



## STS 133 Return Samples: Air Quality aboard Shuttle (STS-133) and International Space Station (ULF5)

**Space Shuttle:** The toxicological assessments of 2 canisters (mini-GSC or GSCs) from the Shuttle are reported in Table 1. Analytical methods have not changed from earlier reports. The percent recoveries of the 3 surrogates (<sup>13</sup>C-acetone, fluorobenzene, and chlorobenzene) from the 2 Shuttle GSCs averaged 86, 100, and 87, respectively. Based on the end-of-mission sample, the Shuttle atmosphere was acceptable for human respiration.

Table 1. Analytical Summary of Shuttle Samples (GSC in black and mini-GSC in blue)

Sample Location	Date of Sample	NMVOCs <sup>a</sup> (mg/m <sup>3</sup> )	Freon 218 (mg/m <sup>3</sup> )	T Value <sup>b</sup> (units)	Alcohols (mg/m <sup>3</sup> )	Formaldehyde (µg/m <sup>3</sup> )
Preflight	2/24/11	0.4	<0.1	0.04	0.2	No sample
Mid-deck (end of mission)	3/9/11	2.1	23 <sup>c</sup>	0.11	1.2	No sample
Guideline		25	none	1.0	None <sup>d</sup>	<120

<sup>a</sup> Non-methane volatile organic hydrocarbons, excluding Freon 218

<sup>b</sup> Based on 7-day SMACs and calculated excluding CO<sub>2</sub>, formaldehyde, and siloxanes.

<sup>c</sup> This is residual from the ISS during docked phase.

<sup>d</sup> There is no guideline value because water is not recovered from humidity condensate on Shuttle as it is on ISS.

**International Space Station:** The toxicological assessment of 16 GSCs from the ISS is shown in Table 2. The recoveries of the 3 standards (as listed above) from the GSCs averaged 99, 108 and 97%, respectively. Formaldehyde badges were not returned on this flight.

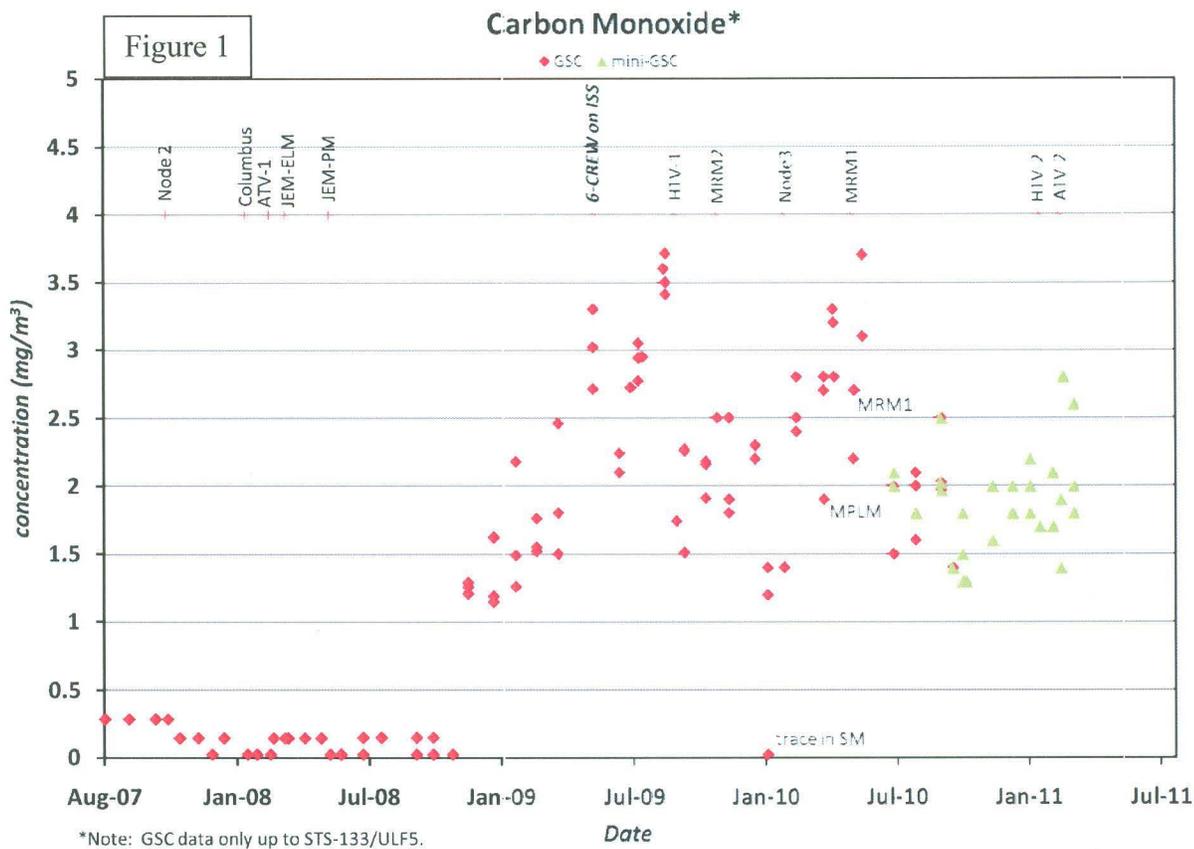
Table 2. Analytical Summary of ISS Results (GSC in black and mini-GSC in blue)

