



2016-TEC-AQ-010

DATE: June 16, 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 Limeró, Ph.D. / SK, Wyle Toxicology and Environmental Chemistry-Air Quality Lead  
*Steve Beck for T. Limeró 6/16/16*

SUBJECT: Analytical Results of 2 OSIRIS-REx Gas Samples collected from the Kennedy Space Center- Payload Hazardous Servicing Facility (PHSF)

## INTRODUCTION

At the request of the NASA JSC Astromaterials Research Office, the Toxicology and Environmental Chemistry Laboratory (TEC) analyzed 2 OSIRIS-REx (Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer) gas samples collected on May 25, 2016 at the Kennedy Space Center-PHSF. The Astromaterials Office is interested in the contaminant levels in the room area and purge gas where the OSIRIS-REx spacecraft will undergo testing and processing. These samples are the third set of samples received from the processing of the spacecraft. The first two sample sets were from the Lockheed Martin facilities in Littleton, Colorado.

The grab 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 PHSF, 2 meters from the spacecraft, and from the nitrogen purge line after it was qualified but before connection to the spacecraft. The samples were received into the TEC-Air Quality Laboratory on June 2, 2016. Sample log information is provided in the table below:

| Sample Tracking # | Canister SN# | Sample Description                   | Sample Date | Date Received | Date Analyses Completed |
|-------------------|--------------|--------------------------------------|-------------|---------------|-------------------------|
| AQ160095          | 21496        | PHSF Air Sample                      | 5/25/16     | 6/2/16        | 6/3/16                  |
| AQ160096          | 25232        | N <sub>2</sub> Purge Line Gas Sample | 5/25/16     | 6/2/16        | 6/3/16                  |

## METHODS

Analyses were accomplished using both gas chromatography (GC) and 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."

The PHSF air sample was also analyzed by the GC method according to the ISO-9001 work instruction WI-TOX-004, "GC Analysis of Volatile Organic Compounds, Carbon Monoxide, Methane, Carbon Dioxide and Hydrogen in Air Samples." This GC-flame ionization detector (FID) method is used for reporting high levels of methanol, ethanol, isopropanol, 2-butanone and acetone if the concentration is above 0.15 parts per million (ppm). Additional compounds may be quantified using this method if their levels are sufficiently high.

## **RESULTS**

The analytical results for the 2 gas samples are reported in Table 1. Concentrations of identified compounds are reported as mg/M<sup>3</sup> 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 2 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/M<sup>3</sup>.

## **QUALITY REVIEW**

Review of the gas 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 Lockheed Martin in Littleton, Colorado. The acetone-C13, fluorobenzene-d5 and chlorobenzene-d5 surrogate relative recoveries ranged from 80% - 106%.

Upon receipt of the samples into the laboratory, the pressures were 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 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 GAS SAMPLES

