



2016-TEC-AQ-009

DATE: June 1, 2016

TO: Scott Messenger / XI3, NASA Astromaterials Research Office Planetary Scientist

CC: Dan Gazda, Ph.D. / SK, NASA Analytical Technical Monitor
Valerie E. Ryder, Ph.D. / SK, NASA Toxicology Technical Monitor

FROM: Tom Limero, Ph.D. / SK, Wyle Toxicology and Environmental Chemistry-Air Quality Lead *n 6/2/16*

SUBJECT: Analytical Results of 3 Area Air Samples from the OSIRIS-REx Lockheed Martin SSB Processing Facility in Littleton, Colorado

INTRODUCTION

At the request of the NASA JSC Astromaterials Research Office, the Toxicology and Environmental Chemistry Laboratory (TEC) analyzed 3 air samples collected by Lockheed Martin (LM) personnel on April 25, 2016 at the Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx) SSB processing facility in Littleton, Colorado. The Astromaterials Office is interested in the contaminant levels in the room areas where the OSIRIS-Rex spacecraft will undergo testing and processing. These samples are the second set of samples received from the processing of the spacecraft at the LM facilities in Colorado.

The grab air samples were collected in verified-clean (proofed), evacuated 500 mL stainless steel Summa-treated canisters supplied by the TEC Laboratory. One sample each was collected in the High Bay and from the Cooling Cart and Purge Gas. The air samples were received into the TEC-Air Quality Laboratory on May 3, 2016. Sample log information is provided in the table below:

Sample Tracking #	Canister SN#	Sample Description	Sample Date	Date Received	Date Analyses Completed
AQ160060	21261	High Bay	4/25/16	5/3/16	5/4/16
AQ160061	35334	Cooling Cart	4/25/16	5/3/16	5/4/16
AQ160062	21263	Purge Gas	4/25/16	5/3/16	5/4/16

METHODS

Analyses were accomplished using gas chromatography/ mass spectrometry (GC/MS). The samples were analyzed for volatile organic compounds by GC/MS according to WI-TOX-003, "Measurement of Volatile Organic Compounds in Spacecraft Air Using Grab Sample Containers."

RESULTS

The analytical results for the 3 air samples are reported in Table 1. Concentrations of identified compounds are reported as mg/M³ at 14.7 psia and 25°C. Quantitative measurements of listed Target Compounds (TO-15) were calculated using a weighted quadratic regression model from the multi-point standardization as described in EPA method TO-15 and WI-TOX-003 for GC/MS measurements. One compound, hexamethylcyclotrisiloxane (HMCTS) in the Special Interest Compounds (SICs) group, was quantified using an average response factor from an internal study performed by TEC-Air Quality. However, the results for HMCTS are estimates due to the variations observed in the response factors at different concentrations. The quantitative measurements of the remaining compounds in the SIC group were based upon estimates of "B" response factors available in the literature ("Compilation of Mass Spectral Data" by A. Cornu and R. Massot). There were no non-target compounds found in the 3 samples having peak areas greater than 10% of the fluorobenzene standard peak.

Compound concentrations listed as "< the laboratory reporting limit" indicate that these compounds were analyzed for, but not detected or detected below the laboratory reporting limit. The laboratory reporting limit for most compounds was 0.025 mg/M³.

QUALITY REVIEW

Review of the air sample measurement data was performed as described in WI-TOX-021 "Flight Sample Quality Assurance Review."

The raw data were reviewed from the instrument data systems and printouts for response integration, compound identification and operating parameters.

The GC/MS instrument used to generate report data was determined to be stable and calibrated during measurements of the samples. The instrument stability was demonstrated to meet specifications by daily bromofluorobenzene tune verification and daily calibration verification by analysis of a mid-range standard. The reported concentrations were quantified using 3 different methods: 1) multiple-point calibrations for the Target compounds, 2) a response factor generated from an internal study for one compound in the SIC group, and 3) "B" response factors obtained from the reference previously mentioned.