Module/Sample	Approx. Date of Sample	NMVOCs <sup>a</sup> (mg/m <sup>3</sup> )	Freon 218 (mg/m <sup>3</sup> )	T Value <sup>b</sup> (units)	Alcohols (mg/m <sup>3</sup> )	Formaldehyde (µg/m <sup>3</sup> )
Lab	5/31/10	6.0	70	0.40	4.5	--
Lab	5/31/10	6.3	54	0.41	4.8	--
JEM	5/31/10	6.8	40	1.41	4.8	--
SM	5/31/10	6.5	28	0.44	4.8	--
SM	7/12/10	5.3	42	0.32	4.0	--
SM	7/12/10	5.9	42	0.31	4.6	--
Lab	7/12/10	5.2	28	0.34	3.7	--
Col	7/12/10	5.6	22	0.32	4.0	--
Lab	8/11/10	6.2	23	0.37	4.6	--
JEM	8/11/10	5.8	23	0.31	4.3	--
JEM	8/11/10	5.3	28	0.30	4.3	--
JEM	8/11/10	6.4	30	0.31	5.2	--
SM	8/11/10	5.5	26	0.33	4.0	--
WRS-1 Rack <sup>c</sup>	10/1/10	4.5	36	0.26	3.1	--
Lab <sup>c</sup>	10/19/10	7.8	36	0.34	5.9	--
PMM (first entry)	03/01/11	22	<1	2.51	9.3	--
Guideline		<25	none	<1.0	<5	<120

<sup>a</sup> Non-methane volatile organic hydrocarbons, excluding Freon 218

<sup>b</sup> Based on 180-d SMACs and calculated excluding CO<sub>2</sub>, formaldehyde, and siloxanes.

<sup>c</sup> Contingency sample taken due to odors.



**Carbon Monoxide Accumulation aboard ISS:** Beginning in late 2008 the nominal concentrations of CO began increasing gradually (figure 1). The results from samples returned on this flight indicate that the CO concentrations, after dropping in late 2009, have cycled upward and then settled back to concentrations near 2 mg/m<sup>3</sup>. In any case, these changes are well below the 180-day SMAC for CO, which is 17 mg/m<sup>3</sup>. There is no threat to crew health. The source of the additional CO is unknown.

**Contingency Samples:** Two contingency samples were acquired in the present set. The WRS-1 sample was taken due to a “hot metal smell” in the area and the Lab sample on October 19, 2011 was taken because of a “funky” smell in the area. No compounds in the first sample could be associated with the hot metal smell; however, the second sample contained somewhat high levels of methanol, ethanol, methyl acetate, and ethyl acetate which together may have contributed to the odor.

