STS 127 Return Samples: Assessment of Air Quality aboard the Shuttle (STS-127) and International Space Station (2J/A)

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 (^{13}C-acetone, fluorobenzene, and chlorobenzene) from the 2 GSCs averaged 113, 96, and 110 %, respectively. Based on the end-of-mission sample, the Shuttle atmosphere was acceptable for human respiration. Note that Freon 218 was present in high concentration because it spread from the ISS atmosphere into the Shuttle during docked operaitons.

Table 1. Analytical Summary of Shuttle Samples

Sample Location	Date of Sample	NMVOCs [a] (mg/m^3)	Freon 218 (mg/m^3)	T Value[b] (units)	Alcohols (mg/m^3)	Formaldehyde (µg/m^3)
Preflight	7/13/09	0.3	0	0.02	0.10	--
Middeck (end mission)	7/31/09	4	165	0.19	0.67	--

[a] Non-methane volatile organic hydrocarbons, excluding Freon 218
[b] Calculated excluding CO_2, formaldehyde, and siloxanes.

The toxicological assessment of 9 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 78, 90 and 75%, respectively. Two formaldehyde-badge lab controls averaged 98% recovery.

Table 2. Analytical Summary of ISS Results

Module/Sample	Approx. Date	NMVOCs[a] (mg/m^3)	Freon 218 (mg/m^3)	T Value[b] (units)	Alcohols (mg/m^3)	Formaldehyde (µg/m^3)
Lab	12/9/08	--	--	--	--	29
SM	12/9/08	--	--	--	--	27
Lab	1/13/09	--	--	--	--	49
SM	1/13/09	--	--	--	--	32
SM	4/9/09	6	220	0.34	4.5	35
Lab	4/9/09	5	210	0.27	4.0	25
Columbus	4/9/09	11	260	**4.91**[c]	5.4	--
Lab	5/27/09	6	230	**3.60**[c]	3.0	--
JEM	5/27/09	7	210	**4.91**[c]	3.3	--
SM	5/27/09	6	200	**3.57**[c]	3.1	--
SM	7/2/09	4	200	0.87	3.1	--
Lab	7/2/09	5	260	0.87	3.3	--
Lab	7/17/09	6	180	**2.58**[c]	3.3	--
Guideline		*<25*	*none*	*<1.0*	*<5*	*<120*

[a] Non-methane volatile organic hydrocarbons, excluding Freon 218
[b] Calculated excluding CO_2, formaldehyde, and siloxanes.
[c] High T values are due to traces of propenal, an irritant. Aliphatic aldehydes from C2 to C6 were also higher than usual in these samples.

The bolded T values are problematic and difficult to interpret. The primary contributor to the elevated T values is acrolein (propenal), which is a primary irritant to the eyes and upper airways. There were no crew reports of nasal or eye irritation during the times of these samples. Furthermore, no apparent source of acrolein could be identified. It is also perplexing that in the first set of three samples only one shows appreciable acrolein, yet in the next three simultaneous samples all show measurable acrolein. The sample on July 17 was taken in conjunction with operation of the Air Quality Monitor DTO, hence there was no contingency involved.

Other than the problem with traces of acrolein in the samples, the air quality was acceptable for respiration. The 24-hour SMAC for acrolein (0.08 mg/m3) is 4-fold higher than the 180-day SMAC (0.02 mg/m3) used to calculate the T values. The 24-hour SMAC allows only a slight risk of minimal irritation. Since the acrolein concentrations never exceeded the 24-hour limit, this may be why no irritation was reported by the crew. In any case, the acrolein concentrations are not sustained, but they do bear watching. Unfortunately, we are constrained to one-month intervals of sampling, which is patently inadequate to identify a source and characterize episodic crew exposures.

