

## STS 129 Return Samples: Assessment of Air Quality aboard the Shuttle (STS-129) and International Space Station (ULF3)



**Space Shuttle:** The toxicological assessments of 2 grab sample canisters (GSCs) from the Shuttle are reported in Table 1. Analytical methods have not changed from earlier reports. The recoveries of the 3 surrogates (<sup>13</sup>C-acetone, fluorobenzene, and chlorobenzene) from the 2 GSCs averaged 109, 101, and 101 %, respectively. Based on the end-of-mission sample, the Shuttle atmosphere was acceptable for human respiration.

Table 1. Analytical Summary of Shuttle Samples

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	11/16/099	0.2	0	0.05	0.1	--
Mid-deck (end mission)	11/27/09	3.2	61	0.16	0.8	--

<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.

**International Space Station:** The toxicological assessment of 5 GSCs and 6 pairs of formaldehyde badges from the ISS is shown in Table 2. The recoveries of the 3 standards (as listed above) from the GSCs averaged 81, 87 and 55%, respectively. The low recovery of chlorobenzene was due to analytical interference from high levels of Freon 218. Results of two GSC samples (9/29/and 10/28) were not reported due to problems with overall surrogate recoveries. Three positive formaldehyde-badge controls averaged 101% recovery.

Table 2. Analytical Summary of ISS Results

Module/Sample	Approx. Date	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	9/4/09	--	--	--	--	21
SM	9/4/09	--	--	--	--	20
HTV [first entry]	9/18/09	22	15	3.2	7.0	--
Lab	9/29/09	4	164	0.4	1.9	25
SM	9/29/09	4	158	0.3	1.9	21
Lab	10/28/09	6	159	1.0 <sup>c</sup>	3.5	35
SM	10/28/09	6	164	0.4	3.6	20
<i>Guideline</i>		<25	<i>none</i>	<1.0	<5	<120

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

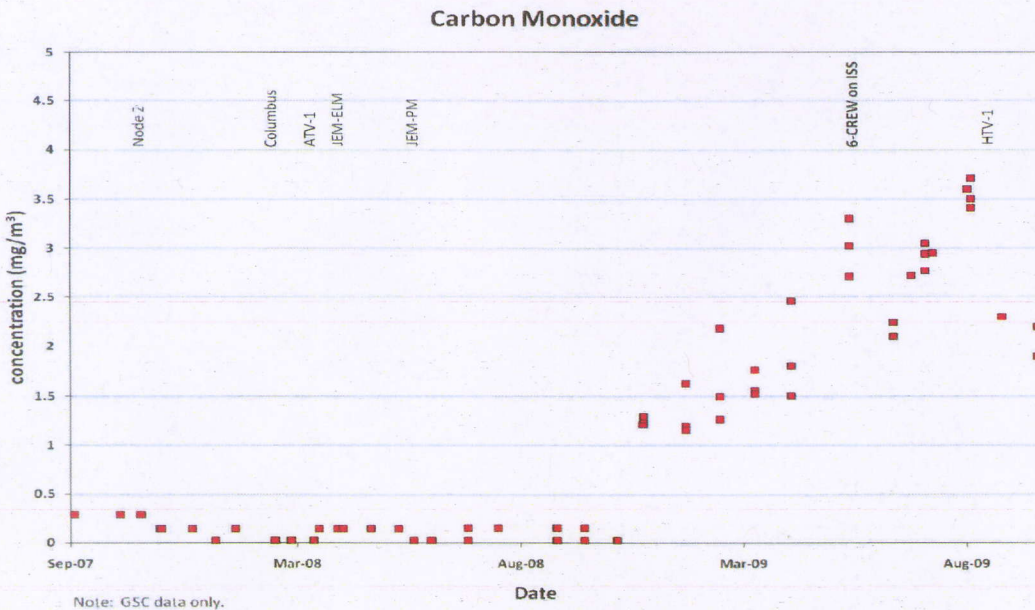
<sup>b</sup> Based on 180-d SMACs and calculated excluding CO<sub>2</sub>, formaldehyde, and siloxanes.

<sup>c</sup> Higher T value is due to traces of propanal, an irritant.

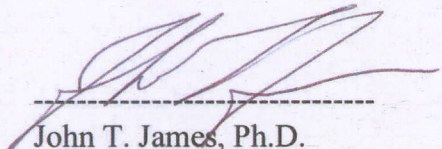
**HTV First Entry:** Upon first entry into the HTV the crew noted a strong odor that was characterized as "new car smell" or somewhat like formaldehyde. Two crewmembers reported mild headaches after working in the area of the HTV for a period of time; this situation persisted for 2-3 days. The odors seemed to be strongest in the area of box foam and investigation is continuing as to the precise source. There is no specific compound in the analytical results that

could have produced the odors reported; however, compounds can often be smelled at extremely low concentrations, well below analytical detection limits. Furthermore, the simple presence of odors can elicit mild headaches in many individuals.

