

Toxicological Assessment of ISS Air Quality: SpX-2 First Ingress



One mini-grab sample container (m-GSC) was collected by crew members onboard ISS during first ingress into SpX-2 on March 3, 2013, three days after late cargo loading and a pre-launch clean air purge.

Complete data tables of all measured concentrations and corresponding T-values based on 7-day and 180-day SMACs are enclosed. A summary of the analytical results is shown in Table 1. Shading indicates data that are limited due to low sample pressures. Recoveries of the 3 surrogate standards from the m-GSC were as follows: ¹³C-acetone, 96%; fluorobenzene, 95%; and chlorobenzene, 68%.

The sample pressure of the m-GSC collected at first ingress was quite low (2.6 psia) relative to the typical pressure range of 13-14 psia, indicating a problem with sample acquisition. The sample was deemed valid due to the lower concentrations of Freon 218 (octafluoropropane) and carbon dioxide relative to typical samples from ISS air, and to the presence of perfluoro-2-methylpentane, a coolant used in the Dragon vehicle; however, data are somewhat limited by a higher detection limit (0.170 mg/m³ compared to the normal detection limit of 0.05 mg/m³) due to the low pressure.

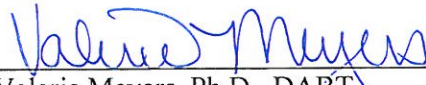
Table 1. Analytical Summary of ISS results

Sample Location	Sample Date	NMVOCs ^a (mg/m ³)	Freon 218 (mg/m ³)	CO ₂ (mg/m ³)	Alcohols (mg/m ³)	T-value ^b (units)
SpaceX-2 first ingress	3/3/2013	19	2.9	3562	11	0.72 (0.52)
<i>Guideline</i>		<25	---	<9300	<5	<1

^a Non-methane volatile organic hydrocarbons, excluding Freon 218

^b Based on 180-d SMACs and calculated excluding CO₂; parentheses indicate value based on 7-day SMACs

Toxicological Evaluation of ISS Air Quality: Although somewhat limited by the low sample pressure, the T-value measured at first entry met acceptable limits and does not pose a concern for crew health. The CO₂ and Freon 218 levels measured in the SpX-2 first ingress sample indicate that some mixing occurred with the ISS atmosphere prior to sample collection. The primary contributor to the total T-value was trimethylsilanol. Perfluoro (2-methyl) pentane vapors, which originate from the heat-exchange fluid used by the Dragon vehicle, were previously detected in the first entry sample at levels on SpX-D (1300 mg/m³), indicating a leak into the habitable volume. The vapor concentration measured at SpX-1 first ingress was 10 mg/m³ and for SpX-2 first ingress 1.5 mg/m³, indicating that steps taken to mitigate the leak have been largely successful.


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5/6/2013
 Date

Enclosures Table 1A: Analytical concentrations of compounds found in the first ingress m-GSC
 Table 2A: T-values corresponding to analytical concentrations in Table 1.

