Assessment of Air Quality in the Space Shuttle
Based on Samples Returned aboard STS-109 in March 2002

The toxicological assessment of grab sample canisters (GSCs) returned aboard STS-109 is reported. Analytical methods have not changed from earlier reports, and surrogate standard recoveries from the GSCs were 83-113%. Pressure tracking indicated no leaks in the canisters.

The two general criteria used to assess air quality are the total-non-methane-volatile organic hydrocarbons (NMVOCs) and the total T-value (minus the CO_2 contribution). Control of atmospheric alcohols is important to ISS water recovery system engineers, and for reference, total alcohols are also shown for each sample. Formaldehyde was not quantified during this flight. These indices of air quality are summarized below:

Sample Location	Date/Type	NMVOCs (mg/m^3)	T Value[a] (units)	Alcohols (mg/m^3)	Formaldehyde (mg/m^3)
Preflight	3/1/02	0.35	0.08	0.0	ns[a]
Middeck	MET 10/16:12	4.1	0.98	1.3	ns
Trip Control	not applicable	0.30	0.13	0.0	ns

[a] No sample was taken.

The T values for the preflight and trip controls were very low, as expected. The T value for the middeck sample was unusually high; this was primarily due to an unusual concentration of carbon monoxide of 9.4 mg/m^3, which resulted in a T contribution of 0.85. The source of carbon monoxide could not be identified.

Overall, the air quality was acceptable for human respiration; however, the unusual concentration of carbon monoxide needs to be investigated.

Enclosures

Table 1: Analytical Results of STS-109 GSC Air Samples-Concentrations
Table 2: Analytical Results of STS-109 GSC Air Samples-T Values Using 7-day SMACs

TABLE 1
ANALYTICAL RESULTS OF
STS-109 GSC AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M3)		
	AA03315 S/N 1003 PREFLIGHT 3/1/02@0130EST	AA03319 S/N 1050 MIDDECK MET 10\16:12	AA03320 S/N 1035 TRIP CONTROL
TARGET COMPOUNDS (TO-14/POLAR)* **			
FREON 12	<0.05	1.20	<0.05
CHLOROMETHANE	<0.05	TRACE	<0.05
FREON 114	<0.05	<0.05	<0.05
METHANOL	TRACE	0.06	TRACE
ACETALDEHYDE	TRACE	0.06	TRACE
VINYL CHLORIDE	<0.05	<0.05	<0.05
BROMOMETHANE	<0.05	<0.05	<0.05
ETHANOL	TRACE	1.04	TRACE
CHLOROETHANE	<0.05	<0.05	<0.05
ACETONITRILE	<0.05	TRACE	TRACE
PROPENAL	<0.05	<0.05	<0.05
ACETONE	TRACE	0.15	TRACE
PROPANAL	TRACE	TRACE	TRACE
2-PROPANOL	TRACE	0.06	TRACE
FREON 11	<0.05	TRACE	<0.05
FURAN	<0.05	<0.05	<0.05
ACRYLONITRILE	<0.05	<0.05	<0.05
PENTANE	<0.05	<0.05	<0.05
2-METHYL-2-PROPANOL	<0.05	TRACE	<0.05
METHYL ACETATE	<0.05	<0.05	<0.05
1,1-DICHLOROETHENE	<0.05	<0.05	<0.05
DICHLOROMETHANE	<0.05	0.13	<0.05
3-CHLOROPROPENE	<0.05	<0.05	<0.05
FREON 113	<0.05	<0.05	<0.05
N-PROPANOL	<0.05	<0.05	<0.05
1,1-DICHLOROETHANE	<0.05	<0.05	<0.05
BUTANAL	TRACE	TRACE	TRACE
2-BUTANONE	TRACE	TRACE	TRACE
1,2-DICHLOROETHENE	<0.05	<0.05	<0.05
2-METHYLFURAN	<0.05	<0.05	<0.05
ETHYL ACETATE	<0.05	<0.05	<0.05
HEXANE	<0.05	<0.05	<0.05
CHLOROFORM	<0.05	<0.05	<0.05
2-BUTENAL	<0.05	<0.05	<0.05
1,2-DICHLOROETHANE	<0.05	<0.05	<0.05
1,1,1-TRICHLOROETHANE	<0.05	<0.05	<0.05
N-BUTANOL	<0.05	TRACE	<0.05
BENZENE	<0.05	<0.05	<0.05
CARBON TETRACHLORIDE	<0.05	<0.05	<0.05
2-PENTANONE	<0.05	<0.05	<0.05
PENTANAL	<0.05	TRACE	<0.05
1,2-DICHLOROPROPANE	<0.05	<0.05	<0.05
1,4-DIOXANE	<0.05	<0.05	<0.05
TRICHLOROETHENE	<0.05	<0.05	<0.05
2,5-DIMETHYLFURAN	<0.05	<0.05	<0.05
4-METHYL-2-PENTANONE	<0.05	<0.05	<0.05