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Enclosures
Table 1A: Analytical concentrations of compounds found in the STS-127 GSCs
Table 1B: Analytical concentrations of compounds found in 2J/A 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-127 GRAB SAMPLE CONTAINER AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/m3)	
	AA04721 Mid-Deck SN 1081 07/31/09 @ 09:21 GMT	AA04701 Preflight SN 1037 07/13/09 @ 17:35 EDT
TARGET COMPOUNDS (TO-14/POLAR)* **		
FREON12	<0.025	<0.025
CHLOROMETHANE	0.025	<0.025
FREON114	<0.025	<0.025
METHANOL	0.14	0.027
ACETALDEHYDE	0.12	0.063
VINYLCHLORIDE	<0.025	<0.025
BROMOMETHANE	<0.025	<0.025
ETHANOL	0.33	TRACE
CHLOROETHANE	<0.025	<0.025
ACETONITRILE	TRACE	TRACE
PROPENAL	<0.025	<0.025
ACETONE	0.15	0.044
PROPANAL	TRACE	TRACE
ISOPROPANOL	0.029	TRACE
FREON11	<0.025	<0.025
FURAN	<0.025	<0.025
ACRYLONITRILE	<0.025	<0.025
PENTANE	<0.025	<0.025
2-METHYL-2-PROPANOL	0.025	<0.025
METHYLACETATE	<0.025	TRACE
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	TRACE	TRACE
2-BUTANONE	TRACE	TRACE
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	TRACE
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

TARGET COMPOUNDS (TOXIC)		
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
OCTAMETHYLCYCLOTETRASILOXANE	*	*

NON-TARGET COMPOUNDS		
OCTAFLUOROPROPANE**	165	<0.025
BROMOTRIFLUOROMETHANE+	**3.0**	<0.025

DIFLUOROCHLOROMETHANE	<0.025	TRACE
CARBONYLSULFIDE	<0.025	<0.025
1,1,1,2-TETRAFLUORO-2-CHLOROETHANE	<0.025	0.078
ISOPRENE	0.060	<0.025
HEXAMETHYLCYCLOTRISILOXANE	*	*
DECAMETHYLCYCLOPENTASILOXANE	*	*

TOTAL ALCOHOLS PLUS ACETONE	**0.67**	**0.096**

TARGET COMPOUNDS (GC)* **		
CARBON MONOXIDE	4.9	<0.29
METHANE	40	<1.6
HYDROGEN	12	<0.41
CARBON DIOXIDE	6400	TRACE

TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**170**	**0.32**

TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS) MINUS OCTAFLUOROPROPANE	**4.0**	**0.32**

