5	0.42	0.4 (0.1)	400	--
Guideline			*<25*	---	*<5*	*<1[d]*	*<7100[e]*	*<120*

[a]Non-methane volatile organic hydrocarbons, excluding Freon 218
[b]Includes acetone
[c]Sum of the ratios of the measured concentration and the corresponding 180-day SMAC for each compound, excluding CO_2; parentheses indicate value based on 7-day SMACs and applicable to first ingress
[d]T-value <1 used to evaluate routine monthly sampling; <3 used to evaluate first ingress
[e]CO_2 to be controlled as low as reasonably achievable (ALARA) – currently 3 mmHg (7100 mg/m³) or lower
[f]Return flight for formaldehyde samples differs from mGSC return flight and is indicated in parentheses
[g]Average from pair of formaldehyde badges

Four pairs of passive-diffusion formaldehyde badges were deployed in the Lab and SM on 3/21/2016 and 6/6/2106 as part of routine monitoring. Due to limited resupply, single badges were deployed in the same locations on 4/26/2016 to fulfill the May sampling requirement. A summary of the analytical results is provided in Table 1.

Data tables containing concentrations and corresponding T-values based on appropriate Spacecraft Maximum Allowable Concentrations (SMACs) for compounds present at levels above the laboratory reporting limit are enclosed. Complete data tables including compounds assessed but not detected are available upon request. The relative recoveries of the 3 surrogate standards from the 45S mGSC sample were as follows: ^{13}C-acetone, 107%; fluorobenzene-d_5, 112%; and chlorobenzene-d_5, 90%. The average relative recoveries of the 3 surrogate standards from the SpX-8 mGSCs were as follows: 13C-acetone, 108±9%; fluorobenzene-d5, 111±7%; and chlorobenzene-d5, 130±13%. For the SpX-9 samples, relative recoveries was as follows: 13C-acetone, 112±4%; fluorobenzene-d5, 112±5%; and chlorobenzene-d5, 119±14%. For the passive-diffusion formaldehyde badges, 45S positive control recoveries (1 in-flight and 2 lab controls) were 105, 104, and 100%, respectively. The 47S positive control recoveries (1 in-flight and 2 lab controls) were 103, 113, and 108%, respectively.

Simultaneous automated sampling sessions are scheduled on the Air Quality Monitors (AQMs) every 73 hours, which results in 2-3 sampling sessions per unit per week. Monthly average concentrations as well as the Increment average concentrations for compounds measured on the AQMs are presented in Table 2.

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

	Mar	Apr	May	June	Average
2-Propanol	0.1	0.2	0.2	0.1	0.1
Acetone	0.2	0.4	0.4	0.5	0.4
Acrolein	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND
1,2-Dichloroethane	TRACE	ND	ND	ND	TRACE
Decamethylcyclopentasiloxane#	TRACE	TRACE	ND	TRACE	TRACE
Hexanal	ND	ND	ND	ND	ND
Hexane	ND	ND	ND	ND	ND
m,p-Xylenes#	ND	ND	ND	ND	ND
Methanol	0.3	0.4	0.3	0.3	0.3
o-Xylene#	TRACE	TRACE	TRACE	TRACE	TRACE
Octamethylcylcotetrasiloxane#	ND	ND	ND	ND	ND
Toluene#	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND
Acetaldehyde	0.2	0.3	0.2	TRACE	0.2
Dichloromethane	ND	ND	ND	ND	ND
Ethanol	5.6	6.5	6.2	3.0	5.4
Ethyl Acetate	0.1	0.1	0.1	0.1	0.1
Hexamethycyclotrisiloxane#	ND	ND	ND	ND	ND
n-Butanol	0.1	0.1	0.1	0.1	0.1
Trimethylsilanol	0.1	0.1	0.1	0.1	0.1

Derived from prime unit
ND: Not detected
TRACE= >MDL (Minimum Detection Limit), <MQL (Minimum Quantification Limit)

Full in-flight detection capabilities (dual, complimentary instruments: AQM S/N 1018 and AQM S/N 1005) were restored on 3/3/2016 when issues with S/N 1005 were resolved. This allows for greater insight into ISS air quality, and thus more representative T-values, which are calculated to evaluate toxicological risk

to crew. With restoration of full analytical capabilities, the frequency of archive sample collection and formaldehyde badge deployment has been reduced to a 45-day interval (previously monthly).

Since deployment of the new AQM (S/N 1018), ethanol levels measured in-flight have shown very good agreement with mGSC sample results. Quantitation of siloxanes (DMCPS, HMCTS, OMCTS, and TMS) was improved following the deployment of S/N 1018, primarily due to improvements in the calibration process for these analytes, which improved agreement between of mGSC and AQM data.

Toxicological Evaluation of ISS Air Quality

Routine air quality monitoring is performed in-flight using the AQMs. Archive air samples (mGSCs) are collected during each increment and returned for analysis in ground laboratories. Data from the ground analyses complement the in-flight data and provide a more complete understanding of air quality on the ISS. Archive samples for this Increment were returned on SpX-8, 45S, and SpX-9, which confirmed air quality was acceptable during this timeframe. **Importantly, all measured values for routine samples (mGSC and AQM) met T-value guideline criteria (T < 1), indicating no concern for crew health.** The average, rounded T-value for Increment 47 calculated from the mGSC samples was 0.2 (Figure 1). The average T-value calculated from the AQM data (Figure 2) was also 0.2. The reported values continue to be approximately half of historical averages, likely due to installation of carbon filters in Node 1 in May 2015.