**Carbon Monoxide Accumulation aboard ISS:** Over the past few months the nominal concentrations of CO have been increasing gradually (see figure below). The results from samples returned on this flight indicate that the concentrations have dropped somewhat; however, they have not returned to pre-October 2008 levels. In any case, these changes are well below the 180-day SMAC of CO, which is  $17 \text{ mg/m}^3$ . There is no threat to crew health.



**General Observations about ISS Air Quality:** This is a very limited set of samples on which to base 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 not recurred. None-the-less, we must still be vigilant when dealing with nominal atmospheres in ISS. Unmanned modules require special attention when the crew first enters.

  
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Enclosures

Table 1A: Analytical concentrations of compounds found in the STS-129 GSCs

Table 1B: Analytical concentrations of compounds found in ULF3 GSCs

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

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

**TABLE 1A  
ANALYTICAL RESULTS OF  
STS-129 RETURN GRAB SAMPLE CONTAINER AIR SAMPLES**

CHEMICAL CONTAMINANT	CONCENTRATION (mg/m <sup>3</sup> )	
	AA04801 Mid-Deck SN 1008 11/27/09 @ 9:33 GMT	AA04792 Preflight SN 1056 11/16/09 @ 9:00 EST
	<b>TARGET COMPOUNDS (TO-14/POLAR)***</b>	
FREON12	<0.025	<0.025
CHLOROMETHANE	0.030	<0.025
FREON114	<0.025	<0.025
METHANOL	0.15	0.043
ACETALDEHYDE	0.047	TRACE
VINYLCHLORIDE	<0.025	<0.025
BROMOMETHANE	<0.025	<0.025
ETHANOL	0.38	0.040
CHLOROETHANE	<0.025	<0.025
ACETONITRILE	<0.025	<0.025
PROPENAL	<0.025	<0.025
ACETONE	0.16	0.031
PROPANAL	TRACE	TRACE
ISOPROPANOL	0.058	0.031
FREON11	<0.025	<0.025
FURAN	<0.025	<0.025
ACRYLONITRILE	<0.025	<0.025
PENTANE	<0.025	<0.025
2-METHYL-2-PROPANOL	TRACE	<0.025
METHYLACETATE	<0.025	<0.025
1,1-DICHLOROETHENE	<0.025	<0.025
DICHLOROMETHANE	<0.025	<0.025
3-CHLOROPROPENE	<0.025	<0.025
FREON113	<0.025	<0.025
N-PROPANOL	TRACE	<0.025
1,1-DICHLOROETHANE	<0.025	<0.025
BUTANAL	<0.025	<0.025
2-BUTANONE	<0.025	<0.025
CIS-1,2-DICHLOROETHENE	<0.025	<0.025
2-METHYLFURAN	<0.025	<0.025
ETHYLACETATE	<0.025	<0.025
HEXANE	<0.025	<0.025
CHLOROFORM	<0.025	<0.025
2-BUTENAL	<0.025	<0.025
1,2-DICHLOROETHANE	<0.025	<0.025
1,1,1-TRICHLOROETHANE	<0.025	<0.025
N-BUTANOL	<0.025	<0.025
BENZENE	<0.025	<0.025
CARBONTETRACHLORIDE	<0.025	<0.025
2-PENTANONE	<0.025	<0.025
2-METHYLHEXANE	<0.025	<0.025
2,3-DIMETHYLPENTANE	<0.025	<0.025
PENTANAL	<0.025	<0.025
3-METHYLHEXANE	<0.025	<0.025
1,2-DICHLOROPROPANE	<0.025	<0.025
1,4-DIOXANE	<0.025	<0.025
TRICHLOROETHENE	<0.025	<0.025
2,5-DIMETHYLFURAN	<0.025	<0.025
N-HEPTANE	<0.025	<0.025

4-METHYL2-PENTANONE	<0.025	<0.025
CIS-1,3-DICHLOROPROPENE	<0.025	<0.025
2-PENTENAL	<0.025	<0.025
TRANS-1,3-DICHLOROPROPENE	<0.025	<0.025
1,1,2-TRICHLOROETHANE	<0.025	<0.025
TOLUENE	<0.025	<0.025
HEXANAL	<0.025	<0.025
MESITYLOXIDE	<0.025	<0.025
1,2-DIBROMOETHANE	<0.025	<0.025
BUTYLACETATE	<0.025	<0.025
OCTANE	<0.025	<0.025
TETRACHLOROETHENE	<0.025	<0.025
CHLOROBENZENE	<0.025	<0.025
ETHYLBENZENE	<0.025	<0.025
M/P-XYLENES	<0.025	<0.025
2-HEPTANONE	<0.025	<0.025
CYCLOHEXANONE	<0.025	<0.025
HEPTANAL	<0.025	<0.025
STYRENE	<0.025	<0.025
1,1,2,2-TETRACHLOROETHANE	<0.025	<0.025
O-XYLENE	<0.025	<0.025
NONANE	<0.025	<0.025
1,3,5-TRIMETHYLBENZENE	<0.025	<0.025
1,2,4-TRIMETHYLBENZENE	<0.025	<0.025
1,3-DICHLOROBENZENE	<0.025	<0.025
1,4-DICHLOROBENZENE	<0.025	<0.025
1,2-DICHLOROBENZENE	<0.025	<0.025
1,2,4-TRICHLOROBENZENE	<0.025	<0.025
HEXACHLORO-1,3-BUTADIENE	<0.025	<0.025