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

+Corrected for Mass 69

< : 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
2J/A RETURN GRAB SAMPLE CONTAINER AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/m3)								
	AA04723 S/N 1066 SM 04/09/09 @ 18:47 GMT	AA04724 S/N 1054 LAB 04/09/09 @ 18:52 GMT	AA04725 S/N 1088 COLUMBUS 04/09/09 @ 18:54 GMT	AA04726 S/N 1108 LAB 05/27/09 @ 18:34 GMT	AA04727 S/N 1107 JEM 05/27/09 @ 18:37 GMT	AA04728 S/N 1101 SM 05/27/09 @ 18:39 GMT	AA04729 S/N 1098 SM 07/02/09 @ 15:15 GMT	AA04730 S/N 1100 LAB 07/02/09 @ 15:30 GMT	AA04731 S/N 1104 MID-LAB 07/17/09 @ 18:30 GMT
TARGET COMPOUNDS (TO-14/POLAR)* **									
FREON12	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CHLOROMETHANE	<0.025	<0.025	TRACE	TRACE	TRACE	TRACE	<0.025	<0.025	<0.025
FREON114	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
METHANOL	0.24	0.18	0.27	0.36	0.36	0.25	0.20	0.38	0.21
ACETALDEHYDE	0.048	0.055	0.86	0.95	0.99	0.75	0.074	0.15	0.43
VINYLCHLORIDE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
BROMOMETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
ETHANOL *	**3.5**	**3.4**	**3.5**	**1.9**	**2.0**	**2.0**	**2.3**	**2.3**	**2.4**
CHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
ACETONITRILE	<0.025	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
PROPENAL	<0.025	<0.025	0.080	0.054	0.071	0.052	TRACE	TRACE	0.034
ACETONE	0.22	0.17	1.1	0.40	0.64	0.49	0.23	0.27	0.37
PROPANAL	TRACE	0.029	0.67	0.31	0.43	0.39	0.03	0.042	0.23
ISOPROPANOL	0.14	0.14	0.23	0.13	0.17	0.14	0.14	0.14	0.15
FREON11	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
FURAN	<0.025	<0.025	<0.025	<0.025	TRACE	TRACE	TRACE	<0.025	<0.025
ACRYLONITRILE	<0.025	<0.025	TRACE	<0.025	TRACE	TRACE	<0.025	<0.025	<0.025
PENTANE	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-METHYL-2-PROPANOL	<0.025	<0.025	TRACE	TRACE	0.043	TRACE	<0.025	<0.025	TRACE
METHYLACETATE	TRACE	TRACE	TRACE	<0.025	TRACE	TRACE	TRACE	TRACE	<0.025
1,1-DICHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
DICHLOROMETHANE	0.026	TRACE	0.030	0.028	0.032	0.028	TRACE	TRACE	TRACE
3-CHLOROPROPENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
FREON113	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
N-PROPANOL	0.17	0.056	0.12	0.087	0.089	0.066	0.046	0.051	0.072
1,1-DICHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
BUTANAL	<0.025	TRACE	0.37	0.20	0.16	0.17	TRACE	0.033	0.12
2-BUTANONE	TRACE	TRACE	0.35	0.14	0.23	0.24	TRACE	0.035	0.12
CIS-1,2-DICHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-METHYLFURAN	<0.025	<0.025	TRACE	TRACE	TRACE	TRACE	<0.025	<0.025	TRACE
ETHYLACETATE	0.044	0.036	0.052	0.028	0.029	0.031	0.044	0.041	0.027
HEXANE	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CHLOROFORM	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-BUTENAL	0.039	<0.025	0.082	0.12	0.079	0.078	<0.025	0.031	0.10
1,2-DICHLOROETHANE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	0.029	TRACE
1,1,1-TRICHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
N-BUTANOL	0.23	0.10	0.17	0.10	0.079	0.13	0.12	0.094	0.12
BENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.045
CARBONTETRACHLORIDE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-PENTANONE	<0.025	<0.025	0.15	0.070	0.092	0.14	<0.025	TRACE	0.054
2-METHYLHEXANE	TRACE	<0.025	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	<0.025
2,3-DIMETHYLPENTANE	TRACE	<0.025	TRACE	TRACE	TRACE	TRACE	TRACE	<0.025	<0.025
PENTANAL	<0.025	TRACE	0.31	0.12	0.054	0.099	TRACE	TRACE	0.087
3-METHYLHEXANE	0.025	TRACE	0.026	0.029	0.035	0.030	TRACE	TRACE	TRACE
1,2-DICHLOROPROPANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,4-DIOXANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
TRICHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2,5-DIMETHYLFURAN	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
N-HEPTANE	<0.025	<0.025	TRACE	<0.025	TRACE	TRACE	<0.025	<0.025	<0.025
4-METHYL2-PENTANONE	<0.025	<0.025	TRACE	<0.025	TRACE	TRACE	<0.025	<0.025	<0.025
CIS-1,3-DICHLOROPROPENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-PENTENAL	<0.025	<0.025	TRACE	TRACE	TRACE	TRACE	<0.025	<0.025	TRACE
TRANS-1,3-DICHLOROPROPENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025

