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

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- 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
Statistical Analysis Definitions

- **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)

\[ RPD = \left(\frac{X_1 - X_2}{\bar{X}}\right) \times 100 \]
Odor Analysis Results

• Odor Round Robin Participants
  – JAXA
  – NASA WSTF
• 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 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

**T-Values**

<table>
<thead>
<tr>
<th>Material</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>06-40779, 3M 425 Aluminum</td>
<td>9.99766</td>
<td>0.00226</td>
<td>18.48</td>
<td>7.763</td>
<td>9.06</td>
<td>7.60</td>
<td>83.63</td>
</tr>
<tr>
<td>Tape06-40778, K-Flex ECO Closed Cell Elastomeric Foam</td>
<td>0.417765</td>
<td>0.00002</td>
<td>0.142816</td>
<td>0.17</td>
<td>0.18</td>
<td>0.17</td>
<td>46.11</td>
</tr>
</tbody>
</table>
Toxic Offgassing Analysis Results (continued)

- 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 (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  \(T = 9.99766\)
- 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 (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 \( T = 0.00226 \)
- Tape06-40778, K-Flex ECO \( T = 0.00002 \)
- Closed Cell Elastomeric Foam
MSFC Intra-laboratory Comparison
- T-Values Calculation Used for MSFC Results

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

Where:
- \( Q_{pg} \) = micrograms of compound per gram of sample
- \( TL \) = 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 \( T = 18.480 \)
- Tape06-40778, 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
- \( TL = SMAC \text{ (mg/m}^3\text{)} \times 65000 \)
- 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>4.99</td>
<td>5.35</td>
<td>13.11</td>
</tr>
<tr>
<td>3-CHLORO-1-PROPENE</td>
<td>0.951</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>0.181</td>
<td>0.22</td>
<td>0.41</td>
<td>0.41</td>
<td>0.21</td>
<td>0.29</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>5.35</td>
<td>3.98</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>1.07</td>
<td>1.12</td>
<td>8.90</td>
</tr>
</tbody>
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*Values in PPM*