As typical, surrogate compounds (3) were added to the sample containers during their preparation prior to delivery to the LM SSB facility. The acetone-C13, fluorobenzene-d5 and chlorobenzene-d5 surrogate relative recoveries were good, ranging from 101% - 112%.

Upon receipt of the sample into the laboratory, the pressure was initially measured and also measured during subsequent steps of the sample processing to ensure sample integrity.

Instrument calibration and check standard data for each instrument were reviewed along with the results from all air sample analyses. All procedures and hardware were monitored for any errors or anomalies and no unusual trends impacting data quality were observed.



Internal Quality Reviewer

TABLE 1
ANALYTICAL RESULTS OF
OSIRIS REX GSC AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M ³)		
	AQ160060 21261 High Bay Sample 4/25/2016	AQ160061 35334 Cooling Cart Sample 4/25/2016	AQ160062 21263 Purge Gas Sample 4/25/2016
	TARGET COMPOUNDS (TO-15) *		
Octafluoropropane (Perfluoropropane)	<0.10	<0.10	<0.10
Perfluoro(2-methylpentane)	<0.050	<0.050	<0.050
Propene	<0.025	<0.025	<0.025
Propane	TRACE	TRACE	<0.025
Carbonyl sulfide (Carbon oxide sulfide)	<0.025	<0.025	<0.025
Freon 12 (Dichlorodifluoromethane)	<0.025	<0.025	<0.025
Chloromethane	<0.025	<0.025	<0.025
Freon 114 (1,2-Dichloro-1,1,2,2-tetrafluoroethane)	<0.025	<0.025	<0.025
Isobutane	<0.025	<0.025	<0.025
Vinyl chloride	<0.025	<0.025	<0.025
Methanol	TRACE	TRACE	<0.025
Acetaldehyde	0.025	0.42	0.034
2-Methyl-1-propene	<0.025	<0.025	<0.025
Butane	TRACE	TRACE	<0.025
1,3-Butadiene	<0.025	<0.025	<0.025
Bromomethane	<0.025	<0.025	<0.025
Chloroethane	<0.025	<0.025	<0.025
Ethanol	TRACE	0.026	<0.025
Freon 11 (Trichlorofluoromethane)	<0.025	<0.025	<0.025
Propenal (Acrolein)	<0.025	<0.025	<0.025
Acetonitrile	<0.025	<0.025	<0.025
Acetone	0.053	0.13	0.046
Propanal (Propionaldehyde)	<0.025	TRACE	<0.025
Furan	<0.025	<0.025	<0.025
Pentane	<0.025	<0.025	<0.025
2-Propanol (Isopropanol)	0.11	0.20	0.062
Isoprene (2-Methyl-1,3-butadiene)	<0.025	<0.025	<0.025
1,1-Dichloroethene	<0.025	<0.025	<0.025
Dimethyl sulfide	<0.025	<0.025	<0.025
Acrylonitrile	<0.025	<0.025	<0.025
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	<0.025	<0.025	<0.025
2-Methyl-2-propanol	<0.025	<0.025	<0.025
Methyl acetate	<0.025	<0.025	<0.025
3-Chloropropene (Allyl chloride)	<0.025	<0.025	<0.025
Methylene chloride (Dichloromethane)	<0.025	<0.025	<0.025
Carbon disulfide	<0.025	<0.025	<0.025
1-Propanol	<0.025	<0.025	<0.025
Trimethylsilanol	<0.025	<0.025	<0.025
1,1-Dichloroethane	<0.025	<0.025	<0.025
Butanal (Butyraldehyde)	<0.025	TRACE	TRACE
2-Butanone (Methyl ethyl ketone)	TRACE	0.026	<0.025
Hexane	<0.025	<0.025	<0.025
2-Methylfuran	<0.025	<0.025	<0.025
cis-1,2-Dichloroethene	<0.025	<0.025	<0.025
trans-1,2-Dichloroethene	<0.025	<0.025	<0.025
Ethyl acetate	<0.025	<0.025	<0.025
Chloroform	<0.025	<0.025	<0.025
1,1,1-Trichloroethane	<0.025	<0.025	<0.025
2-Butenal	<0.025	TRACE	<0.025
1,2-Dichloroethane	<0.025	<0.025	<0.025
Benzene	<0.025	<0.025	<0.025
Carbon tetrachloride	<0.025	<0.025	<0.025
1-Butanol	<0.025	<0.025	<0.025
2-Methylhexane	<0.025	<0.025	<0.025
2,3-Dimethylpentane	<0.025	<0.025	<0.025
3-Methylhexane	<0.025	<0.025	<0.025
2-Pentanone	<0.025	<0.025	<0.025
Pentanal	<0.025	<0.025	<0.025
n-Heptane	<0.025	<0.025	<0.025
Trichloroethene	<0.025	<0.025	<0.025
1,2-Dichloropropane	<0.025	<0.025	<0.025
2,5-Dimethylfuran	<0.025	<0.025	<0.025
1,4-Dioxane	<0.025	<0.025	<0.025
4-Methyl-2-pentanone (MIBK)	<0.025	<0.025	<0.025
cis-1,3-Dichloropropene	<0.025	<0.025	<0.025
2-Pentenal	<0.025	<0.025	<0.025
trans-1,3-Dichloropropene	<0.025	<0.025	<0.025
Toluene	<0.025	<0.025	<0.025
1,1,2-Trichloroethane	<0.025	<0.025	<0.025
Mesityl oxide (4-Methyl-3-penten-2-one)	<0.025	<0.025	<0.025
Octane	<0.025	<0.025	<0.025
Hexanal	<0.025	<0.025	<0.025
Butyl acetate	<0.025	<0.025	<0.025
Tetrachloroethene (Perchloroethene)	<0.025	<0.025	<0.025
1,2-Dibromoethane (EDB)	<0.025	<0.025	<0.025
Chlorobenzene	<0.025	<0.025	<0.025
Ethylbenzene	<0.025	<0.025	<0.025
m & p-Xylene	<0.050	<0.050	<0.050
2-Heptanone	<0.025	<0.025	<0.025
Nonane	<0.025	<0.025	<0.025
Styrene (Ethenylbenzene)	<0.025	<0.025	<0.025
Heptanal	<0.025	<0.025	<0.025
o-Xylene	<0.025	<0.025	<0.025
Cyclohexanone	<0.025	<0.025	<0.025
1,1,2,2-Tetrachloroethane	<0.025	<0.025	<0.025
Octamethylcyclotetrasiloxane	<0.075	<0.075	<0.075
1,3,5-Trimethylbenzene	<0.025	<0.025	<0.025

