GLAST Large Area Telescope

LAT Pre-Shipment Review

Mechanical Test: Plans and Procedures

John Ku
Design Integration and Analysis

Stanford Linear Accelerator Center
Purpose / Contents

• Demonstrate readiness to proceed with environmental testing of the integrated flight instrument, i.e. the LAT:
  – Is requirements compliant
  – Has been appropriately tested at lower levels of assembly
  – Passes comprehensive systems test
  – Pre-test analyses complete
  – Environmental Test plans and procedures complete
  – Facilities readiness and certification verified
  – STE and MGSE complete, fabricated, and ready for use
  – Manpower is sufficient to cover all planned for activities
Requirements compliant

- All flight system design analyses have been successfully completed and demonstrate adequate margin
  - Mission System Spec → 433-SPEC-0001
    - Stiffness, mass, stability
  - LAT-SC Interface Requirements Spec → 433-IRD-0001
  - LAT Environmental Requirements Spec → LAT-SS-00778
    - Design and Test loads
  - LAT Performance Verification Plan → LAT-MD-00408-04c
    - Verification test definition
Requirements compliant

• Requirements / Design Update, i.e. Changes since CDR
  – Shear Plates added at CAL-Grid interface to address slippage concerns
    • Added mounting bosses to the Grid for Shear Plate mounting
    • Modified EMI Skirt pieces to accommodate Shear Plate mounting to the Grid
    • Removed corner tabs from CAL base plate
    • **Rationale:** friction alone is not a good way to ensure no slippage. Tight mechanical fit via liquid shims solves this problem
    • **Approved:** Documented in LAT-TD-02472-01, Section 3 & 5A
  – Finalized Radiator Mount Bracket
    • **Rationale:** Thermal distortion of radiators could induce high stresses in RMB. Stiffness of RMB reduced in X-direction to minimize thermally induced stress
    • **Approved:** Documented in LAT-TD-02472-01, Section 5C
    – ICDs updated and approved
    – Resultant changes to verification matrix incorporated and approved
**Requirements Compliant**

- Current calculations for system performance are fully compliant with requirements
- Completed analysis of current design demonstrate adequate margin for mechanical loads and stress from handling, test and flight environments