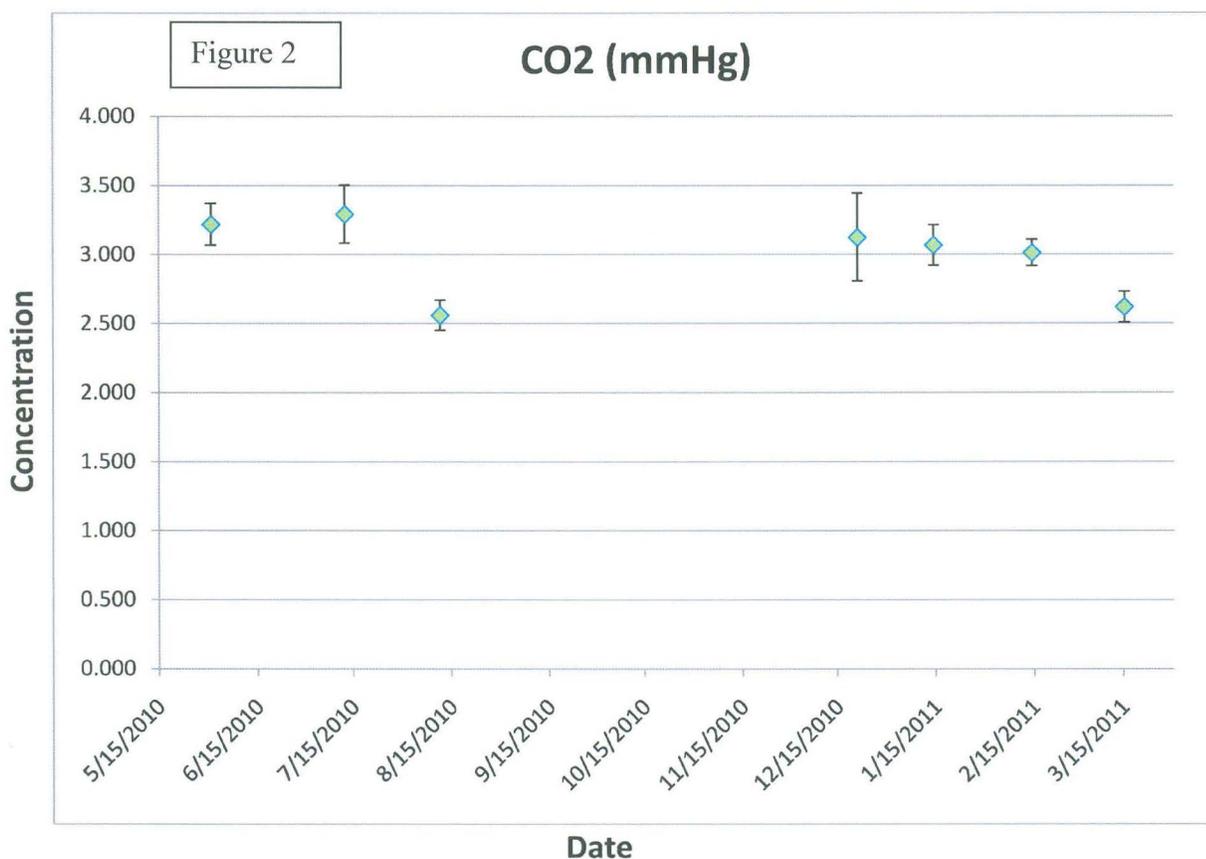
**High T Value Samples:** The high T-Value (1.41) in the JEM was due to traces of propenal and furan in the sample. These were not detected in any other sample. The high T-Value (2.51) in the first-entry sample of the PMM was primarily due to trimethylsilanol (0.82) and fluorotrimethylsilane (0.65). This sample also showed an unusually high amount of 2-propanol (6.3 mg/m<sup>3</sup>), which elevated the “alcohols” value above 5. The alcohol may have been residue from cleaning.

**General Observations about ISS Air Quality:**

This is a very limited set of samples on which to perform an air quality assessment. However, based on these samples, we have no reason to believe that nominal ISS air is unsafe to breathe. Past observations of sporadic elevations of propenal have recurred once, but at a lower level. We must continue to be vigilant when dealing with nominal atmospheres in ISS. New, unmanned modules, such as the PMM, require special attention when the crew first enters.

**Carbon Dioxide:** This anthropogenic compound has drawn much attention recently because of the possibility that it could contribute to the effects of intracranial hypertension experienced because of spaceflight-induced fluid shifts. From now on we will maintain a plot (Figure 2) of carbon dioxide concentrations ( $\pm$ SD) by averaging the values found in the 3-5 samples taken each month in diverse locations of the ISS. This will enable us to estimate the average exposure of crewmembers to carbon dioxide during their stay aboard the ISS. In general, concentrations are being maintained below 3.5 mmHg.

**Contaminated Samples:** GSC samples taken in the Lab on 5/31/10 and from the SM on 7/12/10 were invalid because of internal contamination. The source of contamination has been isolated to a specific series of GSC numbers, although the precise origin of the contamination is uncertain.



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Enclosures

Table 1A: Analytical concentrations of compounds found in the STS-133 GSCs

Table 1B: Analytical concentrations of compounds found in ULF5 GSCs

Table 2A: T-values of the compounds in table 1A

Table 2B: T-values of the compounds in table 1B