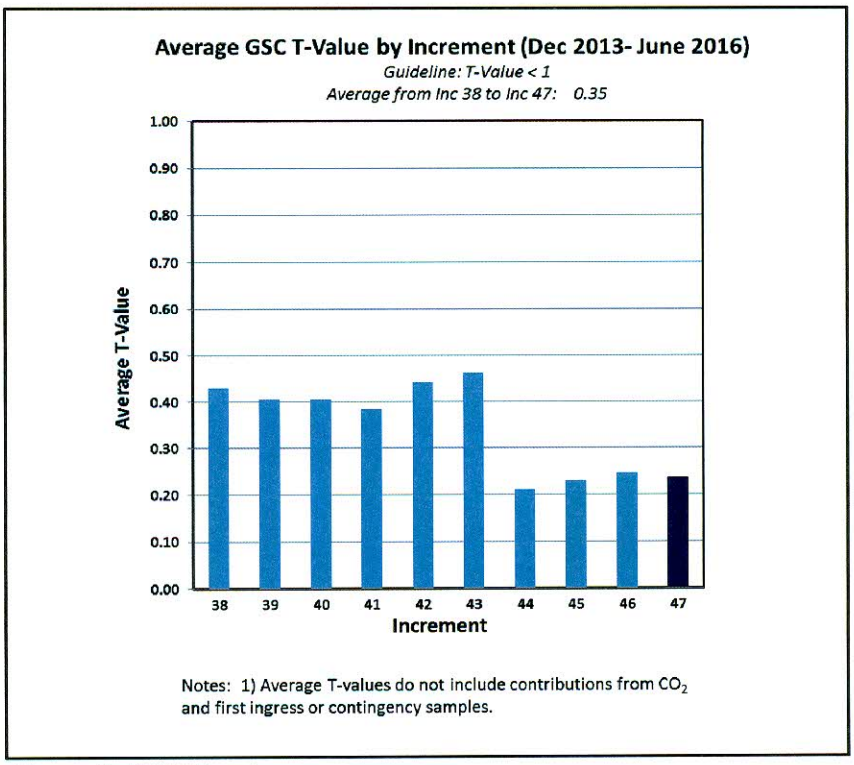

Figure 1. GSC T-values

No mGSC samples contained a carbon dioxide (CO_2) concentration above the Increment limit documented in Chits 013929 and 014278, which request that the 24 hour average concentration not exceed 3 mmHg (7100 mg/m^3). While mGSC CO_2 sampling provides an estimate of the extent of ISS air dilution in first ingress air samples (single points in time), the major constituent analyzer (MCA) routinely monitors CO_2 levels and, for this reason, is better suited for evaluation of short and long-term trends in CO_2 data. The

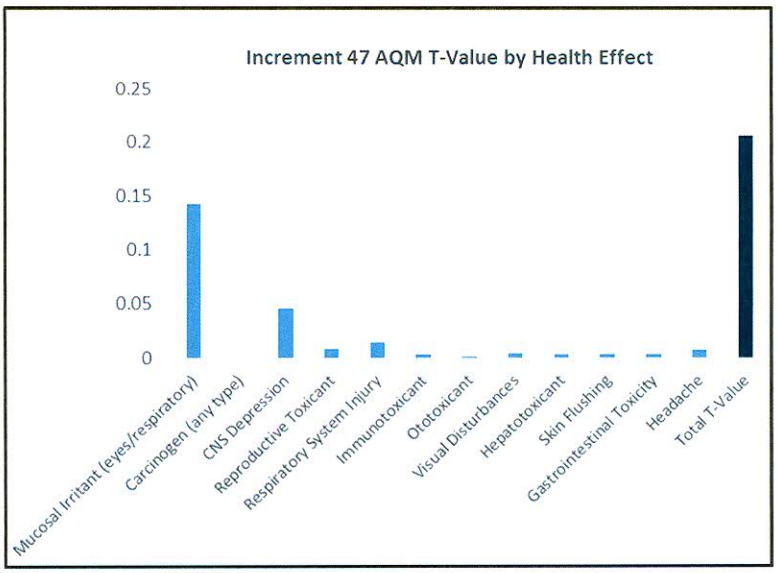

Figure 2. AQM T-values

MCA data concentrations 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. As part of an investigation into strategies to successfully maintain the 24 average CO_2 concentration at 3 mmHg, segmented operations were implemented from 5/2/2016-5/20/2016. In addition, multiple long-term investigations are underway to identify additional ways to monitor and reduce CO_2 on ISS.

Alcohol values in routine monthly samples collected in March, April, and June continued to exceed the alcohol guideline of <5 mg/m^3, which is intended to protect the water recovery system from risk of overloading. These levels are primarily due to elevated ethanol levels on ISS during this time frame. Elevated ethanol levels were also detected in US water samples during Increment 47 (see Water Quality discussion below). Total alcohols in the nominal May sample collected on 4/26/16 in the Lab were elevated (15 mg/m^3) compared to other nominal samples. This was due to higher than normal levels of ethanol (7.5 mg/m^3) and isopropanol (4.8 mg/m^3), which led to a correspondingly high NMVOC total. Occasionally,

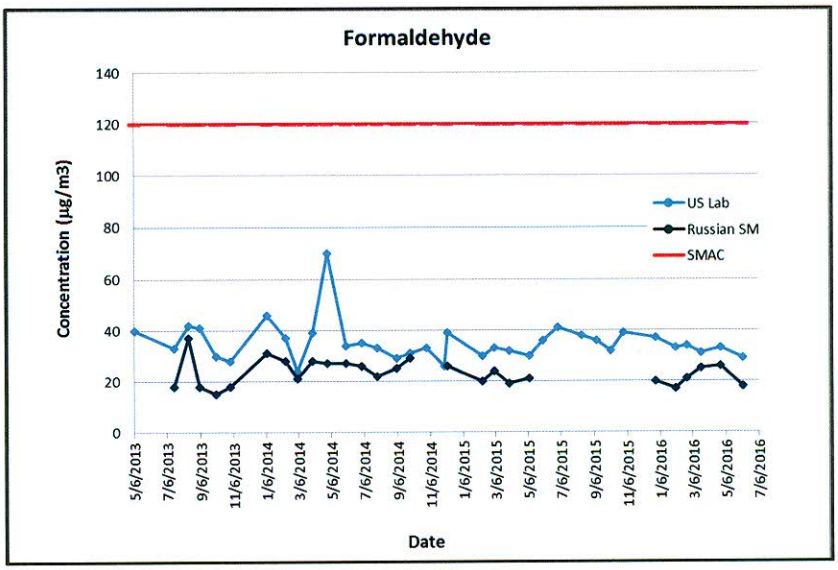

Figure 3. Formaldehyde trending in ISS air.

isopropanol contaminates sample canisters during assembly, presumably due to cleaning agents in the preparation area. Due to the high concentration detected, which is uncharacteristic for ISS air even following vehicle docking, and because there was no spike in AQM isopropanol readings before or after this date, contamination of the canister is the most likely explanation of the result. Formaldehyde levels in the US Lab (shown in Table 1 and Figure 3) are generally consistent with historic levels and remain below the SMAC of 120 $\mu g/m^3$.

Node 3 Investigation Samples

Corresponding air and water samples were collected to investigate the association between siloxanes in ISS air and DMSD in the humidity condensate. These samples were also used to check for point sources of siloxanes in Node 3. Archive air samples were collected in mGSCs on 4/26/16 and 5/3/2016. One of the AQMs (S/N 1005) was also moved to Node 3 as part of this effort. An additional AQM run was initiated on May 3rd to coincide with collection of a condensate sample. Based on the results from the archive samples and the AQM analyses, it was determined that the concentrations of targeted siloxanes were not elevated in Node 3 and did not show a strong correlation with DMSD levels in condensate samples. This suggests that the relationship between atmospheric siloxane concentrations and the DMSD concentration in condensate may be more complicated than originally thought.