<table>
<thead>
<tr>
<th>Subsystem / Description</th>
<th>Source for Loads [Ref 1 &amp; 2]</th>
<th>Load Case [7.2]</th>
<th>Peak Stress/Load [Mpa/N]</th>
<th>Mat</th>
<th>Mass Factor [7.1]</th>
<th>SF(y)</th>
<th>Allowable F(y) [Mpa/N]</th>
<th>Source for Allowable</th>
<th>MS(y)</th>
<th>SF(u)</th>
<th>Allowable F(u) [MPa/N]</th>
<th>Source for Allowable</th>
<th>MS(u)</th>
<th>Ref</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRID</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perimeter Wall Bulk Stress</td>
<td>Sep-03 Air</td>
<td>28.3</td>
<td>6061-T6</td>
<td>1.1138</td>
<td>2.0</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>2.62</td>
<td>2.6</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>2.37</td>
<td>T-8.2-27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior Wall Bulk Stress</td>
<td>Sep-03 Air</td>
<td>14.3</td>
<td>6061-T6</td>
<td>1.1138</td>
<td>2.0</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>6.57</td>
<td>2.6</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>5.66</td>
<td>T-8.2-27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wing Stresses near SC Mt</td>
<td>Sep-03 MECO</td>
<td>59.3</td>
<td>6061-T6</td>
<td>1.1138</td>
<td>2.0</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>0.82</td>
<td>2.6</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>0.61</td>
<td>T-8.2-27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wing DSHP Holes</td>
<td>Sep-03 Air</td>
<td>4.8</td>
<td>6061-T6</td>
<td>1.1138</td>
<td>2.0</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>21.35</td>
<td>2.6</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>18.69</td>
<td>T-8.2-27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wing Corner</td>
<td>N/A</td>
<td>16.9</td>
<td>6061-T6</td>
<td>1.087</td>
<td>1.25</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>5.56</td>
<td>2.6</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>4.78</td>
<td>T-8.2-27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wing Corner</td>
<td>N/A</td>
<td>125.0</td>
<td>6061-T6</td>
<td>1.087</td>
<td>1.25</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>0.42</td>
<td>1.40</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>0.45</td>
<td>T-8.2-27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calorimeter/Grid #6 Inserts</td>
<td>Sep-03 Air</td>
<td>3923.3</td>
<td>#6 Helicoil</td>
<td>1.1144</td>
<td>2.0</td>
<td>N/A</td>
<td>A-p.372</td>
<td>N/A</td>
<td>2.6</td>
<td>7104</td>
<td>A-p.372</td>
<td>0.84</td>
<td>A-p.372</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calorimeter/Grid #6 Fasteners</td>
<td>Sep-03 Air</td>
<td>3923.3</td>
<td>A-286</td>
<td>1.1144</td>
<td>2.0</td>
<td>7775</td>
<td>AMS5726C</td>
<td>0.80</td>
<td>2.6</td>
<td>10364</td>
<td>AMS5726C</td>
<td>1.27</td>
<td>S-8.6.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calorimeter/Grid #8 Inserts</td>
<td>Sep-03 Air</td>
<td>5520.2</td>
<td>#8 Helicoil</td>
<td>1.1144</td>
<td>2.0</td>
<td>N/A</td>
<td>A-p.382</td>
<td>N/A</td>
<td>2.6</td>
<td>10120</td>
<td>A-p.382</td>
<td>0.95</td>
<td>A-p.382</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calorimeter/Grid #8 Fasteners</td>
<td>Sep-03 Air</td>
<td>5520.2</td>
<td>A-286</td>
<td>1.1144</td>
<td>2.0</td>
<td>11169</td>
<td>AMS5726C</td>
<td>0.88</td>
<td>2.6</td>
<td>14893</td>
<td>AMS5726C</td>
<td>1.40</td>
<td>S-8.6.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC Mount Bushing (ID Bearing)</td>
<td>Sep-03 A-286</td>
<td>301.4</td>
<td>A-286</td>
<td>1.114</td>
<td>2.0</td>
<td>876</td>
<td>AMS5726C</td>
<td>0.30</td>
<td>2.6</td>
<td>1344</td>
<td>AMS5726C</td>
<td>0.54</td>
<td>A-p.229</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC Mount Pin Hole (e/D=1.5)</td>
