Assessment of Air Quality in the International Space Station (ISS) and Space Shuttle Based on Samples Returned aboard STS-111 (UF2) in June 2002

The toxicological assessments of grab sample canisters (GSCs) and 2 solid sorbent air samplers (SSASs) returned aboard STS-111 are reported. Analytical methods have not changed from earlier reports. Surrogate standard recoveries from the GSCs were 86-106% and 62% to 136% from the SSASs; 2 tubes with low surrogate recoveries were not reported. Pressure tracking indicated no leaks in the canisters during analysis. Recoveries from lab and trip controls for formaldehyde analyses ranged from 87 to 96%.

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 CO₂ and formaldehyde contributions). Because of the inertness of Freon 218 (octafluoropropane, OFP), its contribution to the NMVOC is subtracted and tabulated separately. Control of atmospheric alcohols is important to the water recovery system engineers, hence total alcohols (including acetone) are also shown for each sample. Because formaldehyde is quantified from sorbent badges, its concentration is listed separately. These five indices of air quality are summarized below:

<table>
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<tr>
<th>Sample Location</th>
<th>Date</th>
<th>NMVOCs - OFP (mg/m³)</th>
<th>OFP (mg/m³)</th>
<th>T Value⁵</th>
<th>Alcohols (mg/m³)</th>
<th>Formaldehyde (mg/m³)</th>
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Acceptable Guideline: <25 85000 <1 <5d 0.050

²Formaldehyde and CO₂ not included in T calculation.
³n/a = not in analysis plan for SSAS or preflight samples
⁴ns = no sample
⁵New guideline based on memo MSFC FD21 (03-012), November 2002 (Perry)

The table shows that the air quality in general was acceptable for crew respiration; however, certain values shown in bold require further explanation. The 1.05 T value on 2/28/02 was caused by an unusually high measurement of hexamethyldicyclosiloxane (T value = 0.50), which is not a concern. The MPLM T value of 1.42 and the alcohol level of 7.5 mg/m³ were due to an overall polluted atmosphere, which was expected at first entry. The major T-value component was...
carbon monoxide at a contribution of 0.44 units. Since the crew was only exposed momentarily to the polluted atmosphere, no health effects are expected. The formaldehyde value of 0.060 mg/m³ found in the Lab sample from 3/27/02 is cause for concern because the Lab consistently shows higher concentrations of formaldehyde than the SM and occasionally the concentrations are above the acceptable guideline.

Levels of OFP have remained low, suggesting that no further leaks of the SM air conditioner have occurred.

Enclosures
1A: Analytical Results of STS-111/UF2 GSC Samples
1B: Analytical Results of UF2 SSAS
2A: T Values of STS-111/UF2 GSC Samples
2B: T Values of UF2 SSAS
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<th>AAR1382 SN1837 Lab 05/23/2002 15:41 GMT</th>
<th>AAR1383 SN1088 MPLM 1 06/08/2002 21:28 GMT</th>
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<: 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 mg/m³ for C3H8; 1.6 mg/m³ for CH4; 0.2 mg/m³ for VOCs and 0.02 mg/m³ for propenal.)

BL: Area below the search routine limit (<2% of the fluorobenzene peak area).

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

NOTE: High levels (above 1.5 ppm) of Methanol, Ethanol, Acetone, Isopropanol and 2-Butanone are routinely reported based on calibrated GC-PID measurements.
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<td>#REF!</td>
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**Notes:**
- Values are less than the laboratory report detection limit.
- Measurements are calibrated by in-situ calibration, verified by mid-point continuing calibration.
### TABLE 2A
ANALYTICAL RESULTS OF ISS U2/STS11 CONTAINER AIR SAMPLES

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<tr>
<th>CHEMICAL CONTAMINANT</th>
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| TOTAL T-VALUE            | 0.83453  | 1.26105  | 1.26190  | 1.48533  | 0.11855  | 0.08767  |

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.

