

Toxicological Assessment of ISS Air Quality: April – May 2013 (Increment 35)



A summary of the analytical results from 4 mini-grab sample containers (mGSCs) collected on ISS and returned aboard 33S is shown in Table 1. Due to the launch delay of the ATV4 resupply mission, monthly samples were reduced in April and May by omitting sampling of the Service Module in order to ensure contingency samplers were available if needed. Complete data tables of all measured concentrations and corresponding T-values based on 180-day SMACs are enclosed. The detection limit for all target compounds, except m/p-xylenes and hexachloro-1,3-butadiene was 0.025 mg/m³. The detection limit for m/p-xylenes and hexachloro-1,3-butadiene and all non-target compounds was 0.05 mg/m³. The average recoveries of the 3 surrogate standards from the mGSCs were as follows: ¹³C-acetone, 116 ± 12%; ⁵D-fluorobenzene, 117 ± 7%; and ⁵D-chlorobenzene, 111 ± 15%. Initial measured sample pressures were between 13.9 and 14.1 psia for all samples, indicating nominal sample collection.

A summary of the analytical results from 3 pairs of passive-diffusion formaldehyde badges collected on ISS and returned aboard 33S is also provided in Table 1. In an effort to conserve samples due to the delay of the ATV4 resupply mission, FMK sampling was only conducted in the US Lab in May. Positive control recoveries (1 trip and 2 lab controls) were 79%, 87%, and 116%, respectively.

Table 1. Analytical Summary of ISS results

Sample Location	Sample Date	NMVOCs ^a (mg/m ³)	Freon 218 (mg/m ³)	Alcohols (mg/m ³)	T Value ^b (units)	CO ₂ (mg/m ³)	Formaldehyde (µg/m ³)
Lab	4/1/2013	9.9	19	6.2	0.39	7400	41
JPM	4/1/2013	11	20	6.4	0.46	7300	--
SM ^c	4/1/2013	--	--	--	--	--	36
Lab	5/6/2013	8.9	18	5.3	0.39	7600	40
Col	5/6/2013	10	18	5.3	0.53	8200	--
<i>Guideline</i>		<25	---	<5	<1	<9300	<120

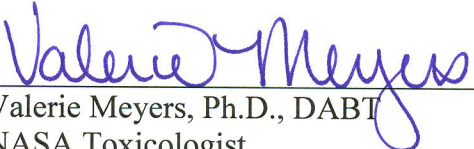
^a Non-methane volatile organic hydrocarbons, excluding Freon 218

^b Based on 180-d SMACs and calculated excluding CO₂ and formaldehyde


^c No samples were collected in the SM during this time period in an effort to conserve contingency mGSCs

Toxicological Evaluation of ISS Air Quality: Routine monthly sampling provides a very limited set of samples on which to perform an air quality assessment. However, based on these samples, there is no concern for crew health. Slightly elevated alcohol values were reported, with ethanol being the primary contributor. The alcohol guideline (<5 mg/m³) is intended to protect the water recovery system from risk of overloading, and reported values are not a concern for crew health. The primary contributors to the total T-value across all sampling locations throughout this time period were the cyclic siloxanes, hexamethylcyclotrisiloxane and

decamethylcyclopentasiloxane. These compounds were measured below levels of health concern; however, they may contribute to periodic accumulation of siloxanes in the water recovery system. GSCs provide only a snapshot of conditions and are not ideal for evaluating potential CO₂ exposures. However, reported levels were below 4 mmHg (9300 mg/m³), as requested for this Increment in Chit 11188.



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Enclosures Table 1: Analytical concentrations of compounds found in the 33S mGSCs
 Table 2: T-values corresponding to analytical concentrations in Table 1, based on
 180-day SMACs.