<b>TARGET COMPOUNDS (TOXIC)</b>		
1,3-BUTADIENE	<0.025	<0.025
ETHYLENE OXIDE	<0.025	<0.025
CARBON DISULFIDE	<0.025	<0.025
2-METHYL-2-PROPENAL	<0.025	<0.025
3-BUTEN-2-ONE	<0.025	<0.025
2-ETHOXYETHANOL	<0.025	<0.025
DIMETHYLDISULFIDE	<0.025	<0.025
OCTAMETHYLCYCLOTETRAILOXANE	*	*

<b>NON-TARGET COMPOUNDS</b>		
OCTAFLUOROPROPANE**	61	<0.025
SULFURHEXAFLUORIDE	0.11	<0.025
BROMOTRIFLUOROMETHANE	2.2	<0.025
PROPENE	TRACE	<0.025
CARBONYLSULFIDE	<0.025	<0.025
ISOPRENE	0.080	<0.025
HEXAMETHYLCYCLOTRISILOXANE	*	*
DECAMETHYLCYCLOPENTASILOXANE	*	*

<b>TOTAL ALCOHOLS PLUS ACETONE</b>	<b>0.76</b>	<b>0.14</b>
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<b>TARGET COMPOUNDS (GC)***</b>		
CARBON MONOXIDE	5.09	< 0.57
METHANE	33	< 1.6
HYDROGEN	13	< 0.41
CARBON DIOXIDE	5300	TRACE

<b>TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)</b>	<b>65</b>	<b>0.17</b>
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<b>TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS) MINUS OCTAFLUOROPROPANE</b>	<b>3.2</b>	<b>0.17</b>
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\*Present, subject to large, random variability, therefore not quantifiable

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

TRACE: Amount detected is sufficient for compound identification only.

\*\* Measurements are calibrated by one-point calibration

\*\*\* Measurements are calibrated by multi-point initial calibration and verified by mid-point continuing calibration.

**TABLE 1B  
ANALYTICAL RESULTS OF  
ULF3 RETURN GRAB SAMPLE CONTAINER AIR SAMPLES**

CHEMICAL CONTAMINANT	CONCENTRATION (mg/m3)				
	AA04794	AA04796	AA04797	AA04798	AA04799
	S/N 1095 HTV 09/18/09 @ 18:25 GMT	S/N 1011 Mid-LAB 09/29/09 @ 11:45 GMT	S/N 1031 Mid-SM 09/29/09 @ 11:50 GMT	S/N 1041 SM 10/28/09 @ 17:23 GMT	S/N 1097 LAB 10/28/09 @ 17:25 GMT
<b>TARGET COMPOUNDS (TO-14/POLAR)***</b>					
FREON12	0.049	0.057	0.059	<0.025	<0.025
CHLOROMETHANE	0.026	<0.025	<0.025	<0.025	<0.025
FREON114	<0.025	<0.025	<0.025	<0.025	<0.025
<b>METHANOL **</b>	0.73	0.38	0.28	0.44	0.42
ACETALDEHYDE	0.73	0.069	0.062	0.093	0.24
VINYLCHEMICAL	<0.025	<0.025	<0.025	<0.025	<0.025
BROMOMETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
<b>ETHANOL *</b>	<b>3.5</b>	<b>0.87</b>	<b>1.0</b>	<b>2.5</b>	<b>2.3</b>
CHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
ACETONITRILE	TRACE	TRACE	TRACE	TRACE	TRACE
PROPENAL	TRACE	<0.025	<0.025	<0.025	TRACE
ACETONE	0.54	0.29	0.30	0.27	0.29
PROPANAL	0.16	0.040	0.035	0.033	0.082
<b>ISOPROPANOL *</b>	<b>2.1</b>	0.22	0.20	0.18	0.18
FREON11	<0.025	<0.025	<0.025	<0.025	<0.025
FURAN	<0.025	<0.025	<0.025	<0.025	<0.025
ACRYLONITRILE	<0.025	<0.025	<0.025	<0.025	<0.025
PENTANE	0.028	<0.025	<0.025	<0.025	<0.025
2-METHYL-2-PROPANOL	0.089	<0.025	<0.025	<0.025	<0.025
METHYLACETATE	TRACE	<0.025	<0.025	0.091	0.083
1,1-DICHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025
DICHLOROMETHANE	TRACE	TRACE	TRACE	TRACE	TRACE
3-CHLOROPROPENE	<0.025	<0.025	<0.025	<0.025	<0.025
FREON113	<0.025	<0.025	<0.025	<0.025	<0.025
N-PROPANOL	0.026	0.034	0.041	0.10	0.16
1,1-DICHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
BUTANAL	0.056	TRACE	TRACE	<0.025	0.037
2-BUTANONE	0.083	0.043	0.034	0.029	0.055
CIS-1,2-DICHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025
2-METHYLFURAN	TRACE	<0.025	<0.025	<0.025	<0.025
ETHYLACETATE	0.57	0.030	0.032	0.17	0.14
HEXANE	0.035	TRACE	TRACE	TRACE	<0.025
CHLOROFORM	<0.025	<0.025	<0.025	<0.025	<0.025
2-BUTENAL	<0.025	<0.025	<0.025	<0.025	<0.025
1,2-DICHLOROETHANE	<0.025	TRACE	TRACE	TRACE	TRACE
1,1,1-TRICHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
N-BUTANOL	0.10	0.070	0.077	0.12	0.14
BENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
CARBONTETRACHLORIDE	<0.025	<0.025	<0.025	<0.025	<0.025
2-PENTANONE	TRACE	<0.025	<0.025	<0.025	TRACE
2-METHYLHEXANE	0.40	<0.025	<0.025	TRACE	TRACE
2,3-DIMETHYLPENTANE	0.51	<0.025	<0.025	TRACE	TRACE
PENTANAL	0.067	TRACE	<0.025	<0.025	TRACE
3-METHYLHEXANE	0.75	<0.025	<0.025	TRACE	TRACE
1,2-DICHLOROPROPANE	<0.025	<0.025	<0.025	<0.025	<0.025
1,4-DIOXANE	<0.025	<0.025	<0.025	<0.025	<0.025
TRICHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025
2,5-DIMETHYLFURAN	<0.025	<0.025	<0.025	<0.025	<0.025

