Test 6, Test 7, and Gas Standard Analysis Results

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

Horacio Perez III
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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

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

% Relative Standard Deviation (%RSD)

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

Relative Percent Difference (RPD)

\[
RPD = \left(\frac{X_1 - \bar{X}}{\bar{X}}\right) \times 100
\]
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><strong>83.63</strong></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><strong>46.11</strong></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 (\( \mu \)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  \( T = 9.99766 \)
- 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 (\(\mu\)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 \(T = 18.480\)
- Tape 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
\( TL = \text{SMAC (mg/m}^3\) \times 65000
SMAC (ppm) Conversion = 0.4089 = 22.4 L/mole \times (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*

* Values in PPM

<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>
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<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>
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<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>
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<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>