**TABLE 1
ANALYTICAL RESULTS OF
SOYUZ 33S RETURN GSC AIR SAMPLES**

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M ³)			
	AA05508 S/N 2023 LAB	AA05509 S/N 2024 JPM	AA05510 S/N 2025 LAB	AA05511 S/N 2026 COL
	04/01/13 @ 17:00 GMT	04/01/13 @ 17:05 GMT	05/06/13 @ 08:45 GMT	05/06/13 @ 08:46 GMT
TARGET COMPOUNDS (TO-14/POLAR)				
FREON12	<0.025	<0.025	<0.025	<0.025
CHLOROMETHANE	<0.025	<0.025	<0.025	<0.025
FREON114	<0.025	<0.025	<0.025	<0.025
METHANOL	0.46	0.49	0.51	0.53
ACETALDEHYDE	0.21	0.21	0.21	0.20
VINYLCHLORIDE	<0.025	<0.025	<0.025	<0.025
BROMOMETHANE	<0.025	<0.025	<0.025	<0.025
ETHANOL *	5.1	5.4	4.2	4.0
CHLOROETHANE	<0.025	<0.025	<0.025	<0.025
ACETONITRILE	TRACE	TRACE	TRACE	TRACE
PROPENAL	<0.025	<0.025	<0.025	<0.025
ACETONE	0.34	0.28	0.39	0.43
PROPANAL	<0.025	<0.025	<0.025	<0.025
ISOPROPANOL	0.21	0.12	0.16	0.18
FREON11	<0.025	<0.025	<0.025	<0.025
FURAN	<0.025	<0.025	<0.025	<0.025
ACRYLONITRILE	<0.025	<0.025	<0.025	<0.025
PENTANE	TRACE	TRACE	TRACE	TRACE
2-METHYL-2-PROPANOL	TRACE	TRACE	TRACE	TRACE
METHYLACETATE	TRACE	TRACE	0.11	0.12
1,1-DICHLOROETHENE	<0.025	<0.025	<0.025	<0.025
DICHLOROMETHANE	TRACE	TRACE	TRACE	TRACE
3-CHLOROPROPENE	<0.025	<0.025	<0.025	<0.025
FREON113	<0.025	<0.025	<0.025	<0.025
N-PROPANOL	0.036	0.042	0.039	0.043
1,1-DICHLOROETHANE	<0.025	<0.025	<0.025	<0.025
BUTANAL	<0.025	<0.025	<0.025	<0.025
2-BUTANONE	TRACE	TRACE	TRACE	TRACE
CIS-1,2-DICHLOROETHENE	<0.025	<0.025	<0.025	<0.025
2-METHYLFURAN	<0.025	<0.025	<0.025	<0.025
ETHYLACETATE	0.063	0.064	0.23	0.26
HEXANE	<0.025	<0.025	<0.025	<0.025
CHLOROFORM	<0.025	<0.025	<0.025	<0.025
2-BUTENAL	<0.025	<0.025	<0.025	<0.025
1,2-DICHLOROETHANE	0.032	0.034	0.032	0.034
1,1,1-TRICHLOROETHANE	<0.025	<0.025	<0.025	<0.025
N-BUTANOL	0.077	0.085	0.082	0.087
BENZENE	<0.025	<0.025	<0.025	<0.025
CARBONTETRACHLORIDE	<0.025	<0.025	<0.025	<0.025
2-PENTANONE	<0.025	<0.025	<0.025	<0.025
2-METHYLHEXANE	TRACE	TRACE	TRACE	TRACE
2,3-DIMETHYLPENTANE	<0.025	<0.025	TRACE	TRACE
PENTANAL	<0.025	<0.025	<0.025	<0.025
3-METHYLHEXANE	TRACE	0.026	0.036	0.038
1,2-DICHLOROPROPANE	<0.025	<0.025	<0.025	<0.025
1,4-DIOXANE	<0.025	<0.025	<0.025	<0.025
TRICHLOROETHENE	<0.025	<0.025	<0.025	<0.025
2,5-DIMETHYLFURAN	<0.025	<0.025	<0.025	<0.025
N-HEPTANE	<0.025	<0.025	TRACE	TRACE
4-METHYL-2-PENTANONE	<0.025	<0.025	<0.025	<0.025
CIS-1,3-DICHLOROPROPENE	<0.025	<0.025	<0.025	<0.025
2-PENTENAL	<0.025	<0.025	<0.025	<0.025
TRANS-1,3-DICHLOROPROPENE	<0.025	<0.025	<0.025	<0.025
1,1,2-TRICHLOROETHANE	<0.025	<0.025	<0.025	<0.025
TOLUENE	0.030	0.031	0.033	0.033
HEXANAL	<0.025	<0.025	<0.025	<0.025
MESITYLOXIDE	<0.025	<0.025	<0.025	<0.025
1,2-DIBROMOETHANE	<0.025	<0.025	<0.025	<0.025
BUTYLACETATE	<0.025	<0.025	<0.025	<0.025
OCTANE	<0.025	<0.025	<0.025	<0.025
TETRACHLOROETHENE	<0.025	<0.025	<0.025	<0.025
CHLOROENZENE	<0.025	<0.025	<0.025	<0.025
ETHYLBENZENE	<0.025	<0.025	<0.025	<0.025
M/P-XYLENES	<0.050	<0.050	<0.050	<0.050
2-HEPTANONE	<0.025	<0.025	<0.025	<0.025
CYCLOHEXANONE	<0.025	<0.025	<0.025	TRACE
HEPTANAL	<0.025	<0.025	<0.025	<0.025
STYRENE	<0.025	<0.025	<0.025	<0.025
1,1,2,2-TETRACHLOROETHANE	<0.025	<0.025	<0.025	<0.025
O-XYLENE	0.083	0.083	0.14	0.14
NONANE	<0.025	<0.025	<0.025	<0.025
1,3,5-TRIMETHYLBENZENE	<0.025	<0.025	<0.025	<0.025
1,2,4-TRIMETHYLBENZENE	<0.025	<0.025	<0.025	<0.025
1,3-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025
1,4-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025
1,2-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025
1,2,4-TRICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025
HEXACHLORO-1,3-BUTADIENE	<0.050	<0.050	<0.050	<0.050