N-HEPTANE	0.36	<0.025	<0.025	<0.025	TRACE
4-METHYL2-PENTANONE	<0.025	<0.025	<0.025	<0.025	<0.025
CIS-1,3-DICHLOROPROPENE	<0.025	<0.025	<0.025	<0.025	<0.025
2-PENTENAL	<0.025	<0.025	<0.025	<0.025	<0.025
TRANS-1,3-DICHLOROPROPENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,1,2-TRICHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
TOLUENE	0.13	TRACE	TRACE	0.031	TRACE
HEXANAL	0.028	<0.025	<0.025	<0.025	TRACE
MESITYLOXIDE	<0.025	<0.025	<0.025	<0.025	<0.025
1,2-DIBROMOETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
BUTYLACETATE	<0.025	<0.025	<0.025	TRACE	<0.025
TETRACHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025
CHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
ETHYLBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
M/P-XYLENES	TRACE	<0.025	<0.025	<0.025	<0.025
2-HEPTANONE	<0.025	<0.025	<0.025	<0.025	<0.025
CYCLOHEXANONE	TRACE	0.083	0.065	0.083	0.092
HEPTANAL	<0.025	<0.025	<0.025	<0.025	<0.025
STYRENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,1,2,2-TETRACHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
O-XYLENE	TRACE	TRACE	TRACE	0.041	0.031
1,3,5-TRIMETHYLBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,2,4-TRIMETHYLBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,3-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,4-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,2-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,2,4-TRICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
HEXACHLORO-1,3-BUTADIENE	<0.025	<0.025	<0.025	<0.025	<0.025

#### TARGET COMPOUNDS (TOXIC)

1,3-BUTADIENE	<0.025	<0.025	<0.025	<0.025	<0.025
ETHYLENE OXIDE	<0.025	<0.025	<0.025	<0.025	<0.025
CARBON DISULFIDE	0.043	<0.025	<0.025	<0.025	<0.025
2-METHYL-2-PROPENAL	0.030	<0.025	<0.025	<0.025	TRACE
3-BUTEN-2-ONE	TRACE	<0.025	<0.025	<0.025	<0.025
2-ETHOXYETHANOL	<0.025	<0.025	<0.025	<0.025	<0.025
DIMETHYLDISULFIDE	<0.025	<0.025	<0.025	<0.025	<0.025
OCTAMETHYLCYCLOTETRA-SILOXANE	##	##	##	##	##