OA-6 Ingress

Overall, contaminant levels were lower in the OA-6 sample than the OA-4 sample. The difference was primarily attributable to CO (7 mg/m^3 versus 11 mg/m^3), TMS (1.8 mg/m^3 versus 2.4 mg/m^3), and methane (2.9 mg/m^3 versus 9.8 mg/m^3). Octafluoropropane (Freon 218), which was determined to be a payload contaminant in the OA-4 ingress sample, was much lower (9 mg/m^3 versus 195 mg/m^3) and more representative of a concentration that would be expected as a result of infiltrating ISS air. Freon 218 is a relatively non-toxic compound typically present on ISS that is used to estimate the degree of dilution with the ISS atmosphere prior to sample collection. Although still detected in a low quantity, fluorotrimethylsilane also decreased in the OA-6 ingress sample compared to OA-4 (0.6 mg/m^3 versus 0.9 mg/m^3), which is significant since this compound can substantially affect the T-value. A complete vehicle offgas test (OGT) was not performed to predict first ingress concentrations, however, a special ground-based OGT was conducted to monitor for fluorotrimethylsilane prior to cargo integration. Unlike the OA-4 OGT, the OA-6 OGT was conducted in the absence of stored cargo in an effort to determine whether or not the vehicle was the source of the contaminant. The test results indicated that this compound was not offgassed in detectable concentrations over the test period of 58 days. Since the compound was absent during the empty vehicle OGT but present in the first ingress sample at low levels, it is likely that cargo, rather than the vehicle, is the source of this contaminant. In addition to fluorotrimethylsilane, other compounds that contributed to the in-flight T-value were TMS and CO. The overall T-value for OA-6 (1.6) was lower than OA-4 (2.2).

SpX-8 Ingress

The overall T-value for SpX-8 (0.07) was slightly lower than SpX-6 (0.11), with CO and acetaldehyde comprising the majority of this result. Compared to the SpX-6 ingress sample (refer to memorandum TOX-VR-2016-04 for results), the concentrations of most detectable compounds were slightly lower. Specifically, isopropanol, HMCTS, methane, and CO all decreased. On-orbit sample collection for SpX-8 occurred sooner than SpX-6. This was apparent because CO_2 and Freon 218 levels were significantly lower in SpX-8 ingress samples (CO_2: 2770 mg/m^3 versus 700 mg/m^3 and Freon 218: 44 mg/m^3 versus 5.6 mg/m^3).

BEAM Ingress

The BEAM ingress sample was collected two minutes after hatch opening on 6/6/2016. Low concentrations of isopropanol (0.13 mg/m^3), toluene (0.13 mg/m^3), OMCTS (0.14 mg/m^3), HMCTS (2.7 mg/m^3), and methane (2.3 mg/m^3) were detected in the sample. These concentrations led to a low overall T-value (0.1),

with toluene, HMCTS, TMS, and acetaldehyde being the primary contributors. These results were expected, based on OGT results of the flight unit conducted in December 2014 by the Toxicology and Environmental Chemistry Laboratory. The calculated T-value at first ingress was consistent with the predicted OGT T-value of 0.4.

WATER QUALITY

Archive samples were collected from the Potable Water Dispenser (PWD) in the US segment during Increment 47. In addition, samples of condensate were also collected from the US segment during the Increment. All water samples were returned on 45S and SpX-8. Complete data tables with results from these analyses can be found in reports 2016-TEC-WQ-004 and 2016-TEC-WQ-005. A summary of select analytical results is provided in Table 3. Expanded summary tables, containing organic carbon recoveries and results for analytes detected in the samples at concentrations above reporting limits, are included as attachments to this report.

Table 3. Summary of ISS Water Analyses

Return Flight	Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	Conductivity (µS/cm)	Total Iodine (mg/L)	Total Silver (µg/L)
45S	PWD (ambient)	4/4/2016	0.11	<1	2	<0.05	<1
45S	PWD (hot)	5/25/2016	0.13	<1	2	<0.05	<1
SpX-8	US Condensate [a]	4/19/2016	173	32	320	NA	7
SpX-8	US Condensate [a]	4/26/2016	149	37	330	NA	64
SpX-8	US Condensate [a]	5/3/2016	126	36	290	NA	60

[a]US Condensate is not considered potable. The ISS Water Recovery System successfully removes contaminants and excess minerals from wastewater and condensate prior to consumption.

Toxicological Evaluation of ISS Water Quality: Routine water quality monitoring is performed in-flight using the total organic carbon analyzer (TOCA). Archive water samples are also collected during each increment and returned for 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

Total organic carbon (TOC) concentrations from in-flight and ground analyses performed on samples from the U.S. potable water system between June 2015 and June 2016 are shown in Figure 4. The TOC concentrations measured by the TOCA in the U.S. potable water samples (PWD TOC) and product water samples (WPA PFU2) were below the method reporting limit (285 µg/L) throughout the Increment. TOC concentrations in the U.S. archive samples (Archive TOC) were 130 µg/L for the PWD hot sample and 110 µg/L for the PWD ambient sample. Results for all U.S. potable samples were well below the Spacecraft Water Exposure Guideline (SWEG) of 3.0 mg/L (3000 µg/L).

Although dimethylsilanediol (DMSD) was present in the humidity condensate samples, it was not detected in either of the potable water samples. Only trace levels of other organics were detected. Silicon was detected in both U.S. samples (PWD ambient = 78 µg/L and PWD hot = 46 µg/L) at levels typically found when no DMSD is present, but at lower levels than what was detected during Increment 46. Zinc was also detected in lower concentrations in the Increment 47 PWD samples compared to Increment 46 (2-3 µg/L vs 42 µg/L). Concentrations for both Increments are well under the 1000 day SWEG (2,000 µg/L). Low levels of aluminum (2 µg/L) and nickel (3 µg/L) were also detected in the U.S. potable water samples. **Importantly, all chemical parameters measured in U.S. potable water samples collected during**

Increment 47 met the requirements listed in SSP 41000 and all compounds measured in these archive samples were below ISS Medical Operations Requirement Document (MORD) limits.