<td>Sep-03 A-286</td>
<td>252.3</td>
<td>6061-T6</td>
<td>1.1133</td>
<td>1.25</td>
<td>365</td>
<td>MIL-HDBK-5J</td>
<td>0.04</td>
<td>1.40</td>
<td>476</td>
<td>MIL-HDBK-5J</td>
<td>0.21</td>
<td>A-p.229</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SC Mount Pin Hole (e/D=1.5)</td>
<td>Pre-test GSLT</td>
<td>168.0</td>
<td>6061-T6</td>
<td>1.00</td>
<td>1.00</td>
<td>365</td>
<td>MIL-HDBK-5J</td>
<td>1.17</td>
<td>1.12</td>
<td>476</td>
<td>MIL-HDBK-5J</td>
<td>1.53</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC Mount Keenserts (HD)</td>
<td>Sep-03 MECO</td>
<td>40515.0</td>
<td>7/16&quot; HD</td>
<td>1.114</td>
<td>1.25</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>1.14</td>
<td>86131</td>
<td>KNH720J</td>
<td>0.36</td>
<td>A-p.363</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SC Mount Keenserts (HD)</td>
<td>Pre-test GSLT</td>
<td>48703.6</td>
<td>7/16&quot; HD</td>
<td>1.00</td>
<td>1.00</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>1.12</td>
<td>86131</td>
<td>KNH720J</td>
<td>0.36</td>
<td>A-p.363</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC Mounts Bolts (200 ksi)</td>
<td>Sep-03 MECO</td>
<td>40515.0</td>
<td>A-286</td>
<td>1.114</td>
<td>1.25</td>
<td>70300</td>
<td>AMS5726C</td>
<td>0.25</td>
<td>1.40</td>
<td>78111</td>
<td>AMS5726C</td>
<td>0.24</td>
<td>A-p.234</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SC Mounts Bolts (200 ksi)</td>
<td>Pre-test GSLT</td>
<td>48703.6</td>
<td>A-286</td>
<td>1.00</td>
<td>1.00</td>
<td>70300</td>
<td>AMS5726C</td>
<td>0.44</td>
<td>1.12</td>
<td>78111</td>
<td>AMS5726C</td>
<td>0.43</td>
<td>A-p.234</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHEAR PLATES 1/1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC Mount Plate (Tension)</td>
<td>Sep-03 Air</td>
<td>104.4</td>
<td>7075-T7351</td>
<td>1.1133</td>
<td>1.25</td>
<td>407</td>
<td>MIL-HDBK-5J</td>
<td>1.80</td>
<td>1.40</td>
<td>476</td>
<td>MIL-HDBK-5J</td>
<td>1.93</td>
<td>A-p.254</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Quarter Plate (Shear)</td>
<td>Nov-01 Air</td>
<td>90.1</td>
<td>7075-T7351</td>
<td>1.1133</td>
<td>2.0</td>
<td>244</td>
<td>MIL-HDBK-5J</td>
<td>0.22</td>
<td>2.6</td>
<td>285</td>
<td>MIL-HDBK-5J</td>
<td>0.09</td>
<td>A-p.260</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corner Plate (Tension)</td>
<td>Nov-01 Air</td>
<td>83.0</td>
<td>7075-T7351</td>
<td>1.1133</td>
<td>2.0</td>
<td>407</td>
<td>MIL-HDBK-5J</td>
<td>1.20</td>
<td>2.6</td>
<td>476</td>
<td>MIL-HDBK-5J</td>
<td>0.98</td>
<td>A-p.268</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior Plate (Shear)</td>
<td>Nov-01 Air</td>
<td>34.5</td>
<td>7075-T7351</td>
<td>1.1133</td>
<td>2.0</td>
<td>421</td>
<td>MIL-HDBK-5J</td>
<td>2.18</td>
<td>2.6</td>
<td>621</td>
<td>MIL-HDBK-5J</td>
<td>1.86</td>
<td>A-p.244</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grid Wall (Bearing)</td>
<td>Sep-03 Air</td>
<td>24.8</td>
<td>6061-T6</td>
<td>1.1133</td>
<td>2.0</td>
<td>421</td>
<td>MIL-HDBK-5J</td>
<td>6.63</td>
<td>2.6</td>
<td>621</td>
<td>MIL-HDBK-5J</td>
<td>7.66</td>
<td>A-p.250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pin Socket (Bearing)</td>
<td>Sep-03 Air</td>
<td>79.8</td>
<td>6061-T6</td>
<td>1.1133</td>
<td>2.0</td>
<td>421</td>
<td>MIL-HDBK-5J</td>
<td>1.37</td>
<td>2.6</td>
<td>621</td>
<td>MIL-HDBK-5J</td>
<td>1.69</td>
<td>A-p.253</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shear Pin</td>
<td>Sep-03 Air</td>
<td>69.5</td>
<td>17-4PH</td>
<td>1.1133</td>
<td>2.0</td>
<td>703</td>
<td>MIL-HDBK-5J</td>
<td>3.54</td>
<td>2.6</td>
<td>786</td>
<td>MIL-HDBK-5J</td>
<td>2.91</td>
<td>A-p.251</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Requirements Compliant