#### NON-TARGET COMPOUNDS

OCTAFLUOROPROPANE++	15	164	158	164	159
SULFURHEXAFLUORIDE	<0.025	<0.025	<0.025	0.065	0.064
1,1,1,2-TETRAFLUROETHANE	0.15	1.5	1.5	0.40	0.35
1,1-DIFLUOROETHANE	0.13	<0.025	<0.025	<0.025	<0.025
CHLORODIFLUOROMETHANE	TRACE	<0.025	<0.025	0.23	0.20
CARBONYLSULFIDE	0.086	TRACE	TRACE	TRACE	TRACE
1-CHLORO-1,1-DIFLUOROETHANE	0.11	<0.025	<0.025	<0.025	<0.025
<b>ISOBUTANE +</b>	<b>2.5</b>	<b>&lt;0.025</b>	<b>&lt;0.025</b>	<b>TRACE</b>	<b>TRACE</b>
1-BUTENE	0.065	TRACE	TRACE	TRACE	TRACE
ISOPRENE	TRACE	0.11	0.13	0.17	0.12
TRIMETHYLSILANOL	4.7	0.40	0.33	0.36	0.40
1,3-DIOXOLANE	0.056	0.047	0.044	0.064	0.057
CARBONICACID,DIMETHYLESTER	0.25	0.033	0.031	0.049	0.042
C7-ALKANE	0.23	<0.025	<0.025	<0.025	<0.025
HEXAMETHYLDISILOXANE	0.48	<0.025	<0.025	<0.025	<0.025
C7-ALKANE	0.18	<0.025	<0.025	<0.025	<0.025
DIMETHYLCYCLOPENTANE	0.026	<0.025	<0.025	<0.025	<0.025
METHYLCYCLOHEXANE	0.073	<0.025	<0.025	<0.025	<0.025
C8-ALKANE	<0.025	<0.025	<0.025	<0.025	<0.025
HEXAMETHYLCYCLOTETRA-SILOXANE	##	##	##	##	##
C9-ALKANE	0.12	<0.025	<0.025	<0.025	<0.025

C11-ALKANE	0.41	<0.025	<0.025	<0.025	<0.025
C11-ALKANE	0.16	<0.025	<0.025	<0.025	<0.025
LIMONENE	TRACE	0.029	TRACE	0.31	0.25
C11-ALKANE	0.36	<0.025	<0.025	<0.025	<0.025
C11-ALKANE	0.069	<0.025	<0.025	<0.025	<0.025
C11-ALKANE	0.60	<0.025	<0.025	<0.025	<0.025
C11-ALKANE	0.081	<0.025	<0.025	<0.025	<0.025
C11-ALKANE	0.061	<0.025	<0.025	<0.025	<0.025
C11-ALKANE	0.11	<0.025	<0.025	<0.025	<0.025
C11-ALKANE	0.034	<0.025	<0.025	<0.025	<0.025
C11-ALKANE	<0.025	<0.025	<0.025	<0.025	<0.025
C11-ALKANE	0.032	<0.025	<0.025	<0.025	<0.025
DECAMETHYLCYCLOPENTASILOXANE	##	##	##	##	##
C11-ALKANE	0.057	<0.025	<0.025	<0.025	<0.025

<b>TOTAL ALCOHOLS PLUS ACETONE</b>	<b>7.0</b>	<b>1.9</b>	<b>1.9</b>	<b>3.6</b>	<b>3.5</b>
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<b>TARGET COMPOUNDS (GC)***</b>					
CARBON MONOXIDE	1.7	2.3	2.3	1.9	2.2
METHANE	TRACE	14	14	11	11
HYDROGEN	2.1	4.0	4.0	4.0	4.0
CARBON DIOXIDE	3300	5700	7000	8400	6700

<b>TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)</b>	<b>37</b>	<b>170</b>	<b>160</b>	<b>170</b>	<b>160</b>
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<b>TOTAL CONCENTRATION - OFP</b>	<b>22</b>	<b>4.4</b>	<b>4.4</b>	<b>5.9</b>	<b>5.9</b>
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+ CORRECTED FOR ACETALDEHYDE

++Measurements are quantified by single-point calibration

\* FROM GC/FID RESULTS

\*\*FROM GC RESULTS; MeOH Conc.=GC MeOH Conc.-(2\* GC/MS ACETALDEHYDE Conc.)

## Present, subject to large, random variability, therefore not quantifiable

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

TRACE: Amount detected is sufficient for compound identification only.

\*\*\* Measurements are calibrated by multi-point initial calibration and verified by mid-point continuing calibration.

**TABLE 2A  
ANALYTICAL RESULTS OF  
STS-129 RETURN GRAB SAMPLE CONTAINER AIR SAMPLES**

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)	
	AA04801 Mid-Deck SN 1008 11/27/09 @ 9:33 GMT	AA04792 Preflight SN 1056 11/16/09 @ 9:00 EST
<b>TARGET COMPOUNDS (TO-14/POLAR)</b>		
FREON12	ND	ND
CHLOROMETHANE	0.00074	ND
FREON114	ND	ND
METHANOL	0.00162	0.00048
ACETALDEHYDE	0.01182	0.00313
VINYLCHLORIDE	ND	ND
BROMOMETHANE	ND	ND
ETHANOL	0.00019	0.00002
CHLOROETHANE	ND	ND
ACETONITRILE	ND	ND
PROPENAL	0.00000	ND
ACETONE	0.00307	0.00060
PROPANAL	0.00114	0.00114
ISOPROPANOL	0.00039	0.00020
FREON11	ND	ND
FURAN	ND	ND
ACRYLONITRILE	ND	ND
PENTANE	ND	ND
2-METHYL-2-PROPANOL	0.00008	ND
METHYLACETATE	ND	ND
1,1-DICHLOROETHENE	ND	ND
DICHLOROMETHANE	ND	ND
3-CHLOROPROPENE	ND	ND
FREON113	ND	ND
N-PROPANOL	0.00013	ND
1,1-DICHLOROETHANE	ND	ND
BUTANAL	ND	ND
2-BUTANONE	ND	ND
CIS-1,2-DICHLOROETHENE	ND	ND
2-METHYLFURAN	ND	ND
ETHYLACETATE	ND	ND
HEXANE	ND	ND
CHLOROFORM	ND	ND
2-BUTENAL	ND	ND
1,2-DICHLOROETHANE	ND	ND
1,1,1-TRICHLOROETHANE	ND	ND
N-BUTANOL	ND	ND
BENZENE	ND	ND
CARBONTETRACHLORIDE	ND	ND
2-PENTANONE	ND	ND
2-METHYLHEXANE	ND	ND
2,3-DIMETHYLPENTANE	ND	ND
PENTANAL	ND	ND
3-METHYLHEXANE	ND	ND
1,2-DICHLOROPROPANE	ND	ND
1,4-DIOXANE	ND	ND
TRICHLOROETHENE	ND	ND
2,5-DIMETHYLFURAN	ND	ND
N-HEPTANE	ND	ND