1,1,2-TRICHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
TOLUENE	TRACE	TRACE	0.030	0.027	0.027	TRACE	TRACE	<0.025	TRACE
HEXANAL	<0.025	TRACE	0.23	0.080	TRACE	0.076	TRACE	TRACE	0.063
MESITYLOXIDE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	TRACE
1,2-DIBROMOETHANE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
BUTYLACETATE	TRACE	<0.025	TRACE	<0.025	<0.025	TRACE	TRACE	<0.025	<0.025
TETRACHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
ETHYLBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
M/P-XYLENES	TRACE	<0.025	TRACE	TRACE	TRACE	TRACE	<0.025	TRACE	<0.025
2-HEPTANONE	<0.025	<0.025	0.14	TRACE	<0.025	TRACE	<0.025	<0.025	<0.025
CYCLOHEXANONE	TRACE	TRACE	0.094	0.055	0.029	0.051	0.041	0.052	0.048
HEPTANAL	<0.025	<0.025	0.17	0.090	<0.025	0.062	TRACE	0.032	0.050
STYRENE	<0.025	<0.025	<0.025	<0.025	<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	<0.025	<0.025	<0.025	<0.025
O-XYLENE	0.039	0.029	0.041	0.045	0.048	0.048	0.039	0.043	0.030
1,3,5-TRIMETHYLBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,2,4-TRIMETHYLBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,3-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,4-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,2-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
1,2,4-TRICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
HEXACHLORO-1,3-BUTADIENE	<0.025	<0.025	<0.025	<0.025	<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	<0.025	<0.025	<0.025	<0.025
ETHYLENE OXIDE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CARBON DISULFIDE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	<0.025
2-METHYL-2-PROPENAL	<0.025	<0.025	TRACE	TRACE	TRACE	TRACE	<0.025	TRACE	TRACE
3-BUTEN-2-ONE	<0.025	<0.025	TRACE	TRACE	TRACE	<0.025	<0.025	<0.025	<0.025
2-ETHOXYETHANOL	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
DIMETHYLDISULFIDE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
OCTAMETHYLCYCLOTETRASILOXANE	##	##	##	##	##	##	##	##	##

NON-TARGET COMPOUNDS									
OCTAFLUOROPROPANE**	220	210	260	230	210	200	200	260	182
SULFURHEXAFLUORIDE	<0.025	<0.025	<0.025	TRACE	0.025	TRACE	TRACE	0.027	TRACE
1,1-DIFLUOROETHANE	<0.025	<0.025	<0.025	0.057	<0.025	<0.025	<0.025	TRACE	<0.025
CHLORODIFLUOROMETHANE	<0.025	<0.025	<0.025	0.030	TRACE	TRACE	<0.025	<0.025	<0.025
PROPENE	TRACE	TRACE	0.056	0.052	0.072	0.066	TRACE	0.028	TRACE
FLUOROTRIMETHYLSILANE	TRACE	TRACE	TRACE	TRACE	0.17	TRACE	TRACE	TRACE	TRACE
ISOPRENE	0.15	0.099	0.13	0.22	0.069	0.079	0.13	0.17	0.099
TRIMETHYLSILANOL	0.26	0.28	0.38	0.31	0.23	0.25	0.26	0.39	0.28
1,3-DIOXOLANE	0.070	0.059	0.096	0.091	0.086	0.10	0.074	0.10	0.069
2-HEXANONE	<0.025	<0.025	0.10	0.058	0.044	0.088	<0.025	<0.025	0.035
CYCLOPENTANONE	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
HEXAMETHYLCYCLOTRISILOXANE	##	##	##	##	##	##	##	##	##
METHYLCYCLOPENTANONE	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
C8-KETONE	<0.025	<0.025	0.33	0.040	<0.025	0.025	<0.025	<0.025	TRACE
BENZALDEHYDE	TRACE	0.033	0.066	0.079	TRACE	0.071	TRACE	0.050	0.043
C8-KETONE	<0.025	<0.025	0.14	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025
C8-ALDEHYDE	<0.025	<0.025	0.033	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-ETHYL-1-HEXANOL	0.057	0.057	0.071	<0.025	<0.025	TRACE	0.059	0.049	TRACE
C10-KETONE	<0.025	<0.025	0.026	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
LIMONENE	0.22	0.14	0.10	<0.025	<0.025	0.047	0.033	0.040	<0.025
C10-KETONE	<0.025	<0.025	0.11	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
DECAMETHYLCYCLOPENTASILOXANE	##	##	##	##	##	##	##	##	##