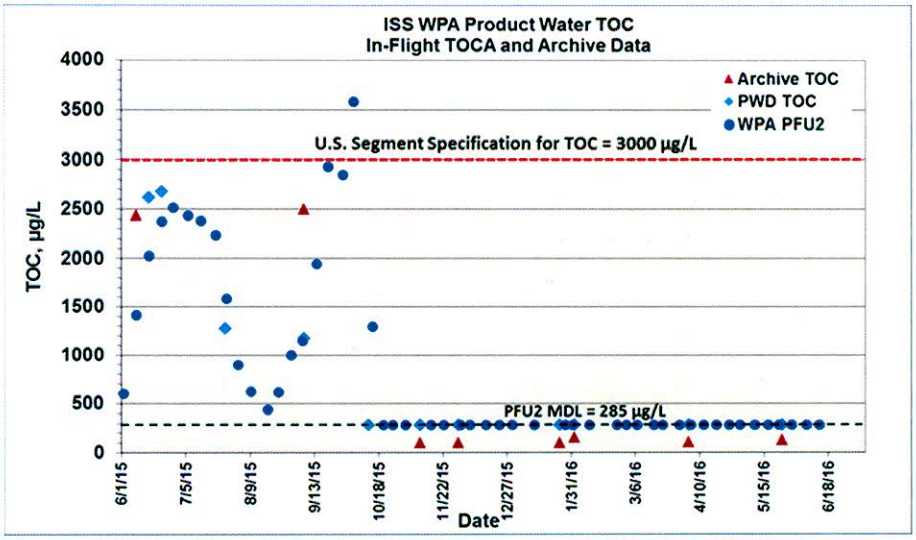

Figure 4. Total Organic Carbon (TOC) trending in US Potable Water

Iodine is a biocide used in the US segment. It is added to the water produced by the Water Processor Assembly (WPA), but removed prior to crew consumption to avoid potential thyroid dysfunction. Total iodine levels in the samples collected from the PWD were below detection limits (0.05 mg/L), indicating effective removal of iodine. For additional information regarding microbial analyses, please see the Increment 47 post-flight report issued by the JSC Environmental Microbiology Laboratory.

Condensates

Historically, elevated TOC concentrations in US potable water samples have been attributed to increased levels of dimethylsilanediol (DMSD), which is thought to be a hydrolysis byproduct of linear and cyclical siloxanes in cabin air. It has been hypothesized that the Condensing Heat Exchanger (CHX) may contribute to localized high concentrations of siloxanes due to adsorption on the CHX coating, despite the overall lower ISS air concentrations due to carbon filter installation. To monitor the production of DMSD following CHX dry out, a series of condensate samples was collected along with corresponding archival air samples. The TOC concentrations in the three condensate samples collected on 4/19/2016, 4/26/2016, and 5/3/2016 were 173 mg/L, 149 mg/L, and 126 mg/L, respectively. The TOC level of the first sample collected was similar to the historical average (170 mg/L). The concentration in subsequent samples decreased over a span of two weeks, with the final sample containing a level similar to recent samples. Interestingly, a corresponding decrease in DMSD was not detected. The concentration of DMSD in the three water samples was 32 mg/L, 37 mg/L, and 36 mg/L, similar to the result from the Increment 46 sample (35 mg/L). In addition, comparison with atmospheric siloxane and silanol concentrations measured by the AQM and in archival air samples did not suggest a strong correlation with condensate DMSD levels. Based on these results, it appears that hydrolysis of larger siloxanes on the CHX coating during dryouts may not be the only source of DMSD in ISS condensate.

Multiple compounds were detected at concentrations above 1.0 mg/L, but most were comparable to those previously reported. However, values observed for formaldehyde in the second and third samples (5.78 – 5.94 mg/L) were the highest condensate concentrations recorded in the last decade. The source of this compound has not yet been identified.

A. Romoser 1/9/17

Amelia Romoser, Ph.D., DABT
KBRwyle Toxicologist

Date

Valerie Ryder 1/9/17

Concurrence by Valerie Ryder, Ph.D., DABT
NASA Toxicologist

Date

Enclosures

Tables 1A, 1B, and 1C: Analytical concentrations of compounds quantified in mGSCs returned on SpX-8, SpX-9, and 45S

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

Table 2C: T-values corresponding to OA-6 and SpX-8 ingress concentrations (Table 1A), based on 7-day and 180-day SMACs

Table 2D: T-values corresponding to BEAM ingress concentrations (Table 1C), based on 7-day and 180-day SMACs

Table 3: Analytical concentrations of compounds quantified in US potable water samples returned on 45S

Table 4: Analytical concentrations of compounds quantified in US condensate samples returned on SpX-8