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	AQ160060 21261 High Bay Sample 4/25/2016	AQ160061 35334 Cooling Cart Sample 4/25/2016	AQ160062 21263 Purge Gas Sample 4/25/2016
1,2,4-Trimethylbenzene	<0.025	<0.025	<0.025
1,3-Dichlorobenzene	<0.025	<0.025	<0.025
1,4-Dichlorobenzene	<0.025	<0.025	<0.025
1,2-Dichlorobenzene	<0.025	<0.025	<0.025
Decamethylcyclopentasiloxane	<0.15	<0.15	<0.15
1,2,4-Trichlorobenzene	<0.050	<0.050	<0.050
Hexachlorobutadiene	<0.075	<0.075	<0.075
NON-TARGET COMPOUNDS			
No non-target compounds found			
SPECIAL INTEREST COMPOUNDS **			
Ethylene oxide	<0.050	<0.050	<0.050
2-Methyl-2-propenal	<0.050	<0.050	<0.050
3-Butene-2-one	<0.050	<0.050	<0.050
2-Ethoxyethanol	<0.050	<0.050	<0.050
Dimethyl disulfide	<0.050	<0.050	<0.050
Hexamethylcyclotrisiloxane #	<0.10	0.10	<0.10
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	0.25	0.98	0.15

* Quantified using a multi-point calibration

** Quantified using "B" response factor except where noted; concentrations are estimates only.

Response factor generated from an internal study

<: Value is less than the laboratory reporting limit.

TRACE: Amount detected is sufficient for compound identification only. One-half of the detection limit was used in the Total Concentration Summation.