TABLE 1
ANALYTICAL RESULTS OF
SOYUZ 33S RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M ³)			
	AA05508 S/N 2023 LAB	AA05509 S/N 2024 JPM	AA05510 S/N 2025 LAB	AA05511 S/N 2026 COL
	04/01/13 @ 17:00 GMT	04/01/13 @ 17:05 GMT	05/06/13 @ 08:45 GMT	05/06/13 @ 08:46 GMT
SPECIAL INTEREST COMPOUNDS **				
1,3-BUTADIENE	<0.050	<0.050	<0.050	<0.050
ETHYLENE OXIDE	<0.050	<0.050	<0.050	<0.050
2-METHYL-2-PROPENAL	<0.050	<0.050	<0.050	<0.050
3-BUTEN-2-ONE	<0.050	<0.050	<0.050	<0.050
2-ETHOXYETHANOL	<0.050	<0.050	<0.050	<0.050
DIMETHYL DISULFIDE	<0.050	<0.050	<0.050	<0.050
OCTAFLUOROPROPANE &	19	20	18	18
PERFLUORO-2-METHYLPENTANE &	<0.050	<0.050	<0.050	<0.050
CARBONYL SULFIDE &	TRACE	TRACE	TRACE	TRACE
ISOBUTANE &	<0.025	<0.025	<0.025	TRACE
2-METHYL-1-PROPENE &	TRACE	TRACE	0.026	0.027
DIMETHYL SULFIDE &	<0.025	<0.025	<0.025	<0.025
CARBON DISULFIDE &	TRACE	TRACE	TRACE	TRACE
TRIMETHYLSILANOL &	0.12	0.14	0.13	0.15
OCTAMETHYLCYCLOTETRAILOXANE &	<0.050	<0.050	<0.050	0.14
DECAMETHYLCYCLOPENTASILOXANE &	1.6	1.8	1.3	1.6
HEXAMETHYLCYCLOTRISILOXANE %	0.99	1.5	0.99	2.0
NON-TARGET COMPOUNDS **				
SULFURHEXAFLUORIDE	<0.050	<0.050	<0.050	<0.050
1,1,1,2-TETRAFLUOROETHANE	0.24	0.26	0.066	0.068
C6-ALKENE	<0.050	<0.050	<0.050	<0.050
C4-SUBSTITUTEDBENZENE	<0.050	<0.050	<0.050	<0.050
C9-ALKANE	<0.050	<0.050	<0.050	<0.050
2-ETHYL-1-HEXANOL	0.12	0.13	0.098	0.084
LIMONENE	0.056	0.053	0.053	0.066
C10-ALKANE	<0.050	<0.050	<0.050	<0.050
TOTAL ALCOHOLS PLUS ACETONE	6.2	6.4	5.3	5.3
TARGET COMPOUNDS (GC)				
CARBON MONOXIDE	0.36	0.35	0.41	0.40
METHANE	6.8	6.9	11	12
HYDROGEN	3.3	3.3	5.3	5.3
CARBON DIOXIDE	7400	7300	7600	8200
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	29	31	27	28
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	9.9	11	8.9	10

* GC/FID data results are in bold

** Quantified using "B" response factors except where noted

& Quantified using a multi-point calibration

% Response factor generated from an internal study

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

TRACE: Amount detected is sufficient for compound identification only.