TABLE 1A
ANALYTICAL RESULTS OF SPACEX-8 RETURN GRAB AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)						
	AQ160105 SN 2024 LAB 03/21/16 @ 07:45 GMT	**AQ160106 SN 2022 SM 03/21/16 @ 07:45 GMT**	**AQ160107 SN 2019 OA-6 Ingress 03/27/16 @ 09:30 GMT**	**AQ160108 SN 2028 SpX-8 Ingress 04/11/16 @ 08:15 GMT**	**AQ160109 SN 2038 LAB 04/26/16 @ 10:19 GMT**	**AQ160110 SN 2030 NODE 3 DMSD Invest. 04/26/16 @ 10:20 GMT**	**AQ160111 SN 2037 NODE 3 DMSD Invest. 05/03/16 @ 12:15 GMT**
TARGET COMPOUNDS (TO-15) **							
Octafluoropropane (Perfluoropropane) *	**82**	**79**	**9.0**	**5.6**	**76**	**74**	**79**
Propene	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025
Propane	<0.025	<0.025	0.039	<0.025	<0.025	<0.025	<0.025
Carbonyl sulfide (Carbon oxide sulfide)	<0.025	<0.025	0.051	<0.025	<0.025	<0.025	<0.025
Chloromethane	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025
Isobutane	<0.025	<0.025	4.9	<0.025	<0.025	<0.025	<0.025
Methanol	**0.45**	**0.45**	0.28	**0.44**	0.66	0.56	**0.69**
Acetaldehyde	0.23	0.27	0.41	0.043	0.21	0.18	0.20
2-Methyl-1-propene	<0.025	<0.025	0.19	<0.025	<0.025	<0.025	<0.025
Butane	<0.025	<0.025	0.069	<0.025	<0.025	<0.025	<0.025
Ethanol	**7.7**	**7.3**	**1.4**	**0.90**	**7.5**	**5.8**	**5.2**
Acetone	0.28	0.28	0.58	0.078	0.94	0.28	0.31
Propanal (Propionaldehyde)	<0.025	<0.025	0.038	<0.025	<0.025	<0.025	<0.025
2-Propanol (Isopropanol)	0.094	0.080	**2.2**	0.17	0.49	0.19	0.15
Isoprene (2-Methyl-1,3-butadiene)	0.046	0.049	<0.025	<0.025	0.032	0.034	0.029
2-Methyl-2-propanol	<0.025	<0.025	0.051	<0.025	<0.025	<0.025	<0.025
Methylene chloride (Dichloromethane)	<0.025	<0.025	0.070	<0.025	<0.025	<0.025	<0.025
Carbon disulfide	<0.025	<0.025	0.062	<0.025	<0.025	<0.025	<0.025
1-Propanol	TRACE	TRACE	0.052	<0.025	4.8	1.9	0.031
Trimethylsilanol	0.095	0.066	1.8	0.029	0.089	0.070	0.078
Butanal (Butyraldehyde)	<0.025	<0.025	0.031	<0.025	<0.025	<0.025	<0.025
2-Butanone (Methyl ethyl ketone)	<0.025	<0.025	0.31	<0.025	<0.025	<0.025	<0.025
Ethyl acetate	0.053	0.047	0.078	<0.025	0.050	0.041	0.040
1-Butanol	0.041	0.041	0.073	<0.025	0.060	0.050	0.041
4-Methyl-2-pentanone (MIBK)	<0.025	<0.025	0.044	<0.025	<0.025	<0.025	<0.025
Toluene	<0.025	<0.025	0.086	<0.025	<0.025	<0.025	<0.025
Mesityl oxide (4-Methyl-3-penten-2-one)	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025
Octamethylcyclotetrasiloxane	<0.125	<0.125	0.15	<0.125	<0.125	<0.125	<0.125
SPECIAL INTEREST COMPOUNDS ***							
Hexamethylcyclotrisiloxane #	<0.10	<0.10	2.0	<0.10	<0.10	<0.10	<0.10
NON-TARGET COMPOUNDS ***							
1,1,1,2-Tetrafluoroethane	0.074	0.065	1.4	<0.050	0.089	0.079	0.078
1,1-Difluoroethane	<0.050	<0.050	0.056	<0.050	<0.050	<0.050	<0.050
Fluorotrimethylsilane	<0.050	<0.050	0.59	<0.050	<0.050	<0.050	<0.050
Carbonic acid, dimethyl ester	<0.050	<0.050	0.064	<0.050	<0.050	<0.050	<0.050
Hexamethyldisiloxane	<0.050	<0.050	0.32	<0.050	<0.050	<0.050	<0.050
C11-Alkane	<0.050	<0.050	0.29	<0.050	<0.050	<0.050	<0.050
C11-Alkane	<0.050	<0.050	0.10	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	0.088	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	0.40	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	0.17	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	0.48	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	0.37	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	0.37	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	0.15	<0.050	<0.050	<0.050	<0.050
TOTAL ALCOHOLS PLUS ACETONE	**8.6**	**8.2**	**4.6**	**1.6**	**15**	**8.7**	**6.4**
TARGET COMPOUNDS (GC) **							
Carbon monoxide	0.92	0.92	7.0	2.5	1.6	1.6	1.4
Methane	3.2	3.2	2.0	2.7	11	11	9.6
Hydrogen	4.0	4.0	0.75	0.70	5.4	5.4	5.4
Carbon dioxide	6400	6800	1600	700	6100	6300	6200
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**91**	**88**	**29**	**7.3**	**91**	**83**	**86**
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**9.1**	**8.7**	**20**	**1.7**	**15**	**9.1**	**6.8**

* GC/FID data results are in bold

** Quantified using a multi-point calibration

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

Response factor generated from an internal study

< : Value is less than the laboratory report detection limit.

TRACE: Amount detected is sufficient for compound identification only. One-half of the detection limit was used in the Total Concentration summation.

OFP - Octafluoropropane

TABLE 1B
ANALYTICAL RESULTS OF SPACEX-9 RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)	
	AQ160242 SN 2034 LAB 06/06/16 @ 08:04GMT	AQ160243 SN 2031 JPM 06/06/16 @ 08:04GMT
TARGET COMPOUNDS (TO-15) **		
Octafluoropropane (Perfluoropropane) *	**87**	**90**
Methanol *	**0.38**	**0.30**
Acetaldehyde	0.32	0.29
2-Methyl-1-propene	TRACE	TRACE
Ethanol *	**4.4**	**4.2**
Acetone	0.51	0.52
2-Propanol (Isopropanol)	0.19	0.16
Isoprene (2-Methyl-1,3-butadiene)	0.039	0.041
1-Propanol	0.78	0.034
Trimethylsilanol	0.11	0.13
Butanal (Butyraldehyde)	<0.025	TRACE
Ethyl acetate	0.036	0.037
1-Butanol	0.045	0.048
SPECIAL INTEREST COMPOUNDS ***		
All Special Interest Compounds were below the reporting limit		
NON-TARGET COMPOUNDS ***		
1,1,1,2-Tetrafluoroethane	0.064	0.067
TOTAL ALCOHOLS PLUS ACETONE	**6.3**	**5.2**
TARGET COMPOUNDS (GC) **		
Carbon monoxide	1.5	1.5
Methane	6.9	7.2
Hydrogen	6.5	6.6
Carbon dioxide	6500	6400
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**94**	**96**
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**6.9**	**5.8**

* GC/FID data results are in bold

** Quantified using a multi-point calibration

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

< : Value is less than the laboratory report detection limit.

TRACE: Amount detected is sufficient for compound identification only. One-half of the detection limit was used in the Total Concentration summation.

OFP - Octafluoropropane

TABLE 1C
ANALYTICAL RESULTS OF 45S RETURN GRAB AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3) AQ160196 SN 2035 BEAM INGRESS 06/06/16 @ 08:50 GMT
TARGET COMPOUNDS (TO-15) **	
Octafluoropropane (Perfluoropropane) *	**4.5**
Methanol	0.042
Acetaldehyde	0.038
Ethanol	0.16
Acetone	0.090
2-Propanol (Isopropanol)	0.13
Trimethylsilanol	0.034
Toluene	0.13
Octamethylcyclotetrasiloxane	0.14
SPECIAL INTEREST COMPOUNDS	
Hexamethylcyclotrisiloxane #	2.7
NON-TARGET COMPOUNDS ***	
Hexamethyldisiloxane	0.62
TOTAL ALCOHOLS PLUS ACETONE	**0.42**
TARGET COMPOUNDS (GC) **	
Methane	2.3
Hydrogen	0.33
Carbon dioxide	400
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**8.6**
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**4.1**

* GC/FID data results are in bold
** Quantified using a multi-point calibration
*** Quantified using "B" response factor except where noted;
concentrations are estimates only.
Response factor generated from an internal study
OFP - Octafluoropropane

