Toxicological Assessment of ISS Air Quality: June – September 2013 (Increment 36)

Fourteen mini grab sample containers (mGSCs) were collected on ISS between June and September 2013 and were returned on 34S; however, the ATV-4 first ingress mGSC did not contain sufficient sample to report results (initial sample pressure = 1.2 psia). Of the remaining 13 mGSCs, 12 were collected as routine monthly samples in the Russian Service Module (SM), US Laboratory (Lab), and either the Japanese Pressurized Module (JPM) or the Columbus module (Col), and 1 was collected during HTV-4 first ingress.

A summary of the analytical results from the 13 valid mGSCs is shown in Table 1. Complete data tables of all measured concentrations and corresponding T-values based on 180-day SMACs are enclosed. A data table containing T-values based on both the 7-day and 180-day SMACs is enclosed for the HTV-4 first ingress sample. The detection limit for all target compounds, except m/p-xylenes and hexachloro-1,3-butadiene, was 0.025 mg/m^3. The detection limit for m/p-xylenes, hexachloro-1,3-butadiene, and all non-target compounds was 0.05 mg/m^3. The average recoveries of the 3 surrogate standards from the mGSCs were as follows: ^{13}C-acetone, 122 ± 9%; fluorobenzene-d_5, 117 ± 8%; and chlorobenzene-d_5, 113 ± 14%. Initial measured sample pressures for 12 of the mGSCs were between 13.7 and 14.4 psia, indicating nominal sample collection. The initial measured sample pressure for the mGSC collected in the US Lab on 8/14/2013 was marginally lower, at 11.5 psia, but was sufficient to obtain reliable data. A summary of the analytical results from 6 pairs of passive-diffusion formaldehyde badges collected in the US Lab or Russian Service Module (SM) and returned aboard 35S is also provided in Table 1. Positive control recoveries (1 trip and 2 lab controls) were 109%, 100%, and 80%, respectively. Formaldehyde sampling was cancelled in June to preserve contingency badges due to delayed resupply.

Table 1. Analytical Summary of ISS results

Sample Location	Sample Date	NMVOCs[a] (mg/m^3)	Freon 218 (mg/m^3)	Alcohols[b] (mg/m^3)	T-Value[c] (units)	CO_2 (mg/m^3)	Formaldehyde (µg/m3)
JPM	6/24/2013	6.4	7.6	3.1	0.4	6700	--
Lab	6/24/2013	6.3	7.5	3.1	0.4	7000	Cancelled
SM	6/24/2013	5.5	8.5	3.1	0.3	7100	Cancelled
SM	7/18/2013	6.4	7.0	3.4	0.4	6800	18
Lab	7/18/2013	6.3	7.3	3.7	0.4	7000	33
Col	7/18/2013	6.9	7.0	3.6	0.4	7000	--
HTV4	8/10/2013	14	3.7	3.6	2.2 (1.5)	3900	--
Lab	8/14/2013	6.9	5.9	3.4	0.5	7500	42
JPM	8/14/2013	7.1	5.2	3.2	0.5	7700	--
SM	8/14/2013	7.0	6.3	3.6	0.4	7800	37
Lab	9/3/2013	7.2	5.5	3.1	0.5	7600	41
Col	9/3/2013	7.4	5.9	3.2	0.5	7600	--
SM	9/3/2013	6.1	5.2	3.1	0.4	7500	18
Guideline		*<25*	---	*<5*	*<1*	*<9300*	*<160*

[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 used for evaluation of first ingress.

Toxicological Evaluation of ISS Air Quality: Routine monthly sampling provides a very limited set of samples on which to perform an air quality assessment. However, based on these samples, there is no concern for crew health. Formaldehyde levels in the US Lab are consistent with historical levels which are generally between 30-40 $\mu g/m^3$. Concentrations in the Russian SM are generally lower than the US, and were notably lower in July and September. The primary contributor to the total T-value across all sampling locations throughout this time period was hexamethylcyclotrisiloxane. This compound was measured well below levels of health concern but may contribute to periodic accumulation of siloxanes in the water recovery system. In contrast to samples collected in the prior 6 months, alcohol values in all mGSCs were below the alcohol guideline of <5 mg/m^3, which is intended to protect the water recovery system from risk of overloading. mGSCs provide only a snapshot of conditions and are not ideal for evaluating potential CO_2 exposures. However, reported levels were below 4 mmHg (9300 mg/m^3), as requested for this Increment in Chit 011331.

The CO_2 and Freon 218 levels measured in the HTV4 first ingress sample indicate that some mixing occurred with the ISS atmosphere prior to sample collection. The elevated T-value at HTV-4 first ingress was primarily attributed to trimethylsilanol, hexamethylcyclotrisiloxane, fluorotrimethylsilane, and carbon monoxide. The measured T-value of 1.5 based on 7-day SMACs is lower than the predicted T-value of 2.5 resulting from the off-gas test performed by JAXA; however, the primary contaminants measured at first ingress were consistent with those reported by JAXA as the primary contaminants in the off-gas test, and the lower T-value may be the result of the aforementioned dilution with ISS cabin air.

_____ _____

Valerie Meyers, Ph.D., DABT Date
NASA Toxicologist

Enclosures Table 1: Analytical concentrations of compounds found in the mGSCs returned on 34S
Table 2: T-values corresponding to analytical concentrations in Table 1, based on 180-day SMACs
Table 2A: T-values corresponding to the analytical concentrations in Table 1, based on 180-day and 7-day SMACs for HTV-4 first ingress