OFP - Octafluoropropane

TABLE 2
T-VALUES for SOYUZ 33S RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)			
	AA05508	AA05509	AA05510	AA05511
	S/N 2023 LAB 04/01/13 @ 17:00 GMT	S/N 2024 JPM 04/01/13 @ 17:05 GMT	S/N 2025 LAB 05/06/13 @ 08:45 GMT	S/N 2026 COL 05/06/13 @ 08:46 GMT
TARGET COMPOUNDS (TO-14/POLAR)				
FREON12	ND	ND	ND	ND
CHLOROMETHANE	ND	ND	ND	ND
FREON14	ND	ND	ND	ND
METHANOL	0.00514	0.00544	0.00566	0.00588
ACETALDEHYDE	0.05333	0.05304	0.05150	0.05115
VINYLCHLORIDE	ND	ND	ND	ND
BROMOMETHANE	ND	ND	ND	ND
ETHANOL	0.00255	0.00268	0.00208	0.00201
CHLOROETHANE	ND	ND	ND	ND
ACETONITRILE	0.00187	0.00187	0.00187	0.00187
PROPENAL	ND	ND	ND	ND
ACETONE	0.00647	0.00544	0.00746	0.00835
PROPANAL	ND	ND	ND	ND
ISOPROPANOL	0.00139	0.00078	0.00104	0.00120
FREON11	ND	ND	ND	ND
FURAN	ND	ND	ND	ND
ACRYLONITRILE	ND	ND	ND	ND
PENTANE	0.00139	0.00139	0.00139	0.00139
2-METHYL-2-PROPANOL	0.00010	0.00010	0.00010	0.00010
METHYLACETATE	0.00010	0.00010	0.00096	0.00098
1,1-DICHLOROETHENE	ND	ND	ND	ND
DICHLOROMETHANE	0.00125	0.00125	0.00125	0.00125
3-CHLOROPROPENE	ND	ND	ND	ND
FREON113	ND	ND	ND	ND
N-PROPANOL	0.00037	0.00042	0.00040	0.00044
1,1-DICHLOROETHANE	ND	ND	ND	ND
BUTANAL	ND	ND	ND	ND
2-BUTANONE	0.00042	0.00042	0.00042	0.00042
CIS-1,2-DICHLOROETHENE	ND	ND	ND	ND
2-METHYLFURAN	ND	ND	ND	ND
ETHYLACETATE	0.00035	0.00036	0.00130	0.00144
HEXANE	ND	ND	ND	ND
CHLOROFORM	ND	ND	ND	ND
2-BUTENAL	ND	ND	ND	ND
1,2-DICHLOROETHANE	0.01983	0.02152	0.02031	0.02102
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND
N-BUTANOL	0.00192	0.00212	0.00205	0.00217
BENZENE	ND	ND	ND	ND
CARBONTETRACHLORIDE	ND	ND	ND	ND
2-PENTANONE	ND	ND	ND	ND
2-METHYLHEXANE	0.00104	0.00104	0.00104	0.00104
2,3-DIMETHYLPENTANE	ND	ND	0.00104	0.00104
PENTANAL	ND	ND	ND	ND
3-METHYLHEXANE	0.00104	0.00214	0.00300	0.00320
1,2-DICHLOROPROPANE	ND	ND	ND	ND
1,4-DIOXANE	ND	ND	ND	ND
TRICHLOROETHENE	ND	ND	ND	ND
2,5-DIMETHYLFURAN	ND	ND	ND	ND
N-HEPTANE	ND	ND	0.00104	0.00104
4-METHYL-2-PENTANONE	ND	ND	ND	ND
CIS-1,3-DICHLOROPROPENE	ND	ND	ND	ND
2-PENTENAL	ND	ND	ND	ND
TRANS-1,3-DICHLOROPROPENE	ND	ND	ND	ND
1,1,2-TRICHLOROETHANE	ND	ND	ND	ND
TOLUENE	0.00198	0.00208	0.00219	0.00218
HEXANAL	ND	ND	ND	ND
MESITYLOXIDE	ND	ND	ND	ND
1,2-DIBROMOETHANE	ND	ND	ND	ND
BUTYLACETATE	ND	ND	ND	ND
OCTANE	ND	ND	ND	ND
TETRACHLOROETHENE	ND	ND	ND	ND
CHLOROBENZENE	ND	ND	ND	ND
ETHYLBENZENE	ND	ND	ND	ND
M/P-XYLENES	ND	ND	ND	ND
2-HEPTANONE	ND	ND	ND	ND
CYCLOHEXANONE	ND	ND	ND	0.00021
HEPTANAL	ND	ND	ND	ND
STYRENE	ND	ND	ND	ND
1,1,2,2-TETRACHLOROETHANE	ND	ND	ND	ND
NONANE	0.00226	0.00224	0.00368	0.00382
O-XYLENE	ND	ND	ND	ND
1,3,5-TRIMETHYLBENZENE	ND	ND	ND	ND
1,2,4-TRIMETHYLBENZENE	ND	ND	ND	ND
1,3-DICHLOROBENZENE	ND	ND	ND	ND
1,4-DICHLOROBENZENE	ND	ND	ND	ND
1,2-DICHLOROBENZENE	ND	ND	ND	ND
1,2,4-TRICHLOROBENZENE	ND	ND	ND	ND
HEXACHLORO-1,3-BUTADIENE	ND	ND	ND	ND