4-METHYL2-PENTANONE	ND	ND
CIS-1,3-DICHLOROPROPENE	ND	ND
2-PENTENAL	ND	ND
TRANS-1,3-DICHLOROPROPENE	ND	ND
1,1,2-TRICHLOROETHANE	ND	ND
TOLUENE	ND	ND
HEXANAL	ND	ND
MESITYLOXIDE	ND	ND
1,2-DIBROMOETHANE	ND	ND
BUTYLACETATE	ND	ND
OCTANE	ND	ND
TETRACHLOROETHENE	ND	ND
CHLOROBENZENE	ND	ND
ETHYLBENZENE	ND	ND
M/P-XYLENES	ND	ND
2-HEPTANONE	ND	ND
CYCLOHEXANONE	ND	ND
HEPTANAL	ND	ND
STYRENE	ND	ND
1,1,2,2-TETRACHLOROETHANE	ND	ND
O-XYLENE	ND	ND
NONANE	ND	ND
1,3,5-TRIMETHYLBENZENE	ND	ND
1,2,4-TRIMETHYLBENZENE	ND	ND
1,3-DICHLOROBENZENE	ND	ND
1,4-DICHLOROBENZENE	ND	ND
1,2-DICHLOROBENZENE	ND	ND
1,2,4-TRICHLOROBENZENE	ND	ND
HEXACHLORO-1,3-BUTADIENE	ND	ND

<b>TARGET COMPOUNDS (TOXIC)</b>		
1,3-BUTADIENE	ND	ND
ETHYLENE OXIDE	ND	ND
CARBON DISULFIDE	ND	ND
2-METHYL-2-PROPENAL	ND	ND
3-BUTEN-2-ONE	ND	ND
2-ETHOXYETHANOL	ND	ND
DIMETHYLDISULFIDE	ND	ND
OCTAMETHYLCYCLOTETRASILOXANE	*	*

<b>NON-TARGET COMPOUNDS</b>		
OCTAFLUOROPROPANE	0.00072	ND
SULFURHEXAFLUORIDE	0.00009	ND
BROMOTRIFLUOROMETHANE	0.00020	ND
PROPENE	0.00001	ND
CARBONYLSULFIDE	ND	ND
ISOPRENE	0.01335	ND
HEXAMETHYLCYCLOTRISILOXANE	*	*
DECAMETHYLCYCLOPENTASILOXANE	*	*

<b>TARGET COMPOUNDS (GC)</b>		
CARBON MONOXIDE	0.08073	0.00000
METHANE	0.00946	0.00000
HYDROGEN	0.03942	0.00000
CARBON DIOXIDE	0.40545	0.01538

<b>TOTAL T-VALUE</b>	<b>0.56861</b>	<b>0.02095</b>
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<b>TOTAL T-VALUE MINUS OCTAFLUOROPROPANE</b>	<b>0.56789</b>	<b>0.02095</b>
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**\*Present, but not included in total T-Value**

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**  
**ANALYTICAL RESULTS OF**  
**ULF3 RETURN GRAB SAMPLE CONTAINER AIR SAMPLES**