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TKR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top Flange Twist (Bending)</td>
<td>Nov-01 Air</td>
<td>22.0</td>
<td>6061-T6</td>
<td>1.1133</td>
<td>2.0</td>
<td>241</td>
<td>3.92</td>
<td>2.6</td>
<td>476</td>
<td></td>
<td>6.47</td>
<td>2.6</td>
<td>S-8.2.2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder Bolt Joint</td>
<td>GEVS Random</td>
<td>3241.0</td>
<td>A-286</td>
<td>1.114</td>
<td>2.0</td>
<td>11135</td>
<td>0.54</td>
<td>2.6</td>
<td>17026</td>
<td>0.81</td>
<td>A-p.297</td>
<td>SS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grid Wall (Bearing)</td>
<td>GEVS Random</td>
<td>4051.3</td>
<td>6061-T6</td>
<td>1.1133</td>
<td>2.0</td>
<td>15700</td>
<td>Bruhn-D1.7</td>
<td>0.74</td>
<td>2.6</td>
<td>13008</td>
<td>Bruhn-D1.8</td>
<td>0.11</td>
<td>A-p.278</td>
<td>SS</td>
<td></td>
</tr>
<tr>
<td>ACD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-side Pin (3/8&quot;)</td>
<td>Nov-01 MECO</td>
<td>22.6</td>
<td>A-286</td>
<td>1.114</td>
<td>2.0</td>
<td>144.6</td>
<td>0.6* Fly</td>
<td>1.88</td>
<td>2.6</td>
<td>285.6</td>
<td>0.6* Flu</td>
<td>3.37</td>
<td>S-8.6.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACD Inserts (3/8&quot;)</td>
<td>Nov-01 Air</td>
<td>276.5</td>
<td>Helicoil</td>
<td>1.114</td>
<td>2.0</td>
<td>1100</td>
<td>Vendor DS</td>
<td>0.79</td>
<td>2.6</td>
<td>1240</td>
<td>Vendor DS</td>
<td>0.55</td>
<td>S-8.6.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-side Bolts (3/8&quot;)</td>
<td>Nov-01 Air</td>
<td>276.5</td>
<td>A-286</td>
<td>1.114</td>
<td>2.0</td>
<td>1100</td>
<td>AMS5732H</td>
<td>0.79</td>
<td>2.6</td>
<td>1240</td>
<td>AMS5732H</td>
<td>0.55</td>
<td>S-8.6.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corner Bolts (1/4&quot;)</td>
<td>Nov-01 Air</td>
<td>276.5</td>
<td>A-286</td>
<td>1.114</td>
<td>2.0</td>
<td>733</td>
<td>AMS5732H</td>
<td>0.19</td>
<td>2.6</td>
<td>827</td>
<td>AMS5732H</td>
<td>0.03</td>
<td>S-8.6.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulk Stresses</td>
<td>Nov-01 Lift</td>
<td>170.5</td>
<td>6061-T6</td>
<td>1.1144</td>
<td>1.25</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>0.01</td>
<td>1.40</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>0.04</td>
<td>T-8.4.46</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bulk Stresses</td>
<td>Pre-test GSLT</td>
<td>31.9</td>
<td>6061-T6</td>
<td>1</td>
<td>1.00</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>6.55</td>
<td>1.12</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>6.73</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMB/RAD Pin Socket (Bearing)</td>
<td>Nov-01 MECO</td>
<td>293.4</td>
<td>6061-T6</td>
<td>1.1144</td>
<td>1.25</td>
<td>421</td>
<td>MIL-HDBK-5J</td>
<td>0.03</td>
<td>1.40</td>
<td>621</td>
<td>MIL-HDBK-5J</td>
<td>0.36</td>
<td>F-8.4.47</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>RMB/RAD Pin Socket (Bearing)</td>
<td>Pre-test GSLT</td>
<td>408.7</td>
<td>6061-T6</td>
<td>1</td>
<td>1.00</td>
<td>421</td>
<td>MIL-HDBK-5J</td>
<td>0.03</td>
<td>1.12</td>
<td>621</td>
<td>MIL-HDBK-5J</td>
<td>0.36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMB Inserts</td>
<td>N/A EQ</td>
<td>184.6</td>
<td>Helicoil</td>
<td>1.114</td>
<td>2.0</td>
<td>590</td>
<td>Vendor DS</td>
<td>0.43</td>
<td>2.6</td>
<td>900</td>
<td>Vendor DS</td>
<td>0.68</td>
<td>F-8.6-61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMB Bolts</td>
<td>N/A EQ</td>
<td>184.6</td>
<td>A-286</td>
<td>1.114</td>
<td>2.0</td>
<td>590</td>
<td>AMS5732H</td>
<td>0.43</td>
<td>2.6</td>
<td>900</td>
<td>AMS5732H</td>
<td>0.68</td>
<td>F-8.6-61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifting Clevis (Tension)</td>
<td>N/A EQ</td>
<td>86.0</td>
<td>6061-T6</td>
<td>1.1144</td>
<td>2.0</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>0.26</td>
<td>2.6</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>0.11</td>
<td>F-8.4.48</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>EMI Skirts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulk Stresses</td>
<td>Nov-01 Lift</td>
<td>47.9</td>
<td>6061-T6</td>
<td>1.1138</td>
<td>2.0</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>1.26</td>
<td>2.6</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>0.99</td>
<td>T-8.3-39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMI Inserts (1/4&quot;)</td>
<td>Nov-01 Lift</td>
<td>324.7</td>
<td>Helicoil</td>
<td>1.114</td>
<td>2.0</td>
<td>1100</td>
<td>Vendor DS</td>
<td>0.52</td>
<td>2.6</td>
<td>1240</td>
<td>Vendor DS</td>
<td>0.32</td>
<td>S-8.6.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMI Skirt Fasteners (1/4&quot;)</td>
<td>Nov-01 Lift</td>
<td>324.7</td>
<td>A-286</td>
<td>1.114</td>
<td>2.0</td>
<td>1100</td>
<td>AMS5732H</td>
<td>0.52</td>
<td>2.6</td>
<td>1240</td>
<td>AMS5732H</td>
<td>0.32</td>
<td>S-8.6.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-LAT Plate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substrate</td>
<td>Sep-03 Lift</td>
<td>67.7</td>
<td>6061-T6</td>
<td>1.1133</td>
<td>2.0</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>0.60</td>
<td>2.6</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>0.41</td>
<td>S-8.5.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pocket Stresses</td>
<td>Sep-03 Air</td>
<td>67.7</td>
<td>6061-T6</td>
<td>1.1133</td>
<td>2.0</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>0.60</td>
<td>2.6</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>0.41</td>
<td>S-8.5.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Pipes</td>
<td>Sep-03 Air</td>
<td>38.7</td>
<td>6061-T6</td>
<td>1.1133</td>
<td>2.0</td>
<td>241</td>
<td>MIL-HDBK-5J</td>
<td>1.80</td>
<td>2.6</td>
<td>276</td>
<td>MIL-HDBK-5J</td>
<td>1.46</td>
<td>S-8.5.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-LAT #8 Fasteners (shear out)</td>
<td>Sep-03 Air</td>
<td>112.3</td>
<td>6061-T6</td>
<td>1.1133</td>
<td>2.0</td>
<td>365</td>
<td>MIL-HDBK-5J</td>
<td>0.46</td>
<td>2.6</td>
<td>476</td>
<td>MIL-HDBK-5J</td>
<td>0.46</td>
<td>A-p.342</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1/ Shear loads at Calorimeter tabs previously analyzed
2/ Test Required; does not meet GEVS QBA: C=Coupon; X=GSLT; SS=Subsystem
3/ Test Safety factor built into stress calculation
Appropriately tested at lower levels of assembly