TABLE 2
T-VALUES for SOYUZ 33S RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)			
	AA05508 S/N 2023 LAB 04/01/13 @ 17:00 GMT	AA05509 S/N 2024 JPM 04/01/13 @ 17:05 GMT	AA05510 S/N 2025 LAB 05/06/13 @ 08:45 GMT	AA05511 S/N 2026 COL 05/06/13 @ 08:46 GMT
SPECIAL INTEREST COMPOUNDS				
1,3-BUTADIENE	ND	ND	ND	ND
ETHYLENE OXIDE	ND	ND	ND	ND
2-METHYL-2-PROPENAL	ND	ND	ND	ND
3-BUTEN-2-ONE	ND	ND	ND	ND
2-ETHOXYETHANOL	ND	ND	ND	ND
DIMETHYL DISULFIDE	ND	ND	ND	ND
OCTAFLUOROPROPANE	0.00023	0.00024	0.00021	0.00021
PERFLUORO-2-METHYLPENTANE	ND	ND	ND	ND
CARBONYL SULFIDE	0.00104	0.00104	0.00104	0.00104
ISOBUTANE	ND	ND	ND	0.00005
2-METHYL-1-PROPENE	0.00001	0.00001	0.00002	0.00002
DIMETHYL SULFIDE	ND	ND	ND	ND
CARBON DISULFIDE	0.00078	0.00078	0.00078	0.00078
TRIMETHYLSILANOL	0.03090	0.03481	0.03160	0.03834
OCTAMETHYLCYCLOTETRAILOXANE	ND	ND	ND	0.01148
DECAMETHYLCYCLOPENTASILOXANE	0.10334	0.11860	0.08812	0.10691
HEXAMETHYLCYCLOTRIILOXANE	0.11033	0.16336	0.10951	0.21786
NON-TARGET COMPOUNDS				
SULFURHEXAFLUORIDE	ND	ND	ND	ND
1,1,1,2-TETRAFLUOROETHANE	0.00232	0.00245	0.00063	0.00065
C6-ALKENE	ND	ND	ND	ND
C4-SUBSTITUTEDBENZENE	ND	ND	ND	ND
C9-ALKANE	ND	ND	ND	ND
2-ETHYL-1-HEXANOL	0.00220	0.00246	0.00186	0.00158
LIMONENE	0.00048	0.00046	0.00046	AA055
C10-ALKANE	ND	ND	ND	ND
TARGET COMPOUNDS (GC)				
CARBON MONOXIDE	0.02146	0.02063	0.02416	0.02369
METHANE	0.00195	0.00197	0.00325	0.00327
HYDROGEN	0.00973	0.00955	0.01557	0.01555
CARBON DIOXIDE	0.57004	0.56247	0.58424	0.63319
TOTAL T-VALUE	0.95762	1.02326	0.97124	1.16681
TOTAL T-VALUE - CO2	0.38758	0.46079	0.38700	0.53362

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.