TOTAL ALCOHOLS PLUS ACETONE	**4.5**	**4.0**	**5.4**	**3.0**	**3.3**	**3.1**	**3.1**	**3.3**	**3.3**

TARGET COMPOUNDS (GC)* **									
CARBON MONOXIDE	1.8	1.5	2.5	2.7	3.3	3.0	2.2	2.1	2.7
METHANE	12	11	11	< 1.6	< 1.6	< 1.6	11	10	13
HYDROGEN	2.6	2.6	2.5	2.2	2.3	2.3	3.1	3.1	3.1
CARBON DIOXIDE	11400	8400	9000	10000	10300	11200	7500	7400	8400

TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**230**	**220**	**270**	**240**	**220**	**210**	**200**	**260**	**190**

TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**5.6**	**5.0**	**11**	**6.5**	**6.6**	**6.3**	**4.1**	**4.8**	**5.5**

*** FROM GC/FID RESULTS**

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 single-point calibration.

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

TABLE 2A
ANALYTICAL RESULTS OF
STS-127 GRAB SAMPLE CONTAINER AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)	
	AA04721 Mid-Deck SN 1081 07/31/09 @ 09:21 GMT	AA04701 Preflight SN 1037 07/13/09 @ 17:35 EDT
TARGET COMPOUNDS (TO-14/POLAR)		
FREON12	ND	ND
CHLOROMETHANE	0.00062	ND
FREON114	ND	ND
METHANOL	0.01573	0.00299
ACETALDEHYDE	0.02887	0.01583
VINYLCHLORIDE	ND	ND
BROMOMETHANE	ND	ND
ETHANOL	0.00017	0.00001
CHLOROETHANE	ND	ND
ACETONITRILE	0.00187	0.00187
PROPENAL	0.00000	ND
ACETONE	0.00289	0.00084
PROPANAL	0.00087	0.00087
ISOPROPANOL	0.00020	0.00008
FREON11	ND	ND
FURAN	ND	ND
ACRYLONITRILE	ND	ND
PENTANE	ND	ND
2-METHYL-2-PROPANOL	0.00017	ND
METHYLACETATE	ND	0.00010
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	0.00071	0.00071
2-BUTANONE	0.00042	0.00042
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	0.00059
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

TARGET COMPOUNDS (TOXIC)		
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	*	*

NON-TARGET COMPOUNDS		
OCTAFLUOROPROPANE	0.00194	ND
BROMOTRIFLUOROMETHANE+	**0.00028**	ND

DIFLUOROCHLOROMETHANE	ND	0.00000
CARBONYLSULFIDE	ND	ND
1,1,1,2-TETRAFLUORO-2-CHLOROETHANE	ND	0.00014
ISOPRENE	0.01002	ND
HEXAMETHYLCYCLOTRISILOXANE	*	*
DECAMETHYLCYCLOPENTASILOXANE	*	*

TARGET COMPOUNDS (GC)		
CARBON MONOXIDE	0.07805	0.00000
METHANE	0.01139	0.00000
HYDROGEN	0.03423	0.00000
CARBON DIOXIDE	0.48927	0.01538