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)				
	AA04794 S/N 1095 HTV 09/18/09 @ 18:25 GMT	AA04796 S/N 1011 Mid-LAB 09/29/09 @ 11:45 GMT	AA04797 S/N 1031 Mid-SM 09/29/09 @ 11:50 GMT	AA04798 S/N 1041 SM 10/28/09 @ 17:23 GMT	AA04799 S/N 1097 LAB 10/28/09 @ 17:25 GMT
<b>TARGET COMPOUNDS (TO-14/POLAR)</b>					
FREON12	0.00010	0.00012	0.00012	ND	ND
CHLOROMETHANE	0.00063	ND	ND	ND	ND
FREON114	ND	ND	ND	ND	ND
<b>METHANOL **</b>	0.00807	0.00426	0.00309	0.00491	0.00468
ACETALDEHYDE	0.18208	0.01714	0.01540	0.02331	0.06059
VINYLCHLORIDE	ND	ND	ND	ND	ND
BROMOMETHANE	ND	ND	ND	ND	ND
<b>ETHANOL *</b>	<b>0.00176</b>	<b>0.00043</b>	<b>0.00051</b>	<b>0.00123</b>	<b>0.00114</b>
CHLOROETHANE	ND	ND	ND	ND	ND
ACETONITRILE	0.00187	0.00187	0.00187	0.00187	0.00187
PROPENAL	1.22521	ND	ND	ND	0.60057
ACETONE	0.01042	0.00549	0.00573	0.00529	0.00551
PROPANAL	0.01470	0.00363	0.00319	0.00299	0.00744
<b>ISOPROPANOL *</b>	<b>0.01409</b>	0.00147	0.00133	0.00119	0.00118
FREON11	ND	ND	ND	ND	ND
FURAN	ND	ND	ND	ND	ND
ACRYLONITRILE	ND	ND	ND	ND	ND
PENTANE	0.00312	ND	ND	ND	ND
2-METHYL-2-PROPANOL	0.00074	ND	ND	ND	ND
METHYLACETATE	0.00010	ND	ND	0.00076	0.00069
1,1-DICHLOROETHENE	ND	ND	ND	ND	ND
DICHLOROMETHANE	0.00125	0.00125	0.00125	0.00125	0.00125
3-CHLOROPROPENE	ND	ND	ND	ND	ND
FREON113	ND	ND	ND	ND	ND
N-PROPANOL	0.00027	0.00034	0.00042	0.00103	0.00160
1,1-DICHLOROETHANE	ND	ND	ND	ND	ND
BUTANAL	0.00429	0.00096	0.00096	ND	0.00286
2-BUTANONE	0.00277	0.00142	0.00112	0.00096	0.00182
CIS-1,2-DICHLOROETHENE	ND	ND	ND	ND	ND
2-METHYLFURAN	0.09615	ND	ND	ND	ND
ETHYLACETATE	0.00316	0.00017	0.00018	0.00096	0.00079
HEXANE	0.00315	0.00114	0.00114	0.00114	ND
CHLOROFORM	ND	ND	ND	ND	ND
2-BUTENAL	ND	ND	ND	ND	ND
1,2-DICHLOROETHANE	ND	0.00781	0.00781	0.00781	0.00781
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND
N-BUTANOL	0.00258	0.00174	0.00193	0.00300	0.00341
BENZENE	ND	ND	ND	ND	ND
CARBONTETRACHLORIDE	ND	ND	ND	ND	ND
2-PENTANONE	0.00018	ND	ND	ND	0.00018
2-METHYLHEXANE	0.03340	ND	ND	0.00104	0.00104
2,3-DIMETHYLPENTANE	0.04234	ND	ND	0.00104	0.00104
PENTANAL	0.00418	0.00078	ND	ND	0.00078
3-METHYLHEXANE	0.06241	ND	ND	0.00104	0.00104
1,2-DICHLOROPROPANE	ND	ND	ND	ND	ND
1,4-DIOXANE	ND	ND	ND	ND	ND
TRICHLOROETHENE	ND	ND	ND	ND	ND
2,5-DIMETHYLFURAN	ND	ND	ND	ND	ND

N-HEPTANE	0.02995	ND	ND	ND	0.00104
4-METHYL2-PENTANONE	ND	ND	ND	ND	ND
CIS-1,3-DICHLOROPROPENE	ND	ND	ND	ND	ND
2-PENTENAL	ND	ND	ND	ND	ND
TRANS-1,3-DICHLOROPROPENE	ND	ND	ND	ND	ND
1,1,2-TRICHLOROETHANE	ND	ND	ND	ND	ND
TOLUENE	0.00849	0.00083	0.00083	0.00206	0.00083
HEXANAL	0.00157	ND	ND	ND	0.00069
MESITYLOXIDE	ND	ND	ND	ND	ND
1,2-DIBROMOETHANE	ND	ND	ND	ND	ND
BUTYLACETATE	ND	ND	ND	0.00007	ND
TETRACHLOROETHENE	ND	ND	ND	ND	ND
CHLOROBENZENE	ND	ND	ND	ND	ND
ETHYLBENZENE	ND	ND	ND	ND	ND
M/P-XYLENES	0.00034	ND	ND	ND	ND
2-HEPTANONE	ND	ND	ND	ND	ND
CYCLOHEXANONE	0.00021	0.00139	0.00108	0.00139	0.00154
HEPTANAL	ND	ND	ND	ND	ND
STYRENE	ND	ND	ND	ND	ND
1,1,2,2-TETRACHLOROETHANE	ND	ND	ND	ND	ND
O-XYLENE	0.00034	0.00034	0.00034	0.00110	0.00083
1,3,5-TRIMETHYLBENZENE	ND	ND	ND	ND	ND
1,2,4-TRIMETHYLBENZENE	ND	ND	ND	ND	ND
1,3-DICHLOROBENZENE	ND	ND	ND	ND	ND
1,4-DICHLOROBENZENE	ND	ND	ND	ND	ND
1,2-DICHLOROBENZENE	ND	ND	ND	ND	ND
1,2,4-TRICHLOROBENZENE	ND	ND	ND	ND	ND
HEXACHLORO-1,3-BUTADIENE	ND	ND	ND	ND	ND