TABLE 2A
T-VALUES FOR SPACEX-8 RETURN GRAB AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)				
	AQ160105 SN 2024 LAB 03/21/16 @ 07:45 GMT	**AQ160106 SN 2022 SM 03/21/16 @ 07:45 GMT**	**AQ160109 SN 2038 LAB 04/26/16 @ 10:19 GMT**	**AQ160110 SN 2030 NODE 3 DMSD Invest. 04/26/16 @ 10:20 GMT**	**AQ160111 SN 2037 NODE 3 DMSD Invest. 05/03/16 @ 12:15 GMT**
TARGET COMPOUNDS (TO-15)					
Octafluoropropane (Perfluoropropane)	0.00097	0.00093	0.00090	0.00087	0.00093
Methanol	0.00495	0.00495	0.00737	0.00626	0.00764
Acetaldehyde	0.05825	0.06681	0.05364	0.04414	0.05101
Ethanol	0.00384	0.00366	0.00377	0.00288	0.00258
Acetone	0.00535	0.00543	0.01800	0.00535	0.00594
2-Propanol (Isopropanol)	0.00063	0.00053	0.00325	0.00125	0.00098
Isoprene (2-Methyl-1,3-butadiene)	0.01535	0.01649	0.01081	0.01121	0.00958
1-Propanol	0.00013	0.00013	0.04932	0.01905	0.00032
Trimethylsilanol	0.02366	0.01640	0.02229	0.01760	0.01942
Ethyl acetate	0.00029	0.00026	0.00028	0.00023	0.00022
1-Butanol	0.00102	0.00102	0.00149	0.00126	0.00101
Mesityl oxide (4-Methyl-3-penten-2-one)	ND	ND	0.00031	ND	ND
SPECIAL INTEREST COMPOUNDS					
No Special Interest Compounds					
NON-TARGET COMPOUNDS					
1,1,1,2-Tetrafluoroethane	0.00071	0.00062	0.00086	0.00076	0.00075
TARGET COMPOUNDS (GC)					
Carbon monoxide	0.05401	0.05409	0.09444	0.09200	0.08359
Methane	0.00093	0.00092	0.00317	0.00312	0.00274
Hydrogen	0.01176	0.01188	0.01589	0.01582	0.01580
Carbon dioxide	0.48854	0.52002	0.47124	0.48080	0.47491
TOTAL T-VALUE	**0.67038**	**0.70414**	**0.75703**	**0.70259**	**0.67742**
TOTAL T-VALUE - CO2	**0.18184**	**0.18413**	**0.28579**	**0.22180**	**0.20251**

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

TABLE 2B
T-VALUES FOR SPACEX-9 RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)	
	AQ160242 SN 2034 LAB 06/06/16 @ 08:04 GMT	AQ160243 SN 2031 JPM 06/06/16 @ 08:04 GMT
TARGET COMPOUNDS (TO-15)		
Octafluoropropane (Perfluoropropane)	0.00103	0.00106
Methanol	0.00421	0.00329
Acetaldehyde	0.07943	0.07225
2-Methyl-1-propene	0.00001	0.00001
Ethanol	0.00221	0.00209
Acetone	0.00976	0.01004
2-Propanol (Isopropanol)	0.00130	0.00107
Isoprene (2-Methyl-1,3-butadiene)	0.01299	0.01375
1-Propanol	0.00797	0.00035
Trimethylsilanol	0.02720	0.03162
Butanal (Butyraldehyde)	ND	0.00096
Ethyl acetate	0.00020	0.00021
1-Butanol	0.00113	0.00120
SPECIAL INTEREST COMPOUNDS		
All Special Interest Compounds were below the reporting limit		
NON-TARGET COMPOUNDS		
1,1,1,2-Tetrafluoroethane	0.00061	0.00065
TARGET COMPOUNDS (GC)		
Carbon monoxide	0.08716	0.08604
Methane	0.00198	0.00205
Hydrogen	0.01909	0.01930
Carbon dioxide	0.50149	0.49003
TOTAL T-VALUE	**0.75775**	**0.73597**
TOTAL T-VALUE - CO2	**0.25627**	**0.24594**

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

TABLE 2C
T-VALUES FOR OA-6 & SPACEX-8 INGRESS GRAB AIR SAMPLES

CHEMICAL CONTAMINANT	AQ160107 SN 2019 OA-6 Ingress 03/27/16 @ 09:30 GMT		AQ160108 SN 2028 SpX-8 Ingress 04/11/16 @ 08:15 GMT	
	7-d SMAC	180-d SMAC	7-d SMAC	180-d SMAC
TARGET COMPOUNDS (TO-15)				
Octafluoropropane (Perfluoropropane)	0.00011	0.00011	0.00007	0.00007
Propene	0.00029	0.00029	ND	ND
Propane	0.00036	0.00713	ND	ND
Carbonyl sulfide (Carbon oxide sulfide)	0.00426	0.00426	ND	ND
Chloromethane	0.00030	0.00030	0.00030	0.00030
Isobutane	0.02045	0.02045	0.00005	0.00005
Methanol	0.00316	0.00316	0.00487	0.00487
Acetaldehyde	0.10142	0.10142	0.01068	0.01068
2-Methyl-1-propene	0.00017	0.00017	ND	ND
Butane	0.00048	0.00984	ND	ND
Ethanol	0.00070	0.00070	0.00045	0.00045
Acetone	0.01121	0.01121	0.00150	0.00150
Propanal (Propionaldehyde)	0.00349	0.00349	ND	ND
2-Propanol (Isopropanol)	0.01458	0.01458	0.00116	0.00116
2-Methyl-2-propanol	0.00034	0.00042	ND	ND
Methylene chloride (Dichloromethane)	0.00142	0.00698	ND	ND
Carbon disulfide	0.00389	0.00389	0.00078	0.00078
1-Propanol	0.00053	0.00053	ND	ND
Trimethylsilanol	0.45815	0.45815	0.00728	0.00728
Butanal (Butyraldehyde)	0.00238	0.00238	ND	ND
2-Butanone (Methyl ethyl ketone)	0.01033	0.01033	ND	ND
Ethyl acetate	0.00044	0.00044	ND	ND
1-Butanol	0.00092	0.00183	ND	ND
3-Methylhexane	0.00005	0.00104	ND	ND
Pentanal	0.00078	0.00078	ND	ND
4-Methyl-2-pentanone (MIBK)	0.00031	0.00031	ND	ND
Toluene	0.00573	0.00573	ND	ND
Hexanal	0.00069	0.00069	ND	ND
m & p-Xylene	0.00034	0.00068	0.00034	0.00068
Heptanal	0.00119	0.00119	ND	ND
o-Xylene	0.00034	0.00068	ND	ND
Octamethylcyclotetrasiloxane	0.00054	0.01263	ND	ND
SPECIAL INTEREST COMPOUNDS				
2-Methyl-2-propenal	0.01471	0.01471	ND	ND
Hexamethylcyclotrisiloxane	0.02232	0.22317	ND	ND
NON-TARGET COMPOUNDS				
1,1,2,2-Tetrafluoroethane	0.01356	0.01356	0.00024	0.00024
1,1-Difluoroethane	0.00084	0.00084	ND	ND
Fluorotrimethylsilane	0.73642	0.73642	ND	ND
Carbonic acid, dimethyl ester	0.00643	0.00643	ND	ND
Hexamethyldisiloxane	0.00321	0.00321	ND	ND
C11-Alkane	0.00601	0.00601	ND	ND
C11-Alkane	0.00110	0.00110	ND	ND
C11-Alkane	0.00132	0.00132	ND	ND
C11-Alkane	0.00121	0.00121	ND	ND
C11-Alkane	0.00210	0.00210	ND	ND
C12-Alkane	0.00169	0.00169	ND	ND
C12-Alkane	0.00764	0.00764	ND	ND
C12-Alkane	0.00318	0.00318	ND	ND
C12-Alkane	0.00923	0.00923	ND	ND
C12-Alkane	0.00151	0.00151	ND	ND
C12-Alkane	0.00712	0.00712	ND	ND
C12-Alkane	0.00718	0.00718	ND	ND
C12-Alkane	0.00295	0.00295	ND	ND
C12-Alkane	0.00048	0.00048	ND	ND
TARGET COMPOUNDS (GC)				
Carbon monoxide	0.11066	0.41011	0.03932	0.14572
Methane	0.00058	0.00058	0.00078	0.00078
Hydrogen	0.00222	0.00222	0.00206	0.00206
Carbon dioxide	0.12300	0.12300	0.05182	0.05182
TOTAL T-VALUE	1.73553	2.22714	0.12172	0.22845
TOTAL T-VALUE - CO2	1.61254	2.10414	0.06990	0.17663