Measurements are calibrated by multi-point initial calibration and verified by mid-point continuing calibration.
| CHEMICAL CONTAMINANT | AAD01 LAB | LAB  | SERVICE MODULE | AAD02 LAB | LAB  | SERVICE MODULE | AAD04 LAB | LAB  | SERVICE MODULE | AAD06 LAB | LAB  | SERVICE MODULE | AAD08 LAB | LAB  | SERVICE MODULE |
|----------------------|----------|------|----------------|----------|------|----------------|----------|------|----------------|----------|------|----------------|----------|------|----------------|----------|------|----------------|
| 1,1-DICHLOROETHANE | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          |
| ACETONITRILE         | 0.0003   | 0.0003 | 0.0003          | 0.0003   | 0.0003 | 0.0003          | 0.0003   | 0.0003 | 0.0003          | 0.0003   | 0.0003 | 0.0003          | 0.0003   | 0.0003 | 0.0003          |
| ACROLEIN             | 0.0081   | 0.0082 | 0.0083          | 0.0081   | 0.0082 | 0.0083          | 0.0081   | 0.0082 | 0.0083          | 0.0081   | 0.0082 | 0.0083          | 0.0081   | 0.0082 | 0.0083          |
| ACRYLAMIDE          | 0.0002   | 0.0003 | 0.0003          | 0.0002   | 0.0003 | 0.0003          | 0.0002   | 0.0003 | 0.0003          | 0.0002   | 0.0003 | 0.0003          | 0.0002   | 0.0003 | 0.0003          |
| AMYL ACETATE        | 0.0006   | 0.0006 | 0.0006          | 0.0006   | 0.0006 | 0.0006          | 0.0006   | 0.0006 | 0.0006          | 0.0006   | 0.0006 | 0.0006          | 0.0006   | 0.0006 | 0.0006          |
| AMYLACETATE         | 0.0004   | 0.0004 | 0.0004          | 0.0004   | 0.0004 | 0.0004          | 0.0004   | 0.0004 | 0.0004          | 0.0004   | 0.0004 | 0.0004          | 0.0004   | 0.0004 | 0.0004          |
| ANISOLE             | 0.0005   | 0.0005 | 0.0005          | 0.0005   | 0.0005 | 0.0005          | 0.0005   | 0.0005 | 0.0005          | 0.0005   | 0.0005 | 0.0005          | 0.0005   | 0.0005 | 0.0005          |
| ANILINE             | 0.0005   | 0.0005 | 0.0005          | 0.0005   | 0.0005 | 0.0005          | 0.0005   | 0.0005 | 0.0005          | 0.0005   | 0.0005 | 0.0005          | 0.0005   | 0.0005 | 0.0005          |
| ANISYLFURFURAN      | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          |
| ANISYLFURFURANE     | 0.0005   | 0.0005 | 0.0005          | 0.0005   | 0.0005 | 0.0005          | 0.0005   | 0.0005 | 0.0005          | 0.0005   | 0.0005 | 0.0005          | 0.0005   | 0.0005 | 0.0005          |
| ANISYLFURFURANE 1   | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          |
| ANISYLFURFURANE 2   | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          |
| ANISYLFURFURANE 3   | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          | 0.0001   | 0.0001 | 0.0001          |
|---------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| TARGET COMPOUNDS (C-13) |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
| 2-Butanone           | ND                              | ND                              | ND                              | ND                              | ND                              | ND                              | ND                              | ND                              | ND                              |
| 2-Pentanone          | 0.953                            | 0.953                            | 0.953                            | 0.953                            | 0.953                            | 0.953                            | 0.953                            | 0.953                            | 0.953                            |
| 2-Methyl-2-pentanone | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 4-Heptanone          | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 3-Heptanone          | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 4-Octanol            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| Non-TARGET COMPOUNDS |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
| Propene             | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 2-Carbonylpropane    | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 2-Butene            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 2-Methyl-2-butenone  | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 2-Pentene           | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 3-Methyl-2-pentene   | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 3-Hexene            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 2-Heptene           | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 3-Heptene           | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 2-Octene            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| 3-Octene            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            | 0.000                            |
| TOTAL T-VALUE       | 0.74834                          | 0.74157                          | 0.69188                          | 0.91783                          | 0.53710                          | 1.05405                          | 0.67500                          | 0.65243                          | 0.44987                          |

ND: Values are less than the laboratory report detection limit.

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