TARGET COMPOUNDS (TOXIC)					
1,3-BUTADIENE	ND	ND	ND	ND	ND
ETHYLENE OXIDE	ND	ND	ND	ND	ND
CARBON DISULFIDE	0.00271	ND	ND	ND	ND
2-METHYL-2-PROPENAL	0.01744	ND	ND	ND	0.00735
3-BUTEN-2-ONE	0.02907	ND	ND	ND	ND
2-ETHOXYETHANOL	ND	ND	ND	ND	ND
DIMETHYLDISULFIDE	ND	ND	ND	ND	ND
OCTAMETHYLCYCLOTETRASILOXANE	##	##	##	##	##

NON-TARGET COMPOUNDS					
OCTAFLUOROPROPANE++	0.00018	0.00193	0.00186	0.00193	0.00187
SULFURHEXAFLUORIDE	ND	ND	ND	0.00005	0.00005
1,1,1,2-TETRAFLUROETHANE	0.00154	0.01459	0.01533	0.00399	0.00352
1,1-DIFLUOROETHANE	0.00189	ND	ND	ND	ND
CHLORODIFLUOROMETHANE	0.00000	ND	ND	0.00007	0.00006
CARBONYLSULFIDE	0.00714	0.00104	0.00104	0.00104	0.00104
1-CHLORO-1,1-DIFLUOROETHANE	0.00107	ND	ND	ND	ND
ISOBUTANE +	0.01045	ND	ND	0.00005	0.00005
1-BUTENE	0.00014	0.00003	0.00003	0.00003	0.00003
ISOPRENE	0.00417	0.03610	0.04348	0.05686	0.04145
TRIMETHYLSILANOL	1.17026	0.09970	0.08302	0.08910	0.10025
1,3-DIOXOLANE	0.00155	0.00129	0.00122	0.00178	0.00158
CARBONICACID,DIMETHYLESTER	0.00008	0.00001	0.00001	0.00002	0.00001
C7-ALKANE	0.01886	ND	ND	ND	ND
HEXAMETHYLDISILOXANE	0.00475	ND	ND	ND	ND
C7-ALKANE	0.01529	ND	ND	ND	ND
DIMETHYLCYCLOPENTANE	0.00088	ND	ND	ND	ND
METHYLCYCLOHEXANE	0.00122	ND	ND	ND	ND
C8-ALKANE	ND	ND	ND	ND	ND
HEXAMETHYLCYCLOTRISILOXANE	##	##	##	##	##
C9-ALKANE	0.00832	ND	ND	ND	ND

C11-ALKANE	0.00849	ND	ND	ND	ND
C11-ALKANE	0.00323	ND	ND	ND	ND
LIMONENE	0.00011	0.00026	0.00011	0.00265	0.00217
C11-ALKANE	0.00743	ND	ND	ND	ND
C11-ALKANE	0.00143	ND	ND	ND	ND
C11-ALKANE	0.01253	ND	ND	ND	ND
C11-ALKANE	0.00169	ND	ND	ND	ND
C11-ALKANE	0.00127	ND	ND	ND	ND
C11-ALKANE	0.00219	ND	ND	ND	ND
C11-ALKANE	0.00071	ND	ND	ND	ND
C11-ALKANE	ND	ND	ND	ND	ND
C11-ALKANE	0.00067	ND	ND	ND	ND
DECAMETHYLCYCLOPENTASILOXANE	##	##	##	##	##
C11-ALKANE	0.00120	ND	ND	ND	ND

<b>TARGET COMPOUNDS (GC)</b>					
CARBON MONOXIDE	0.10262	0.13374	0.13275	0.11256	0.12798
METHANE	0.00023	0.00407	0.00406	0.00317	0.00320
HYDROGEN	0.00607	0.01172	0.01188	0.01162	0.01164
CARBON DIOXIDE	0.25113	0.44061	0.54009	0.64599	0.51654

<b>TOTAL T-VALUE</b>	<b>3.45791</b>	<b>0.79768</b>	<b>0.88319</b>	<b>0.99634</b>	<b>1.53102</b>
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<b>TOTAL T-VALUE - OFP</b>	<b>3.45773</b>	<b>0.79575</b>	<b>0.88134</b>	<b>0.99441</b>	<b>1.52915</b>
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+ CORRECTED FOR ACETALDEHYDE

++Measurements are quantified by single-point calibration

\* FROM GC RESULTS

\*\*FROM GC RESULTS; MeOH Conc.=GC MeOH Conc.-(2\* GC/MS ACETALDEHYDE Conc.)

## Present, subject to large, random variability, therefore not quantifiable

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.