• LAT Instrumentation Plan → LAT-TD-00890-03
  – Flight and ground instrumentation defined
• LAT Dynamics Test Plan → LAT-MD-01196-03
  – Sine Vibration, Acoustic, and Mass Properties tests described
• All lower level flight system verification activities have been satisfactorily completed and all discrepancies are sufficiently understood to warrant proceeding
  – Engineering Test Unit testing since CDR are documented and the design reflects the results
    • Coupon Tests
      – Insert pullout and shear strength (keensert, helicoil, potted inserts, bare threads)
      – torque to preload ratios
        – [Link to coupon tests]
• Flight-like coupon tests
  – Grid wing corner
  – Grid EM1X4 Stiffness Verification Test → Complete → LAT-TD-02417
    – [Link to Grid EM1X4 Stiffness Verification Test]
• CAL EM Vibration Test → Complete → LAT-TD-01888
• TKR EM Vibration Test → Complete → LAT-TD-04310
• SC Flexure Strength and Stiffness test → Complete → LAT-TD-07813-01
 Appropriately tested at lower levels of assembly (cont.)

- **Subsystem tests**
  - ACD Static, Dynamic and Modal Test → Complete
  - Flight-Spare Grid4X4 → Complete
    - Strength Test → Complete → LAT-TD-07813-01
    - Static Stiffness Test → Complete → LAT-TD-07813-01
    - Dynamic Stiffness Test → Complete → LAT-TD-07813-01
  - Radiator Tests
    - Acoustic Test → Complete
    - Static Test → NOT COMPLETE → To be performed at NRL prior to LAT acoustic
      - Test Plan → LAT-TD-08047
      - Test Procedure → LAT-TD-08118
Appropriately tested at lower levels of assembly (cont.)