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M3)		
	AA03315 S/N 1003 PREFLIGHT 3/1/02@0130EST	AA03319 S/N 1050 MIDDECK MET 10\16:12	AA03320 S/N 1035 TRIP CONTROL
TARGET COMPOUNDS (TO-14/POLAR)* **			
CIS-1,3-DICHLOROPROPENE	<0.05	<0.05	<0.05
2-PENTENAL	<0.05	<0.05	<0.05
TRANS-1,3-DICHLOROPROPENE	<0.05	<0.05	<0.05
1,1,2-TRICHLOROETHANE	<0.05	<0.05	<0.05
TOLUENE	TRACE	TRACE	<0.05
HEXANAL	TRACE	TRACE	<0.05
MESITYL OXIDE	<0.05	<0.05	<0.05
1,2-DIBROMOETHANE	<0.05	<0.05	<0.05
BUTYL ACETATE	<0.05	<0.05	<0.05
TETRACHLOROETHENE	<0.05	<0.05	<0.05
CHLOROBENZENE	<0.05	<0.05	<0.05
ETHYL BENZENE	<0.05	<0.05	<0.05
M- + P-XYLENES	<0.05	<0.05	<0.05
2-HEPTANONE	<0.05	<0.05	<0.05
CYCLOHEXANONE	<0.05	<0.05	<0.05
HEPTANAL	TRACE	TRACE	TRACE
STYRENE	<0.05	<0.05	<0.05
1,1,2,2-TETRACHLOROETHANE	<0.05	<0.05	<0.05
O-XYLENE	<0.05	<0.05	<0.05
1,3,5-TRIMETHYLBENZENE	<0.05	<0.05	<0.05
1,2,4-TRIMETHYLBENZENE	<0.05	<0.05	<0.05
1,3-DICHLOROBENZENE	<0.05	<0.05	<0.05
1,4-DICHLOROBENZENE	<0.05	<0.05	<0.05
1,2-DICHLOROBENZENE	<0.05	<0.05	<0.05
1,2,4-TRICHLOROBENZENE	<0.05	<0.05	<0.05
HEXACHLORO-1,3-BUTADIENE	<0.05	<0.05	<0.05
TARGET COMPOUNDS (TOXIC)			
1,3-BUTADIENE	<0.05	<0.05	<0.05
ETHYLENE OXIDE	<0.05	<0.05	<0.05
CARBON DISULFIDE	<0.05	TRACE	<0.05
2-METHYL-2-PROPENAL	<0.05	<0.05	<0.05
3-BUTEN-2-ONE	<0.05	<0.05	TRACE
DIMETHYLDISULFIDE	<0.05	<0.05	<0.05
2-ETHOXYETHANOL	<0.05	<0.05	<0.05
OCTAMETHYLCYCLOTETRASILOXANE	0.08	0.09	TRACE
NON-TARGET COMPOUNDS			
BROMOTRIFLUOROMETHANE	BL	1.04	BL
TOTAL ALCOHOLS PLUS ACETONE	**0.0**	**1.3**	**0.0**
TARGET COMPOUNDS (GC)* **			
ETHYLENE	<0.6	<0.6	<0.6
CARBON MONOXIDE	<1.1	9.4	TRACE
METHANE	1.3	13	<0.2
HYDROGEN	<1.6	28	<1.6
CARBON DIOXIDE	770	4700	<56
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**0.35**	**4.1**	**0.30**

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

TRACE: Amount detected is sufficient for compound identification only. Calculations are based on one-half of the laboratory report detection limit (1.1 mg/M3 for CO; 0.2 for CH4; 1.6 for H2; 0.05 for VOCs; and 0.02 mg/M3 for propenal.)

BL: Area below the search routine limit (<20% of the fluorobenzene peak area).

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

NOTE: High levels (above 1.5ppm) of methanol, ethanol, acetone, isopropanol and 2-butanone are routinely reported based on calibrated GC-FID measurements.