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

TABLE 2D
T-VALUES FOR 45S RETURN BEAM INGRESS GRAB AIR SAMPLE

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)	T-VALUE (180-d SMAC)
	AQ160196 SN 2035 BEAM INGRESS 06/06/16 @ 08:50 GMT	**AQ160196 SN 2035 BEAM INGRESS 06/06/16 @ 08:50 GMT**
TARGET COMPOUNDS (TO-15)		
Octafluoropropane (Perfluoropropane)	0.00005	0.00005
Methanol	0.00047	0.00047
Acetaldehyde	0.00953	0.00953
Ethanol	0.00008	0.00008
Acetone	0.00172	0.00172
2-Propanol (Isopropanol)	0.00084	0.00084
Trimethylsilanol	0.00844	0.00844
Toluene	0.00889	0.00889
Octamethylcyclotetrasiloxane	0.00051	0.01197
SPECIAL INTEREST COMPOUNDS		
Hexamethylcyclotrisiloxane	0.03020	0.30204
NON-TARGET COMPOUNDS		
Hexamethyldisiloxane	0.00623	0.00623
TARGET COMPOUNDS (GC)		
Carbon monoxide	0.00182	0.00674
Methane	0.00066	0.00066
Hydrogen	0.00097	0.00097
Carbon dioxide	0.03094	0.03094
TOTAL T-VALUE	**0.10136**	**0.38957**
TOTAL T-VALUE - CO2	**0.07042**	**0.35863**

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

Table 3. Expedition 47 Water Sample Summary Report
US Potable Water Samples

Mission					Soyuz 45/Expedition 47	
Sample Location			Potable Water Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	WPA PWD Ambient	WPA PWD Hot
Sample Description		Test Conducted by			Potable Water	Potable Water
Sample Date					4/4/2016	5/25/2016
Analysis/Sample ID	Units				20160620001	20160620002
Physical Characteristics						
pH	pH units	U.S.	4.5-8.5	41000	5.86	5.36
Conductivity	µS/cm	U.S.			2	2
Iodine (LCV)						
Total I	mg/L	U.S.	6/0.2	pt of consumption)	<0.05	<0.05
Iodine	mg/L	U.S.			<0.05	<0.05
Iodide	mg/L	U.S.			<0.05	<0.05
Trace Metals (ICP/MS)						
Calcium	mg/L	U.S.	30	41000	0.02	0.02
Potassium	mg/L	U.S.	340	41000	<0.01	<0.01
Sodium	mg/L	U.S.			0.02	0.05
Aluminum	µg/L	U.S.			2	2
Nickel	µg/L	U.S.	300	SWEG&41000	3	3
Zinc	µg/L	U.S.	2,000	SWEG&41000	2	3
Silicon (ICP/MS)						
Silicon	µg/L	U.S.			78	46
Total Organic Carbon (Sievers)						
Inorganic Carbon	mg/L	U.S.			1.03	1.02
Organic Carbon	mg/L	U.S.	3	41000	0.11	0.13
Semi-volatiles (GC/MS) - Target List						
Methyl sulfone	µg/L	U.S.			92	101
Semi-volatiles (GC/MS) - Special Interest Compounds (Semi-quantitative - 2 pt curve)						
Dimethylsilanediol (DMSD)	µg/L	U.S.	35,000	SWEG	<1000	<1000
Monomethylsilanetriol (MMST)	µg/L	U.S.	110,000	SWEG	<1000	<1000
Amines (IC)						
Trimethylamine	µg/L	U.S.	Trialkylamines 400	SWEG	<250	<250
Organic Carbon Recovery	percent	U.S.			20.73	19.24
Unaccounted Organic Carbon	mg/L	U.S.			0.09	0.11

Data Qualifiers: None.

