Test 6, Test 7, and Gas Standard Analysis Results

Data compiled by:
NASA Johnson Space Center White Sands Test Facility

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Presentation Contributors

- Japanese Space Exploration Agency (JAXA)
- Tsukuba Space Center (TKSC), Japan
- European Space Agency (ESA)
- NASA White Sands Test Facility (WSTF), USA
- NASA Marshall Space Flight Center (MSFC), USA
- NASA Johnson Space Center (JSC), USA
Agenda

- Statistical Analysis Definitions
- Odor Analysis Results
  - NASA Standard 6001 Test 6
- Toxic Offgassing Analysis Results
  - NASA Standard 6001 Test 7
- Gas Standard Results
  - NASA Standard 6001 Test 7
- Discussion
- Areas of Concern
• Statistics Reported

**Standard Deviation**

\[ S = \sqrt{\frac{\sum_{i=1}^{N} X_i^2 - \left( \frac{\sum_{i=1}^{N} X_i}{N} \right)^2}{N - 1}} \]

**% Relative Standard Deviation (%RSD)**

\[ \%RSD = \frac{S}{X} \times 100\% \]

**Relative Percent Difference (RPD)**

\[ RPD = \left( \frac{|X_1 - X|}{\bar{X}} \right) \times 100 \]
Odor Analysis Results

- Odor Round Robin Participants
  - JAXA
  - NASA WSTF
Odor Analysis Results (continued)

- Odor Round Robin Sample for 2007
  - 06-40779, 3M 425 Aluminum Tape

<table>
<thead>
<tr>
<th>Center</th>
<th>Average Odor Value</th>
<th>RPD</th>
<th>RPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAXA (1/10 dilution)</td>
<td>0.8</td>
<td></td>
<td>--</td>
</tr>
<tr>
<td>NASA (1/10 dilution)</td>
<td>0.6</td>
<td>28.6</td>
<td>30</td>
</tr>
<tr>
<td>JAXA (no dilution)</td>
<td>1.4</td>
<td></td>
<td>--</td>
</tr>
<tr>
<td>NASA (no dilution)</td>
<td>1.0</td>
<td>33.3</td>
<td>18</td>
</tr>
</tbody>
</table>

Sample Selection by NASA WSTF
Odor Analysis Results (continued)

- Odor Round Robin Sample for 2007 (continued)
  - 06-40778, K-Flex ECO Closed Cell Elastomeric Foam

<table>
<thead>
<tr>
<th>Center</th>
<th>Average Odor Value</th>
<th>RPD</th>
<th>RPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAXA (1/10 dilution)</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>NASA (1/10 dilution)</td>
<td>0.8</td>
<td>200</td>
<td>30</td>
</tr>
<tr>
<td>JAXA (no dilution)</td>
<td>1</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>NASA (no dilution)</td>
<td>1.2</td>
<td>18.18</td>
<td>18</td>
</tr>
</tbody>
</table>

Sample Selection by NASA WSTF
Toxic Offgassing Analysis Results

- Round Robin Participants
  - JAXA
  - ESA
  - NASA JSC
  - NASA MSFC
  - NASA WSTF
## Toxic Offgassing Analysis Results (continued)

### T-Values

<table>
<thead>
<tr>
<th>Material</th>
<th>JAXA</th>
<th>MSFC</th>
<th>WSTF</th>
<th>Average</th>
<th>SDEV</th>
<th>% RSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-40779, 3M 425 Aluminum</td>
<td>9.99766</td>
<td>0.00226</td>
<td>0.417765</td>
<td>9.99766</td>
<td>0.00226</td>
<td>0.417765</td>
</tr>
<tr>
<td>06-40778, K-Flex ECO Closed Cell Elastomeric Foam</td>
<td>18.48</td>
<td>0.000226</td>
<td>9.06</td>
<td>0.000226</td>
<td>9.06</td>
<td>0.000226</td>
</tr>
</tbody>
</table>

Average T-Values:
- JAXA: 9.99766
- MSFC: 18.48
- WSTF: 7.63
- Average: 9.06

STDEV:
- JAXA: 0.00226
- MSFC: 0.000226
- WSTF: 0.417765
- Average: 0.142816

% RSD:
- JAXA: 18.48
- MSFC: 0.14
- WSTF: 46.11
- Average: 46.11
• JAXA Intra-laboratory Comparison
  – T-Values Calculation Used for JAXA Results

\[
T = \sum \frac{Q_{pg}}{TL}
\]

Where:
- \( Q_{pg} \) = micrograms of compound per gram of sample
- \( TL \) = Toxic Limit (\( \mu g/g \)) = SMAC(in mg/m^3)\( \times \)(1.433 m^3/kg)

(The 1.433 m^3/kg = (65 m^3/45.359 kg) conversion factor is based on the usage of 100 lbs. of material in a 65 m^3 space craft.)

