
Non-Optimal SSME Trim OMS Mass I-Load Selection

FDD AR # 2009-CAF032 / NCR #015170

FOIG

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Anomaly Description

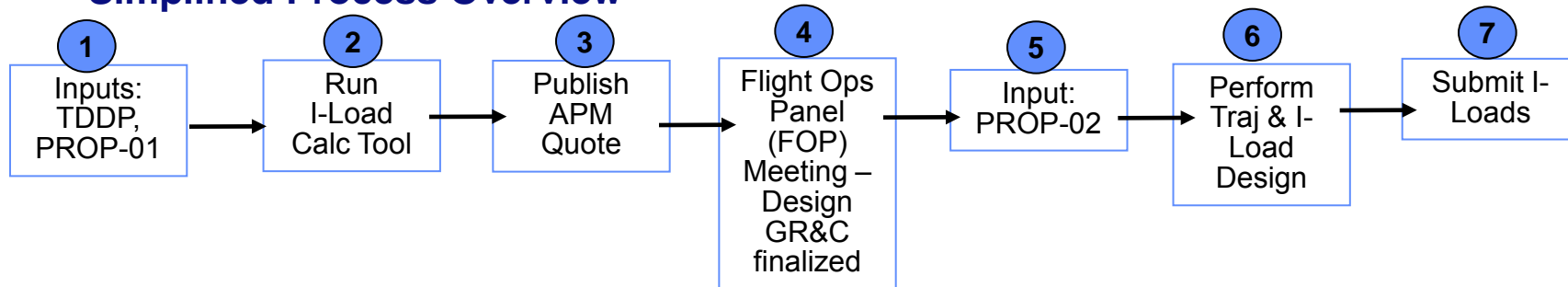
- For STS-130, the value for the OMS Mass I-Load (MASS_OMS) that is used in the ascent DAP to compute SSME trim adjustments was designed without subtracting the amount of OMS propellant consumed during the Nominal OMS Assist burn.
 - The burn should have been included per standard Flight Design process.
 - Originally designed value = 707.40 slugs
 - Properly calculated value = 587.06 slugs
 - Other I-Loads and simulation inputs used to configure and execute the actual Nominal OMS Assist burn were implemented correctly
- Background – MASS_OMS, in conjunction with other mass/CGx/CGz dependent I-Loads, is used to support the Ascent Digital Auto Pilot to compute and track the vehicle CG as a function of mass to calculate the pitch thrust vector deflection trim.
- Originally designed value was submitted by Flight Design into the STAR I-Load database as part of I-Load Occurrence Data Change Report (IOC DCR) #5814.
 - Prior to submittal, value was assessed against standard GN&C trajectory QA criteria and passed

Anomaly Description (continued)

- **Discovery of the issue**
 - I-Load computation was questioned during the Boeing Flight Readiness Verification (FRV) assessment, which is performed between Flight Design's I-Load Submit and I-Load Approval at the SASCB.
- **Short-term corrective action**
 - Before SASCB I-Load Approval, Flight Design decided to submit an updated value which properly incorporated the Nominal OMS Assist burn (IOC DCR #5814A).
 - Recomputed value showed good comparison to Boeing's computed value
 - STS-130 I-Load occurrences, including the updated value, were approved at the SASCB on 5/21/2009.
 - I-Load Approval occurred per original schedule.
- **Impact – What happened as a result of the issue?**
 - Issue was discovered and fixed prior to I-Load Approval
 - No impact to downstream processes (e.g., FSW build)
 - No impact to program milestones (e.g., I-Load Approval)

Causes – How was the error introduced?

- **Simplified Process Overview**



- **Step 2 – I-Load calculation tool is set up to automatically extract inputs from PROP-01**
 - In this case, tool was inadvertently run one day before PROP-01 was delivered
 - Generator workload, and unclear procedures contributed
 - So, OMS Mass I-Load was initially designed without a key input (OMS assist amount)
 - Issue was not discovered (no cues in software output)
- **Step 3 – The next day, per standard procedure, the OMS Assist timer from PROP-01 was manually incorporated into the trajectory simulation for the APM quote**
 - In hindsight, doing so helped make the trajectory valid and therefore actually served to mask the problem
- **Step 6 – Generator verified that there were no changes between PROP-01 and PROP-02**
 - Did not re-run the I-Load calculation tool (since it had already been run in Step 2)
 - Did not realize that the PROP-01 input had not been extracted
 - Procedures did not explicitly ensure that the I-Load was properly updated in the post-FOP time frame, using the key inputs

Causes – Why did FDD QA fail to discover the error?

- I-Load, as originally designed, resulted in trajectories that were within acceptable and approved tolerances – no “red flags”
 - Trajectories were assessed against standard GN&C trajectory QA criteria and passed
- Software tool appeared to work normally
 - Results of the I-Load calculations were published, despite lack of PROP-01 input
- Procedures include optional instructions on how to perform manual I-Load calculations, but these were not completed
 - Calculations are complicated and typically not seen as value-added (that’s what the tool is for)

Potential Impact Assessment

- What could have happened as a result of the issue?
 - Trajectory design passed constraint checks with originally designed I-Load value, indicating it would have been acceptable to fly with the original value
 - Substantial I-Load and trajectory QA is already part of the process, meaning it is unlikely for an “unflyable” I-Load value to be submitted

Long Term Corrective Actions

- **I-Load and trajectory design software –**
 - I-Load Calculation tool is being modified to alert the user if the PROP input is not available

- **Procedures & QA Checklists –**
 - Process is being modified so the I-Load Calculation tool will be run twice, once after the PROP-01 is delivered (pre-FOP) and again after the PROP-02 is delivered (post-FOP)
 - Specific key input data will be recorded in the checklist (fill-in-the-blank) for QA purposes and situational awareness

- **Communicating Lessons Learned**
 - Lessons learned from this experience have been shared via standard FDD Anomaly Reporting process