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable

Table 4. Expedition 47 Water Sample Summary Report
Condensate Samples

Mission			SpX-8/Exp. 47		
Sample Location			WPA Condensate Sample Port	WPA Condensate Sample Port	WPA Condensate Sample Port
Sample Description		Test Conducted	US Condensate sample	US Condensate sample	US Condensate sample
Sample Date		by	4/19/2016	4/26/2016	5/3/2016
Analysis/Sample ID	Units		20160516001	20160516002	20160516003
Physical Characteristics					
pH	pH units	U.S.	7.31	7.75	7.75
Conductivity	µS/cm	U.S.	320	330	290
Anions (IC)					
Bromide	mg/L	U.S.	0.9	0.4	0.3
Fluoride	mg/L	U.S.	0.6	0.3	0.3
Phosphate as P (PO4-P)	mg/L	U.S.	0.12	0.12	0.11
Sulfate	mg/L	U.S.	2.4	0.5	<0.5
Cations (IC)					
Ammonia as Nitrogen (NH3-N)	mg/L	U.S.	42.3	39.9	36.5
Trace Metals (ICPMS)					
Calcium	mg/L	U.S.	0.11	0.10	0.09
Potassium	mg/L	U.S.	0.24	0.06	0.06
Sodium	mg/L	U.S.	0.39	1.14	4.30
Aluminum	µg/L	U.S.	7	16	6
Chromium	µg/L	U.S.	5	6	5
Copper	µg/L	U.S.	9	10	6
Manganese	µg/L	U.S.	17	30	25
Molybdenum	µg/L	U.S.	4	<2	<2
Nickel	µg/L	U.S.	852	885	931
Selenium	µg/L	U.S.	2	<2	<2
Silver	µg/L	U.S.	7	64	60
Zinc	µg/L	U.S.	33,800	7,550	7,120
Silicon (ICPMS)					
Silicon	µg/L	U.S.	12,100	12,200	12,500
Total Organic Carbon (OI)					
Inorganic Carbon	mg/L	U.S.	27.0	19.3	20.1
Organic Carbon	mg/L	U.S.	173	149	126
Volatile Organics					
Acetone	µg/L	U.S.	2,130	1,010	934
Volatile Organics -Special Interest Compounds (Semi-quantitative)					
Acetaldehyde	µg/L	U.S.	not found	200	160
Trimethylsilanol	µg/L	U.S.	140	150	150
Semi-volatiles (GCMS) - Target List					
Benzothiazole	µg/L	U.S.	71	82	70
N-n-Butylbenzenesulfonamide	µg/L	U.S.	145	<40	<40

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable

Table 4. Expedition 47 Water Sample Summary Report
Condensate Samples

Mission			SpX-8/Exp. 47		
Sample Location			WPA Condensate Sample Port	WPA Condensate Sample Port	WPA Condensate Sample Port
Sample Description		Test	US Condensate sample	US Condensate sample	US Condensate sample
Sample Date		Conducted	4/19/2016	4/26/2016	5/3/2016
Analysis/Sample ID	Units	by	20160516001	20160516002	20160516003
Tris(2-Chloroethyl)phosphate	µg/L	U.S.	67	<40	<40
Decamethylcyclopentasiloxane	µg/L	U.S.	42	<40	<40
Dodecamethylcyclohexasiloxane	µg/L	U.S.	31	<40	<40
Methyl sulfone	µg/L	U.S.	157	277	293
Benzoic acid	µg/L	U.S.	796	1,800	1,520
Phenol	µg/L	U.S.	276	366	353
Benzyl alcohol	µg/L	U.S.	8,630	8,120	4,290
Dibutylphthalate	µg/L	U.S.	184	256	246
Diethylphthalate	µg/L	U.S.	549	1,080	1,040
Dimethylphthalate	µg/L	U.S.	40	55	49
Semi-volatiles (GCMS) - Special Interest Compounds (Semi-quantitative - 2 pt curve)					
Acetophenone	µg/L	U.S.	13	not found	not found
Benzaldehyde	µg/L	U.S.	73	110	75
2-Butoxyethanol	µg/L	U.S.	140	170	140
2-(2-Butoxyethoxy)ethanol	µg/L	U.S.	1,000	2,100	1,600
3-tert-Butylphenol	µg/L	U.S.	41	<80	<80
N,N-Dimethyl acetamide	µg/L	U.S.	110	<400	<400
N,N-Dimethylformamide	µg/L	U.S.	350	not found	not found
2-Ethoxyethanol	µg/L	U.S.	>220	not found	not found
2-Ethylhexanoic acid	µg/L	U.S.	270	380	260
Hexanoic acid	µg/L	U.S.	1,200	1,100	840
1-Methyl-2-pyrrolidinone	µg/L	U.S.	430	620	670
Methyl 4-hydroxybenzoate	µg/L	U.S.	not found	not found	60
Monomethyl phthalate	µg/L	U.S.	not found	92	84
2-Phenoxyethanol	µg/L	U.S.	1,300	3,300	2,100
2-Phenyl-2-propanol	µg/L	U.S.	<200	430	430
Phenethyl alcohol	µg/L	U.S.	38	not found	not found
1,3,5-Triallyl-1,3,5-triazine-2,4,6(1H,3H,5H)-trione	µg/L	U.S.	110	53	52
Tributyl phosphate	µg/L	U.S.	63	48	38

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable

Table 4. Expedition 47 Water Sample Summary Report
Condensate Samples

Mission			SpX-8/Exp. 47		
Sample Location			WPA Condensate Sample Port	WPA Condensate Sample Port	WPA Condensate Sample Port
Sample Description		Test	US Condensate sample	US Condensate sample	US Condensate sample
Sample Date		Conducted	4/19/2016	4/26/2016	5/3/2016
Analysis/Sample ID	Units	by	20160516001	20160516002	20160516003
Alcohols (DAI/GCMS)					
1-Butanol	µg/L	U.S.	<400	458	469
Ethanol	µg/L	U.S.	55,500	63,500	60,300
Methanol	µg/L	U.S.	5,600	5,170	4,900
2-Propanol (Isopropanol)	µg/L	U.S.	845	1,340	1,170
Glycols (DAI/GCMS)					
1,2-Ethanediol (Ethylene glycol)	µg/L	U.S.	2,480	3,710	2,740
1,2-Propanediol (Propylene glycol)	µg/L	U.S.	33,200	39,000	23,500
Silanols (LC/RI) (R & D Method -NIST traceable standard not available)					
Dimethylsilanediol (DMSD)	µg/L	U.S.	32,000	37,000	36,000
Carboxylates (IC)					
Acetate	µg/L	U.S.	64,300	54,100	46,300
Butyrate	µg/L	U.S.	<500	593	565
Formate	µg/L	U.S.	2,860	11,400	9,730
Lactate	µg/L	U.S.	44,300	2,920	2,130
Propionate	µg/L	U.S.	1,400	1,730	1,200
Aldehydes					
Formaldehyde	µg/L	U.S.	35	5,780	5,940
Non-volatiles (LC/UV-VIS)					
Urea	µg/L	U.S.	3,730	<1600	<1600
Caprolactam	µg/L	U.S.	5,070	2,990	2,530
Organic Carbon Recovery	percent	U.S.	69.12	75.79	89.01
Unaccounted Organic Carbon	mg/L	U.S.	53.43	36.07	12.53

Data Qualifiers: **20160516001, 002 & 003 -** Possible low bias - trimethylsilanol.

NA=Not analyzed
MI=Matrix Interference
N/A=Not applicable