**TABLE 1A
ANALYTICAL RESULTS OF
SPACE-X-2 RETURN GSC AIR SAMPLES**

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M ³)
	AA05498 + Dragon Module Ingress 03/3/13 @ 18:15 GMT S/N 2011
TARGET COMPOUNDS (TO-14/POLAR)	
FREON12	<0.170
CHLOROMETHANE	<0.170
FREON114	<0.170
METHANOL	0.79
ACETALDEHYDE	0.35
VINYLCHLORIDE	<0.170
BROMOMETHANE	<0.170
ETHANOL *	1.8
CHLOROETHANE	<0.170
ACETONITRILE	<0.170
PROPENAL	<0.170
ACETONE	0.53
PROPANAL	TRACE
ISOPROPANOL	7.4
FREON11	<0.170
FURAN	<0.170
ACRYLONITRILE	<0.170
PENTANE	<0.170
2-METHYL-2-PROPANOL	0.95
METHYLACETATE	<0.170
1,1-DICHLOROETHENE	<0.170
DICHLOROMETHANE	0.93
3-CHLOROPROPENE	<0.170
FREON113	<0.170
N-PROPANOL	TRACE
1,1-DICHLOROETHANE	<0.170
BUTANAL	<0.170
2-BUTANONE	0.33
CIS-1,2-DICHLOROETHENE	<0.170
2-METHYLFURAN	<0.170
ETHYLACETATE	0.18
HEXANE	<0.170
CHLOROFORM	<0.170
2-BUTENAL	<0.170
1,2-DICHLOROETHANE	<0.170
1,1,1-TRICHLOROETHANE	<0.170
N-BUTANOL	0.91
BENZENE	<0.170
CARBONTETRACHLORIDE	<0.170
2-PENTANONE	<0.170
2-METHYLHEXANE	<0.170
2,3-DIMETHYLPENTANE	<0.170
PENTANAL	<0.170
3-METHYLHEXANE	<0.170
1,2-DICHLOROPROPANE	<0.170
1,4-DIOXANE	<0.170
TRICHLOROETHENE	<0.170
2,5-DIMETHYLFURAN	<0.170
N-HEPTANE	<0.170
4-METHYL-2-PENTANONE	TRACE
CIS-1,3-DICHLOROPROPENE	<0.170
2-PENTENAL	<0.170
TRANS-1,3-DICHLOROPROPENE	<0.170
1,1,2-TRICHLOROETHANE	<0.170
TOLUENE	0.57
HEXANAL	<0.170
MESITYLOXIDE	<0.170
1,2-DIBROMOETHANE	<0.170
BUTYLACETATE	TRACE
OCTANE	<0.170
TETRACHLOROETHENE	<0.170
CHLOROBENZENE	<0.170
ETHYLBENZENE	TRACE
M/P-XYLENES	0.22
2-HEPTANONE	<0.170
CYCLOHEXANONE	<0.170
HEPTANAL	<0.170
STYRENE	<0.170
1,1,2,2-TETRACHLOROETHANE	<0.170
O-XYLENE	TRACE
NONANE	<0.170
1,3,5-TRIMETHYLBENZENE	<0.170
1,2,4-TRIMETHYLBENZENE	<0.170
1,3-DICHLOROBENZENE	<0.170
1,4-DICHLOROBENZENE	<0.170
1,2-DICHLOROBENZENE	<0.170
1,2,4-TRICHLOROBENZENE	<0.170
HEXACHLORO-1,3-BUTADIENE	<0.170

**TABLE 1A
ANALYTICAL RESULTS OF
SPACEX-2 RETURN GSC AIR SAMPLES**

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M³)
	AA05498 + Dragon Module Ingress 03/3/13 @ 18:15 GMT S/N 2011

SPECIAL INTEREST COMPOUNDS **	
1,3-BUTADIENE	<0.170
ETHYLENE OXIDE	<0.170
2-METHYL-2-PROPENAL	TRACE
3-BUTEN-2-ONE	<0.170
2-ETHOXYETHANOL	<0.170
DIMETHYL DISULFIDE	<0.170
OCTAFLUOROPROPANE &	2.9
PERFLUORO-2-METHYLPENTANE &	1.5
CARBONYL SULFIDE &	<0.170
ISOBUTANE &	0.63
2-METHYL-1-PROPENE &	<0.170
DIMETHYL SULFIDE &	<0.170
CARBON DISULFIDE &	<0.170
TRIMETHYLSILANOL &	0.74
OCTAMETHYLCYCLOTETRAILOXANE &	0.29
DECAMETHYLCYCLOPENTASILOXANE &	0.90
HEXAMETHYLCYCLOTRIILOXANE %	<0.170

NON-TARGET COMPOUNDS **	
SULFUR HEXAFLUORIDE	<0.170
1,1,1,2-TETRAFLUOROETHANE	<0.170
1,1-DIFLUOROETHANE	<0.170
PROPENE	<0.170
PROPANE	<0.170

TOTAL ALCOHOLS PLUS ACETONE	11
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TARGET COMPOUNDS (GC)	
CARBON MONOXIDE	<0.78
METHANE	2.8
HYDROGEN	1.2
CARBON DIOXIDE	3562

TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	22
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TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	19
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+ Detection limits are higher due to low initial sample pressure and high dilution factor
 < : Value is less than the laboratory report detection limit.
 * GC/FID data results are in bold
 ** Quantified using "B" response factor except where noted
 & Quantified using a multi-point calibration
 % Response factor generated from an internal study
 TRACE: Amount detected is sufficient for compound identification only.
 OFP - Octafluoropropane

