Marshall Space Flight Center

Systems Analysis

National Aeronautics and Space Administration

Mass Properties
For Space Systems
Standards Development

To be Presented at 2013 Society of Allied Weight Engineers Annual Conference,
St. Louis Mo.
Overview

♦ Brief History of AIAA S-120-2006 and ISO 22010 Mass Control Standards for Space Systems

♦ Time for “Renew or Revise” for both AIAA and ISO

♦ AIAA S-120-2006 – CoS chaired by Louis Chang
  ♦ Polling indicates ‘revision’ is appropriate for S-120.
  ♦ Potentially to seek ANSI status

♦ ISO 22010 – chaired by Ian McNeil
  ♦ Draft developed and suspended pending update to S-120.
  ♦ ISO may request adoption of AIAA S-120 Rev A
Focus Areas for Updates

♦ AIAA S-120-2006 & ISO 22010

1. Rework use of “shall” and “should” to be more appropriate
   • Shall is contractual language requires verification
   • Will indicates expected outcomes
   • Should indicates guidance

2. Clarify relationship between MGA categories A5 and A6 relative to mass specification language.

3. Mass margin recommendations for LV’s (does not include recommendations for non-mass concerns)

4. TPM (monitoring) – articulation between Basic & Predicted Mass, Potential Changes (forecast) and Aggregate Mass Maturity by Mass Maturity Category

5. MGA schedule (maturity definitions, range of values)
Uncertainty: MGA and Specification Correlation

Expected development maturity under contract (spec) should correlate with Project/Program Approved MGA Depletion Schedule in Mass Properties Control Plan

- If specification NTE, MGA is inclusive of Actual MGA (A5 & A6)
- If specification is not an NTE Actual MGA (e.g. nominal), then MGA values are reduced by A5 values and A5 is representative of remaining uncertainty
Mass Margin for Launch Vehicles

Current Verbiage in S-120
Applies to Dry Mass

Mass Margin is difference between Required Mass and Predicted Mass.

Performance Margin is difference between Predicted Performance and Required Performance

♦ Performance estimates and corresponding margin should be based on Predicted Mass (and other inputs)
♦ Contractor Mass Margin reserved from Performance Margin
♦ Remaining performance margin allocated according to mass partials
Mass Monitoring for Compliance (TPMs)

- Compliance can be evaluated effectively by comparison of three areas (preferably on a single sheet)
  - Basic and Predicted Mass (including historical trend)
  - Aggregate potential changes (threats and opportunities) which gives Mass Forecast
  - Mass Maturity by category (Estimated/Calculated/Actual)

<table>
<thead>
<tr>
<th>MGA Code</th>
<th>Maturity</th>
<th>Predicted Mass</th>
<th>Design Status Weight % of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-1</td>
<td>Estimated</td>
<td>4,100</td>
<td>4.1%</td>
</tr>
<tr>
<td>E-2</td>
<td>Layout</td>
<td>1,100</td>
<td>1.1%</td>
</tr>
<tr>
<td>C-3</td>
<td>Preliminary Design</td>
<td>20,100</td>
<td>20.6%</td>
</tr>
<tr>
<td>C-4</td>
<td>Released Design</td>
<td>23,900</td>
<td>23.9%</td>
</tr>
<tr>
<td>A-5</td>
<td>Existing Hardware</td>
<td>50,300</td>
<td>50.3%</td>
</tr>
<tr>
<td>A-6</td>
<td>Actual Mass</td>
<td>0.00</td>
<td>0.0%</td>
</tr>
<tr>
<td>A-7</td>
<td>Customer Furnished Equipment</td>
<td>0.00</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Threats and Opportunities List sorted by level of concern (likelihood, consequence) summed for Aggregate.