TABLE 2
ANALYTICAL RESULTS OF
STS-109 GSC AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)		
	AA03315 S/N 1003 PREFLIGHT 3/1/02@0130EST	AA03319 S/N 1050 MIDDECK MET 10\16:12	AA03320 S/N 1035 TRIP CONTROL
TARGET COMPOUNDS (TO-14/POLAR)* **			
FREON 12	ND	0.00255	ND
CHLOROMETHANE	ND	0.00061	ND
FREON 114	ND	ND	ND
METHANOL	0.00278	0.00655	0.00278
ACETALDEHYDE	0.00625	0.01495	0.00625
VINYL CHLORIDE	ND	ND	ND
BROMOMETHANE	ND	ND	ND
ETHANOL	0.00001	0.00052	0.00001
CHLOROETHANE	ND	ND	ND
ACETONITRILE	ND	0.00373	0.00373
PROPENAL	ND	ND	ND
ACETONE	0.00048	0.00281	0.00048
PROPANAL	0.00175	0.00175	0.00175
2-PROPANOL	0.00017	0.00041	0.00017
FREON 11	ND	0.00003	ND
FURAN	ND	ND	ND
ACRYLONITRILE	ND	ND	ND
PENTANE	ND	ND	ND
2-METHYL-2-PROPANOL	ND	0.00017	ND
METHYL ACETATE	ND	ND	ND
1,1-DICHLOROETHENE	ND	ND	ND
DICHLOROMETHANE	ND	0.00257	ND
3-CHLOROPROPENE	ND	ND	ND
FREON 113	ND	ND	ND
N-PROPANOL	ND	ND	ND
1,1-DICHLOROETHANE	ND	ND	ND
BUTANAL	0.00141	0.00141	0.00141
2-BUTANONE	0.00083	0.00083	0.00083
1,2-DICHLOROETHENE	ND	ND	ND
2-METHYLFURAN	ND	ND	ND
ETHYL ACETATE	ND	ND	ND
HEXANE	ND	ND	ND
CHLOROFORM	ND	ND	ND
2-BUTENAL	ND	ND	ND
1,2-DICHLOROETHANE	ND	ND	ND
1,1,1-TRICHLOROETHANE	ND	ND	ND
N-BUTANOL	ND	0.00031	ND
BENZENE	ND	ND	ND
CARBON TETRACHLORIDE	ND	ND	ND
2-PENTANONE	ND	ND	ND
PENTANAL	ND	0.00118	ND
1,2-DICHLOROPROPANE	ND	ND	ND
1,4-DIOXANE	ND	ND	ND
TRICHLOROETHENE	ND	ND	ND
2,5-DIMETHYLFURAN	ND	ND	ND
4-METHYL-2-PENTANONE	ND	ND	ND
CIS-1,3-DICHLOROPROPENE	ND	ND	ND

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)		
	AA03315 S/N 1003 PREFLIGHT 3/1/02@0130EST	AA03319 S/N 1050 MIDDECK MET 10\16:12	AA03320 S/N 1035 TRIP CONTROL
TARGET COMPOUNDS (TO-14/POLAR)* **			
2-PENTENAL	ND	ND	ND
TRANS-1,3-DICHLOROPROPENE	ND	ND	ND
1,1,2-TRICHLOROETHANE	ND	ND	ND
TOLUENE	0.00042	0.00042	ND
HEXANAL	0.00101	0.00101	ND
MESITYL OXIDE	ND	ND	ND
1,2-DIBROMOETHANE	ND	ND	ND
BUTYL ACETATE	ND	ND	ND
TETRACHLOROETHENE	ND	ND	ND
CHLOROBENZENE	ND	ND	ND
ETHYL BENZENE	ND	ND	ND
M- + P-XYLENES	ND	ND	ND
2-HEPTANONE	ND	ND	ND
CYCLOHEXANONE	ND	ND	ND
HEPTANAL	0.00089	0.00089	0.00089
STYRENE	ND	ND	ND
1,1,2,2-TETRACHLOROETHANE	ND	ND	ND
O-XYLENE	ND	ND	ND
1,3,5-TRIMETHYLBENZENE	ND	ND	ND
1,2,4-TRIMETHYLBENZENE	ND	ND	ND
1,3-DICHLOROBENZENE	ND	ND	ND
1,4-DICHLOROBENZENE	ND	ND	ND
1,2-DICHLOROBENZENE	ND	ND	ND
1,2,4-TRICHLOROBENZENE	ND	ND	ND
HEXACHLORO-1,3-BUTADIENE	ND	ND	ND
TARGET COMPOUNDS (TOXIC)			
1,3-BUTADIENE	ND	ND	ND
ETHYLENE OXIDE	ND	ND	ND
CARBON DISULFIDE	ND	0.00156	ND
2-METHYL-2-PROPENAL	ND	ND	ND
3-BUTEN-2-ONE	ND	ND	0.05814
DIMETHYLDISULFIDE	ND	ND	ND
2-ETHOXYETHANOL	ND	ND	ND
OCTAMETHYLCYCLOTETRASILOXANE	0.00027	0.00031	0.00009
NON-TARGET COMPOUNDS			
BROMOTRIFLUOROMETHANE	BL	0.00009	BL
TARGET COMPOUNDS (GC)* **			
ETHYLENE	ND	ND	ND
CARBON MONOXIDE	ND	0.85455	0.05000
METHANE	0.00034	0.00342	ND
HYDROGEN	ND	0.08235	ND
CARBON DIOXIDE	0.05923	0.36154	ND
TOTAL T-VALUE	**0.07584**	**1.34653**	**0.12653**

ND : Value is less than the laboratory report detection limit.
BL: Area below the search routine limit (< 20% of the fluorobenzene peak area).
Note: Number of decimal places in T-Values do not represent significant figures of measurements.
***Measurements are calibrated by multi-point initial calibration and verified by mid-point continuing calibration.