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

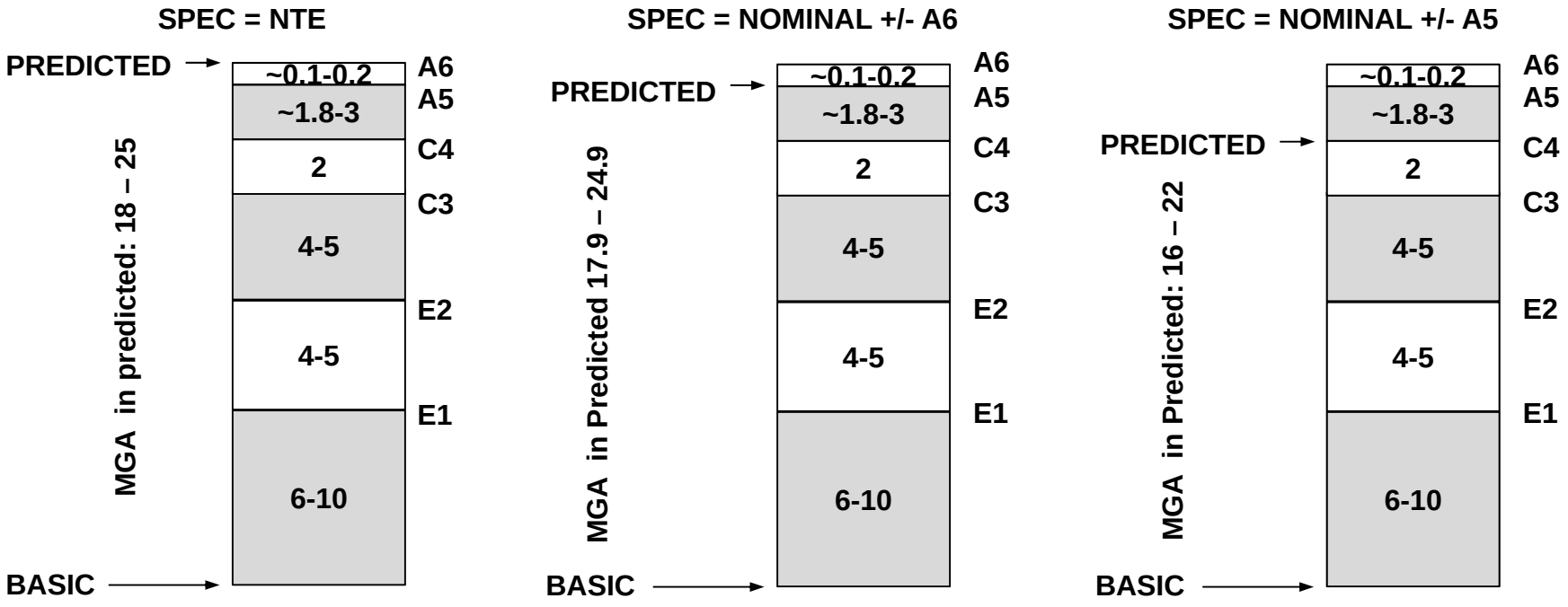
Focus Areas for Updates

- **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

Table 2 — TPM - Guidelines for Mass Assessment

Program Milestone	MGA		Recommended Dry Mass Margin	
	%[1]	Grade	%[1]	Grade
ATP	> 15	Green	> 15	Green
	9 < MGA ≤ 15	Yellow	10 < Mass Margin ≤ 15	Yellow
	≤ 9	Red	≤ 10	Red
SRR	> 15	Green	> 12	Green
	9 < MGA ≤ 15	Yellow	6 < Mass Margin ≤ 12	Yellow
	≤ 9	Red	≤ 6	Red
PDR	> 12	Green	> 9	Green
	8 < MGA ≤ 12	Yellow	5 < Mass Margin ≤ 9	Yellow
	≤ 8	Red	≤ 5	Red
CDR	> 7	Green	> 5	Green
	4 < MGA ≤ 7	Yellow	3 < Mass Margin ≤ 5	Yellow
	≤ 4	Red	≤ 3	Red
Drawing Release Complete	> 3	Green	> 2	Green
	2 < MGA ≤ 3	Yellow	1 < Mass Margin ≤ 2	Yellow
	≤ 2	Red	≤ 1	Red
Final	0		> 1	

[1] The percentages of MGA and Margin in the above chart are defined as follows:

MGA = predicted dry mass - basic dry mass
MGA % = (MGA/basic dry mass) * 100
Mass Margin % = [(allowable dry mass – predicted dry mass)/predicted dry mass] * 100

Current Verbiage in S-120 Applies to Dry Mass

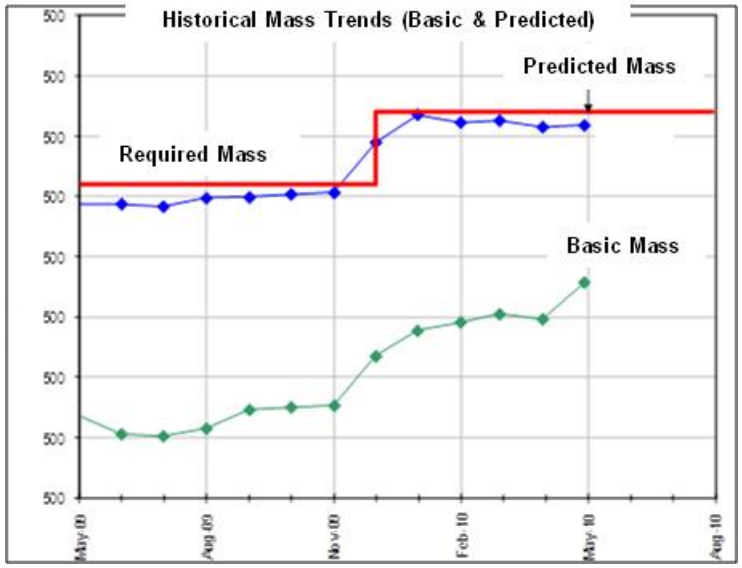
Mass Margin is difference between Required Mass and Predicted Mass.

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)



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

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