TOTAL T-VALUE	**0.67781**	**0.03983**

TOTAL T-VALUE MINUS OCTAFLUOROPROPANE	**0.67587**	**0.03983**

***Present, but not included in total T-Value**

+Corrected for Mass 69

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
2J/A RETURN GRAB SAMPLE CONTAINER AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)								
	AA04723 S/N 1066 SM 04/09/09 @ 18:47 GMT	AA04724 S/N 1054 LAB 04/09/09 @ 18:52 GMT	AA04725 S/N 1088 COLUMBUS 04/09/09 @ 18:54 GMT	AA04726 S/N 1108 LAB 05/27/09 @ 18:34 GMT	AA04727 S/N 1107 JEM 05/27/09 @ 18:37 GMT	AA04728 S/N 1101 SM 05/27/09 @ 18:39 GMT	AA04729 S/N 1098 SM 07/02/09 @ 15:15 GMT	AA04730 S/N 1100 LAB 07/02/09 @ 15:30 GMT	AA04731 S/N 1104 MID-LAB 07/17/09 @ 18:30 GMT
TARGET COMPOUNDS (TO-14/POLAR)									
FREON12	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLOROMETHANE	ND	ND	0.00030	0.00030	0.00030	0.00030	ND	ND	ND
FREON114	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHANOL	0.00265	0.00195	0.00299	0.00399	0.00399	0.00274	0.00225	0.00427	0.00231
ACETALDEHYDE	0.01201	0.01383	0.21535	0.23847	0.24641	0.18827	0.01856	0.03819	0.10847
VINYLCHLORIDE	ND	ND	ND	ND	ND	ND	ND	ND	ND
BROMOMETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHANOL *	**0.00174**	**0.00168**	**0.00173**	**0.00097**	**0.00098**	**0.00100**	**0.00117**	**0.00117**	**0.00121**
CHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACETONITRILE	ND	0.00187	0.00187	0.00187	0.00187	0.00187	0.00187	0.00187	0.00187
PROPENAL	ND	ND	3.99424	2.68995	3.56330	2.62348	0.37134	0.44011	1.69282
ACETONE	0.00418	0.00333	0.02130	0.00767	0.01237	0.00937	0.00437	0.00519	0.00708
PROPANAL	0.00114	0.00266	0.06123	0.02857	0.03881	0.03560	0.00233	0.00384	0.02054
ISOPROPANOL	0.00093	0.00095	0.00151	0.00086	0.00113	0.00096	0.00096	0.00090	0.00102
FREON11	ND	ND	ND	ND	ND	ND	ND	ND	ND
FURAN	ND	ND	ND	ND	0.17857	0.17857	0.17857	ND	ND
ACRYLONITRILE	ND	ND	0.00446	ND	0.00446	0.00446	ND	ND	ND
PENTANE	ND	ND	0.00139	ND	ND	ND	ND	ND	ND
2-METHYL-2-PROPANOL	ND	ND	0.00010	0.00010	0.00035	0.00010	ND	ND	0.00010
METHYLACETATE	0.00010	0.00010	0.00010	ND	0.00010	0.00010	0.00010	0.00010	ND
1,1-DICHLOROETHENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
DICHLOROMETHANE	0.00258	0.00125	0.00303	0.00284	0.00317	0.00283	0.00125	0.00125	0.00125
3-CHLOROPROPENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
FREON113	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-PROPANOL	0.00177	0.00057	0.00123	0.00089	0.00090	0.00067	0.00047	0.00052	0.00073
1,1-DICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND
