Test 6, Test 7, and Gas Standard Analysis Results

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

Horacio Perez III
NASA/JAXA Technical Interchange Meeting
Tsukuba, Japan
June 4-8, 2007
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
### Statistical Analysis Definitions

- **Statistics Reported**

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

- **% Relative Standard Deviation (%RSD)**
  
  \[
  \%RSD = \frac{S}{X} \times 100\%
  \]

- **Relative Percent Difference (RPD)**
  
  \[
  RPD = \frac{\left|X_1 - X_2\right|^2}{\bar{X}^2} \times 100
  \]
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 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
## 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>
• 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
Toxic Offgassing Analysis Results (continued)

• 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 \( T = 0.00226 \)
- Tape 06-40778, K-Flex ECO \( T = 0.00002 \)
- Closed Cell Elastomeric Foam
MSFC Intra-laboratory Comparison

– T-Values Calculation Used for MSFC Results

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

**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  \( T = 18.480 \)
- Tape 06-40778, K-Flex ECO  \( T = 0.142816 \)
- Closed Cell Elastomeric Foam

**Notes:**

- T = Toxic Limit
- TL = Toxic Limit
- Qpg = micrograms of compound per gram of sample
- SMAC = Short Term Maximum Acceptable Concentration
- m^3 = cubic meters
- kg = kilograms
- lbs = pounds
- 65 m^3 = 65 cubic meters
- 45.359 kg = 100 pounds
Toxic Offgassing Analysis Results (continued)

• 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 (mg/m\(^3\)) \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
### Gas Standard Results*

<table>
<thead>
<tr>
<th>Compound</th>
<th>JAXA</th>
<th>JSC</th>
<th>MSFC</th>
<th>WSTF</th>
<th>Scott Specialty Gas Standard</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>0.70</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>0.34</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>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>5.35</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>1.07</td>
<td>1.12</td>
<td>0.10</td>
<td>8.90</td>
</tr>
</tbody>
</table>

* Values in PPM