TABLE 2A
T-VALUES for SPACEX-2 RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)	T-VALUE (180-d SMAC)
	AA05498	AA05498
	Dragon Module Ingress 03/3/13 @ 18:15 GMT S/N 2011	Dragon Module Ingress 03/3/13 @ 18:15 GMT S/N 2011
TARGET COMPOUNDS (TO-14/POLAR)		
FREON12	ND	ND
CHLOROMETHANE	ND	ND
FREON114	ND	ND
METHANOL	0.00878	0.00878
ACETALDEHYDE	0.08655	0.08655
VINYLCHEMIDE	ND	ND
BROMOMETHANE	ND	ND
ETHANOL	0.00091	0.00091
CHLOROETHANE	ND	ND
ACETONITRILE	ND	ND
PROPENAL	ND	ND
ACETONE	0.01025	0.01025
PROPANAL	0.00774	0.00774
ISOPROPANOL	0.04912	0.04912
FREON11	ND	ND
FURAN	ND	ND
ACRYLONITRILE	ND	ND
PENTANE	ND	ND
2-METHYL-2-PROPANOL	0.00632	0.00790
METHYLACETATE	ND	ND
1,1-DICHLOROETHENE	ND	ND
DICHLOROMETHANE	0.01905	0.09336
3-CHLOROPROPENE	ND	ND
FREON113	ND	ND
N-PROPANOL	0.00087	0.00087
1,1-DICHLOROETHANE	ND	ND
BUTANAL	ND	ND
2-BUTANONE	0.01086	0.01086
CIS-1,2-DICHLOROETHENE	ND	ND
2-METHYLFURAN	ND	ND
ETHYLACETATE	0.00100	0.00100
HEXANE	ND	ND
CHLOROFORM	ND	ND
2-BUTENAL	ND	ND
1,2-DICHLOROETHANE	ND	ND
1,1,1-TRICHLOROETHANE	ND	ND
N-BUTANOL	0.01143	0.02285
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	0.00061	0.00061
CIS-1,3-DICHLOROPROPENE	ND	ND
2-PENTENAL	ND	ND
TRANS-1,3-DICHLOROPROPENE	ND	ND
1,1,2-TRICHLOROETHANE	ND	ND
TOLUENE	0.03831	0.03831
HEXANAL	ND	ND
MESITYLOXIDE	ND	ND
1,2-DIBROMOETHANE	ND	ND
BUTYLACETATE	0.00045	0.00045
OCTANE	ND	ND
TETRACHLOROETHENE	ND	ND
CHLOROBENZENE	ND	ND
ETHYLBENZENE	0.00065	0.00170
M/P-XYLENES	0.00298	0.00587
2-HEPTANONE	ND	ND
CYCLOHEXANONE	ND	ND
HEPTANAL	ND	ND
STYRENE	ND	ND
1,1,2,2-TETRACHLOROETHANE	ND	ND
O-XYLENE	0.00117	0.00230
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

TABLE 2A
T-VALUES for SPACEX-2 RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)	T-VALUE (180-d SMAC)
	AA05498 Dragon Module Ingress 03/3/13 @ 18:15 GMT S/N 2011	AA05498 Dragon Module Ingress 03/3/13 @ 18:15 GMT S/N 2011
SPECIAL INTEREST COMPOUNDS		
1,3-BUTADIENE	ND	ND
ETHYLENE OXIDE	ND	ND
2-METHYL-2-PROPENAL	0.05007	0.05007
3-BUTEN-2-ONE	ND	ND
2-ETHOXYETHANOL	ND	ND
DIMETHYL DISULFIDE	ND	ND
OCTAFLUOROPROPANE	0.00003	0.00003
PERFLUORO-2-METHYLPENTANE	0.00010	0.00001
CARBONYL SULFIDE	ND	ND
ISOBUTANE	0.00264	0.00264
2-METHYL-1-PROPENE	ND	ND
DIMETHYL SULFIDE	ND	ND
CARBON DISULFIDE	ND	ND
TRIMETHYLSILANOL	0.18482	0.18482
OCTAMETHYLCYCLOTETRASILOXANE	0.00103	0.02400
DECAMETHYLCYCLOPENTASILOXANE	0.00895	0.05969
HEXAMETHYLCYCLOTRISILOXANE	ND	ND
NON-TARGET COMPOUNDS		
SULFUR HEXAFLUORIDE	ND	ND
1,1,1,2-TETRAFLUOROETHANE	ND	ND
1,1-DIFLUOROETHANE	ND	ND
PROPENE	ND	ND
PROPANE	ND	ND
TARGET COMPOUNDS (GC)		
CARBON MONOXIDE	0.01238	0.04588
METHANE	0.00079	0.00079
HYDROGEN	0.00362	0.00362
CARBON DIOXIDE	0.27398	0.27398
TOTAL T-VALUE	0.79547	0.99499
TOTAL T-VALUE - CO2	0.52149	0.72101

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.