BUTANAL	ND	0.00096	0.02849	0.01501	0.01215	0.01326	0.00096	0.00257	0.00954
2-BUTANONE	0.00042	0.00042	0.01166	0.00452	0.00776	0.00804	0.00042	0.00116	0.00388
CIS-1,2-DICHLOROETHENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLFURAN	ND	ND	0.09615	0.09615	0.09615	0.09615	ND	ND	0.09615
ETHYLACETATE	0.00024	0.00020	0.00029	0.00016	0.00016	0.00017	0.00025	0.00023	0.00015
HEXANE	ND	ND	0.00114	ND	ND	ND	ND	ND	ND
CHLOROFORM	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-BUTENAL	0.02283	ND	0.04805	0.07188	0.04633	0.04596	ND	0.01843	0.06000
1,2-DICHLOROETHANE	0.00781	0.00781	0.00781	0.00781	0.00781	0.00781	0.00781	0.01788	0.00781
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-BUTANOL	0.00577	0.00253	0.00419	0.00252	0.00198	0.00319	0.00289	0.00234	0.00301
BENZENE	ND	ND	ND	ND	ND	ND	ND	ND	0.22724
CARBONTETRACHLORIDE	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-PENTANONE	ND	ND	0.00217	0.00100	0.00131	0.00196	ND	0.00018	0.00077
2-METHYLHEXANE	0.00104	ND	0.00104	0.00104	0.00104	0.00104	0.00104	0.00104	ND
2,3-DIMETHYLPENTANE	0.00104	ND	0.00104	0.00104	0.00104	0.00104	0.00104	ND	ND
PENTANAL	ND	0.00078	0.01942	0.00746	0.00335	0.00619	0.00078	0.00078	0.00546
3-METHYLHEXANE	0.00211	0.00104	0.00215	0.00241	0.00295	0.00246	0.00104	0.00104	0.00104
1,2-DICHLOROPROPANE	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DIOXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLFURAN	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-HEPTANE	ND	ND	0.00104	ND	0.00104	0.00104	ND	ND	ND
4-METHYL2-PENTANONE	ND	ND	0.00009	ND	0.00009	0.00009	ND	ND	ND
CIS-1,3-DICHLOROPROPENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-PENTENAL	ND	ND	0.00595	0.00595	0.00595	0.00595	ND	ND	0.00595
TRANS-1,3-DICHLOROPROPENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-TRICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOLUENE	0.00083	0.00083	0.00198	0.00180	0.00178	0.00083	0.00083	ND	0.00083
HEXANAL	ND	0.00069	0.01261	0.00442	0.00069	0.00420	0.00069	0.00069	0.00350
MESITYLOXIDE	ND	ND	ND	ND	ND	ND	ND	ND	0.00031
1,2-DIBROMOETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND
BUTYLACETATE	0.00007	ND	0.00007	ND	ND	0.00007	0.00007	ND	ND
TETRACHLOROETHENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
M/P-XYLENES	0.00034	ND	0.00034	0.00034	0.00034	0.00034	ND	0.00034	ND
2-HEPTANONE	ND	ND	0.00602	0.00054	ND	0.00054	ND	ND	ND
CYCLOHEXANONE	0.00021	0.00021	0.00157	0.00092	0.00048	0.00086	0.00068	0.00086	0.00081
HEPTANAL	ND	ND	0.00817	0.00428	ND	0.00293	0.00060	0.00151	0.00237

STYRENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-TETRACHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND
O-XYLENE	0.00105	0.00079	0.00110	0.00123	0.00128	0.00130	0.00106	0.00116	0.00080
1,3,5-TRIMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-TRIMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DICHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DICHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-TRICHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLORO-1,3-BUTADIENE	ND	ND	ND	ND	ND	ND	ND	ND	ND

TARGET COMPOUNDS (TOXIC)									
1,3-BUTADIENE	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLENE OXIDE	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON DISULFIDE	0.00078	0.00078	0.00078	0.00078	0.00078	0.00078	0.00078	0.00078	ND
2-METHYL-2-PROPENAL	ND	ND	0.00735	0.00735	0.00735	0.00735	ND	0.00735	0.00735
3-BUTEN-2-ONE	ND	ND	0.02907	0.02907	0.02907	ND	ND	ND	ND
2-ETHOXYETHANOL	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIMETHYLDISULFIDE	ND	ND	ND	ND	ND	ND	ND	ND	ND
OCTAMETHYLCYCLOTETRASILOXANE	##	##	##	##	##	##	##	##	##

NON-TARGET COMPOUNDS									
OCTAFLUOROPROPANE**	0.00263	0.00242	0.00306	0.00270	0.00245	0.00236	0.00239	0.00311	0.00214
SULFURHEXAFLUORIDE	ND	ND	ND	0.00001	0.00002	0.00001	0.00001	0.00002	0.00001
1,1-DIFLUOROETHANE	ND	ND	ND	0.00084	ND	ND	ND	0.00019	ND
CHLORODIFLUOROMETHANE	ND	ND	ND	0.00001	0.00000	0.00000	ND	ND	ND
PROPENE	0.00001	0.00001	0.00007	0.00006	0.00008	0.00008	0.00001	0.00003	0.00001
FLUOROTRIMETHYLSILANE	0.02500	0.02500	0.02500	0.02500	0.33325	0.02500	0.02500	0.02500	0.02500
ISOPRENE	0.05023	0.03296	0.04413	0.07181	0.02287	0.02640	0.04332	0.05796	0.03304
TRIMETHYLSILANOL	0.06544	0.07037	0.09410	0.07855	0.05693	0.06214	0.06577	0.09639	0.07003
1,3-DIOXOLANE	0.00196	0.00164	0.00267	0.00254	0.00238	0.00286	0.00204	0.00279	0.00193
2-HEXANONE	ND	ND	0.00245	0.00141	0.00107	0.00216	ND	ND	0.00085
CYCLOPENTANONE	ND	ND	0.00043	ND	ND	ND	ND	ND	ND
HEXAMETHYLCYCLOTRISILOXANE	#	#	#	#	#	#	#	#	#
METHYLCYCLOPENTANONE	ND	ND	0.00026	ND	ND	ND	ND	ND	ND
C8-KETONE	ND	ND	0.01251	0.00155	ND	0.00097	ND	ND	0.00048
BENZALDEHYDE	0.00007	0.00019	0.00038	0.00045	0.00007	0.00041	0.00007	0.00029	0.00025
C8-KETONE	ND	ND	0.00550	0.00048	ND	ND	ND	ND	ND
C8-ALDEHYDE	ND	ND	0.00136	ND	ND	ND	ND	ND	ND
2-ETHYL-1-HEXANOL	0.00107	0.00108	0.00135	ND	ND	0.00024	0.00112	0.00093	0.00024
C10-KETONE	ND	ND	0.00080	ND	ND	ND	ND	ND	ND
LIMONENE	0.00193	0.00126	0.00089	ND	ND	0.00041	0.00029	0.00035	ND
C10-KETONE	ND	ND	0.00330	ND	ND	ND	ND	ND	ND
DECAMETHYLCYCLOPENTASILOXANE	##	##	##	##	##	##	##	##	##

TARGET COMPOUNDS (GC)									
CARBON MONOXIDE	0.10570	0.08838	0.14485	0.15942	0.19440	0.17774	0.13161	0.12352	0.15978
METHANE	0.00335	0.00323	0.00327	0.00023	0.00023	0.00023	0.00307	0.00298	0.00363
HYDROGEN	0.00754	0.00753	0.00735	0.00640	0.00662	0.00664	0.00912	0.00901	0.00921
CARBON DIOXIDE	0.87491	0.64643	0.69479	0.78486	0.79171	0.86182	0.57889	0.56766	0.64317

TOTAL T-VALUE	**1.21149**	**0.92575**	**5.65912**	**4.38051**	**5.69971**	**4.43334**	**1.46691**	**1.44600**	**3.22416**

TOTAL T-VALUE - OFP	**1.20886**	**0.92333**	**5.65606**	**4.37781**	**5.69727**	**4.43098**	**1.46452**	**1.44288**	**3.22202**

*** FROM GC/FID RESULTS**

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.