Material:
- 06-40779, 3M 425 Aluminum \( T = 9.99766 \)
- Tape06-40778, K-Flex ECO \( T = 0.417765 \)
- Closed Cell Elastomeric Foam
• JSC Intra-laboratory Comparison
  – T-Values Calculation and Values Provided by JSC

\[
T = \sum \frac{Q_{pg}}{TL}
\]

Where:
- \(Q_{pg}\) = micrograms of compound per gram of sample
- \(TL\) = Toxic Limit (\(\mu g/g\)) = SMAC (in mg/m^3) * (1.433 m^3/kg)
  (The 1.433 m^3/kg = (65 m^3/45.359 kg) conversion factor
  is based on the usage of 100 lbs. of material in a 65 m^3
  space craft.)

Material:
- 06-40779, 3M 425 Aluminum \(T = 0.00226\)
- Tape 06-40778, K-Flex ECO \(T = 0.00002\)
- Closed Cell Elastomeric Foam
• MSFC Intra-laboratory Comparison
  – T-Values Calculation Used for MSFC Results

\[ T = \sum_{i} \frac{Q_{pg}}{T_L} \]

Where:
- \( Q_{pg} \) = micrograms of compound per gram of sample
- \( T_L \) = Toxic Limit (µg/g) = SMAC(in mg/m^3)*(1.433 m^3/kg)

(The 1.433 m^3/kg = (65 m^3/45.359 kg) conversion factor is based on the usage of 100 lbs. of material in a 65 m^3 space craft.)

Material:
- 06-40779, 3M 425 Aluminum \( T = 18.480 \)
- 06-40778, K-Flex ECO \( T = 0.142816 \)
- Closed Cell Elastomeric Foam
• WSTF Intra-laboratory Comparison
  – T-Values Calculation Used for WSTF Results

\[ T = \sum \frac{Q_{pg}}{TL} \]

Where:
\( \mu g_n \) = micrograms of compound \( n \)
\( TL_n \) = Toxic Limit (ug) for compound \( n \)
\( TL = \text{SMAC (mg/m}^3\text{)} \times 65000 \)
SMAC (ppm) Conversion = 0.4089 = 22.4 L/mole \( \times \frac{298}{273} \)

Material:
06-40779, 3M 425 Aluminum \( T = 7.763 \)
Tape06-40778, K-Flex ECO \( T = 0.170 \)
Closed Cell Elastomeric Foam
<table>
<thead>
<tr>
<th>Compound</th>
<th>JAXA</th>
<th>JSC</th>
<th>MSFC</th>
<th>WSTF</th>
<th>Average</th>
<th>STDEV</th>
<th>% RSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARBON MONOXIDE</td>
<td>4.96</td>
<td>4.6</td>
<td>6.1</td>
<td>6.1</td>
<td>5.35</td>
<td>0.70</td>
<td>13.11</td>
</tr>
<tr>
<td>3-CHLORO-1-PROPENE</td>
<td>0.95</td>
<td>0.17</td>
<td>0.2</td>
<td>0.2</td>
<td>0.215</td>
<td>0.35</td>
<td>97.33</td>
</tr>
<tr>
<td>1,2-DICHLOROETHANE</td>
<td>0.18</td>
<td>0.22</td>
<td>0.41</td>
<td>0.21</td>
<td>0.29</td>
<td>0.11</td>
<td>39.80</td>
</tr>
<tr>
<td>METHYLENE CHLORIDE</td>
<td>4.37</td>
<td>5.9</td>
<td>2.15</td>
<td>2.15</td>
<td>3.98</td>
<td>1.76</td>
<td>44.22</td>
</tr>
<tr>
<td>VINYL CHLORIDE</td>
<td>-</td>
<td>1</td>
<td>1.2</td>
<td>1.2</td>
<td>1.12</td>
<td>1.10</td>
<td>8.90</td>
</tr>
</tbody>
</table>

* Values in PPM