• Notable fabrication discrepancies and resolution
  – TKR EM Tower failure and other anomalies
    • Numerous issues were uncovered during the post-CDR development of the tower. These issues are all documented on the TKR website:
    • Some anomalies include: Sidewall fastener torque, stress corrosion cracking concerns, pitch adapter failures, wire bond failures, bias circuit delamination
      – Shear plates are held in place by a captive stud and nut. The original nut manufacturing caused galling which could lead to stud failure. Resolution: do not remove defective nuts unless necessary. If necessary, split nut to preserve stud.
      – EBOX SIU RAD750 EEPROM failure – root cause determined to be substandard chip underfill
Passes comprehensive systems test

- Initial flight system comprehensive performance testing has established a valid performance baseline that complies with requirements
- Composition of test and results
Pre-test analysis

- Analyses used to develop test plans are complete
- Sine Vibration Pre-Test Analysis → LAT-TD-08115
  - Frequency response analysis complete
  - Estimated notching calculations complete
  - Spreadsheets for real-time data reduction complete
- Acoustic Vibration Pre-Test Analysis → LAT-TD-08116
  - Acoustic analysis in test configuration complete
  - Spreadsheets for real-time data reduction complete
- Mass Properties Pre-Test Analysis → LAT-TD-08117
  - Mass properties spreadsheet with latest measured data complete
  - Spreadsheets for real-time data reduction complete
Pre-test analysis

- Pre-test analysis example results

![Response X (ALL)](image1)

- Specification Input Acceleration
- Notched Input (notch below 50Hz)

![Response Y (ALL)](image2)

- Specification Input Acceleration
- Notched Input (notch below 50Hz)
Environmental Test Flow

- The mechanical tests, highlighted in red boxes, are part of the environmental test sequence, shown below (see LAT-MD-02717):

![Diagram of the environmental test flow]

- Baseline
  - at SLAC

  - Ship to NRL

- NRL Post-Ship
  - Receive, Unpack

- Sine Vibe
  - Pre Axis
  - Post Axis

- Mount Radiators

- EMI/EMC
  - Pre Axis
  - Post Axis

- Acoustic
  - Pre Axis
  - Post Axis

TESTING IN THERMAL VAC CHAMBER

- Limited Performance Test (L)
- Comprehensive Performance Test (C)
- SVAC Test (S)
- LAT Functional and FSW Test (F)
- TCS Functional Test (T)
- EMI/EMC Emissions/Susceptibility Test (E)
Environmental Test plans and procedures

• Planning is adequate for all mechanical environmental tests
  – A comprehensive environmental test sequence at appropriate exposure levels is planned that will complete all remaining required verification activities
    • Protolflight Sine Vibration Test Procedure
      – LAT-TD-08112
    • Protolflight Acoustic Vibration Test Procedure
      – LAT-TD-08113
    • Mass Properties Test Procedure
      – LAT-TD-08114
• Adequate systems performance testing is planned during and between environmental exposures so as to ensure adequate functionality or uncover any deviations
• Adequate testing for primary and redundant elements is planned
Facilities readiness and certification

- Facility readiness reviews have been completed
- Resultant actions are on track for timely completion
- Handling equipment and test equipment are qualified and ready for use.
- Contamination control plans and required equipment are in place and compliant with requirements
- Integrated LAT testing is scheduled at NRL
- All mechanical test laboratory equipment calibration is current
- The test facilities are fully certified
Manpower

• Remaining activities
  – Complete Radiator Strength Test Procedure and Execute Test
  – Complete all Test Procedures based on completed Pre-test analysis and Test Plans
  – Hold TRR for Mechanical Tests

• Available resources
  – John Ku
  – Marc Campell
  – Mark Molini
  – Jim Haughton
  – Bob Haynes
  – Bill Raynor
  – Paul Baird
  – Chris Fransen
Readiness Statement

• Work to be performed prior to environmental test
  – Complete Test procedures ➔ May 19, 2006
  – Hold Test Readiness Review ➔ May 19, 2006
  – Caveat: Radiator proof test will be performed some time during environemntal test, i.e. prior to radiator integration at NRL (environmental test readiness is not affected by completion of the radiator static strength test)

• Pending completion of the above items, the integrated LAT will be ready to enter mechanical environmental tests to complete all remaining required verification activities