| CHEMICAL CONTAMINANT                               | CONCENTRATION<br>(mg/M <sup>3</sup> ) |  |
|--|---------------------------------------|--|
|  | AQ160095<br>21496                     | AQ160096<br>25232                                    |
|  | PHSF Air Sample<br>5/25/2016          | N <sub>2</sub> Purge Line Gas<br>Sample<br>5/25/2016 |
| <b>TARGET COMPOUNDS (TO-15) **</b>                 |                                       |  |
| Octafluoropropane (Perfluoropropane)               | -0.10                                 | -0.10  |
| Perfluoro(2-methylpentane)                         | -0.050                                | -0.050   |
| Propene  | -0.025                                | -0.025   |
| Propane  | -0.025                                | -0.025   |
| Carbonyl sulfide (Carbon oxide sulfide)            | -0.025                                | -0.025   |
| Freon 12 (Dichlorodifluoromethane)                 | -0.025                                | -0.025   |
| Chloromethane                                      | -0.025                                | -0.025   |
| Freon 114 (1,2-Dichloro-1,1,2,2-tetrafluoroethane) | -0.025                                | -0.025   |
| Isobutane  | -0.025                                | -0.025   |
| Vinyl chloride                                     | -0.025                                | -0.025   |
| Methanol   | -0.025                                | -0.025   |
| Acetaldehyde                                       | TRACE                                 | -0.025   |
| 2-Methyl-1-propene                                 | -0.025                                | -0.025   |
| Butane   | -0.025                                | -0.025   |
| 1,3-Butadiene                                      | -0.025                                | -0.025   |
| Bromomethane                                       | -0.025                                | -0.025   |
| Chloroethane                                       | -0.025                                | -0.025   |
| Ethanol  | -0.025                                | -0.025   |
| Freon 11 (Trichlorofluoromethane)                  | -0.025                                | -0.025   |
| Propenal (Acrolein)                                | -0.025                                | -0.025   |
| Acetonitrile                                       | <0.025                                | <0.025   |
| Acetone  | 0.035                                 | -0.025   |
| Propanal (Propionaldehyde)                         | -0.025                                | -0.025   |
| Furan  | -0.025                                | -0.025   |
| Pentane  | -0.025                                | -0.025   |
| 2-Propanol (Isopropanol) *                         | 0.78                                  | -0.025   |
| Isoprene (2-Methyl-1,3-butadiene)                  | -0.025                                | -0.025   |
| 1,1-Dichloroethene                                 | -0.025                                | -0.025   |
| Dimethyl sulfide                                   | <0.025                                | -0.025   |
| Acrylonitrile                                      | -0.025                                | -0.025   |
| Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)  | -0.025                                | -0.025   |
| 2-Methyl-2-propanol                                | -0.025                                | -0.025   |
| Methyl acetate                                     | -0.025                                | -0.025   |
| 3-Chloropropene (Allyl chloride)                   | <0.025                                | -0.025   |
| Methylene chloride (Dichloromethane)               | -0.025                                | -0.025   |
| Carbon disulfide                                   | -0.025                                | -0.025   |
| 1-Propanol   | <0.025                                | -0.025   |
| Trimethylsilanol                                   | <0.025                                | -0.025   |
| 1,1-Dichloroethane                                 | -0.025                                | <0.025   |
| Butanal (Butyraldehyde)                            | -0.025                                | -0.025   |
| 2-Butanone (Methyl ethyl ketone)                   | -0.025                                | -0.025   |
| Hexane   | -0.025                                | -0.025   |
| 2-Methylfuran                                      | -0.025                                | -0.025   |
| cis-1,2-Dichloroethene                             | -0.025                                | -0.025   |
| trans-1,2-Dichloroethene                           | -0.025                                | -0.025   |
| Ethyl acetate                                      | -0.025                                | -0.025   |
| Chloroform   | -0.025                                | -0.025   |
| 1,1,1-Trichloroethane                              | -0.025                                | -0.025   |
| 2-Butenal  | -0.025                                | -0.025   |
| 1,2-Dichloroethane                                 | <0.025                                | -0.025   |
| Benzene  | -0.025                                | <0.025   |
| Carbon tetrachloride                               | <0.025                                | -0.025   |
| 1-Butanol  | <0.025                                | -0.025   |
| 2-Methylhexane                                     | -0.025                                | -0.025   |
| 2,3-Dimethylpentane                                | -0.025                                | -0.025   |
| 3-Methylhexane                                     | -0.025                                | -0.025   |
| 2-Pentanone  | -0.025                                | -0.025   |
| Pentanal   | -0.025                                | -0.025   |
| n-Heptane  | -0.025                                | -0.025   |
| Trichloroethene                                    | <0.025                                | <0.025   |
| 1,2-Dichloropropane                                | -0.025                                | -0.025   |
| 2,5-Dimethylfuran                                  | -0.025                                | -0.025   |
| 1,4-Dioxane  | -0.025                                | -0.025   |
| 4-Methyl-2-pentanone (MIBK)                        | -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   |
| Toluene  | -0.025                                | -0.025   |
| 1,1,2-Trichloroethane                              | -0.025                                | -0.025   |
| Mesityl oxide (4-Methyl-3-penten-2-one)            | <0.025                                | -0.025   |
| Octane   | -0.025                                | -0.025   |
| Hexanal  | -0.025                                | -0.025   |
| Butyl acetate                                      | -0.025                                | -0.025   |
| Tetrachloroethene (Perchloroethene)                | -0.025                                | <0.025   |
| 1,2-Dibromoethane (EDB)                            | <0.025                                | <0.025   |
| Chlorobenzene                                      | -0.025                                | -0.025   |
| Ethylbenzene                                       | -0.025                                | -0.025   |
| m & p-Xylene                                       | -0.050                                | -0.050   |
| 2-Heptanone  | <0.025                                | <0.025   |
| Nonane   | -0.025                                | -0.025   |
| Styrene (Ethylbenzene)                             | -0.025                                | -0.025   |
| Heptanal   | <0.025                                | -0.025   |
| o-Xylene   | <0.025                                | -0.025   |
| Cyclohexanone                                      | -0.025                                | <0.025   |
| 1,1,2,2-Tetrachloroethane                          | -0.025                                | -0.025   |
| Octamethylcyclotetrasiloxane                       | -0.075                                | -0.075   |
| 1,3,5-Trimethylbenzene                             | -0.025                                | -0.025   |

TABLE 1  
ANALYTICAL RESULTS OF OSIRIS-REx GSC GAS SAMPLES

| CHEMICAL CONTAMINANT                                      | CONCENTRATION<br>(mg/M <sup>3</sup> ) |  |
|---|---------------------------------------|--|
|   | AQ160095<br>21496                     | AQ160096<br>25232                                    |
|   | PHSF Air Sample<br>5/25/2016          | N <sub>2</sub> Purge Line Gas<br>Sample<br>5/25/2016 |
| 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  |
| Decamethylcyclopentasiloxane                              | 0.15                                  | <0.15  |
| 1,2,4-Trichlorobenzene                                    | 0.050                                 | 0.050  |
| Hexachlorobutadiene                                       | 0.075                                 | 0.075  |
| <b>SPECIAL INTEREST COMPOUNDS ***</b>                     |                                       |  |
| Ethylene oxide  | <0.050                                | <0.050   |
| 2-Methyl-2-propenal                                       | <0.050                                | <0.050   |
| 3-Butene-2-one  | <0.050                                | <0.050   |
| 2-Ethoxyethanol   | <0.050                                | <0.050   |
| Dimethyl disulfide  | <0.050                                | <0.050   |
| Hexamethylcyclotrisiloxane #                              | <0.10                                 | <0.10  |
| <b>NON-TARGET COMPOUNDS</b>                               |                                       |  |
| No non-target compounds found                             |                                       |  |
| <b>TOTAL CONCENTRATION<br/>(NON-METHANE HYDROCARBONS)</b> | <b>0.830</b>                          | <b>0.00</b>  |

\* GC/FID data results are in bold

\*\* 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.