

MAY 23, 1983

DA8/Chief, Ascent/Entry Flight Techniques

STS-7-11 Ascent/Entry Flight Techniques Panel Meeting #2 Minutes

The second meeting of the Ascent/Entry Flight Techniques panel was held on - April 22, 1983. NASA Headquarters, Draper, DFRC, and Rockwell participated via teleconference.

Summary

- a. Conducted a review of software modifications affecting ascent.
- b. Reviewed and accepted proposed pre-MECO dumps for STS-9 and 11.
- c. Reviewed proposed ascent/entry DTO's. Directed deletions of STS-8 post-MECO +X maneuver. (No ET photography.)
- d. Baselined proposed entry cg placard.
- e. Baselined alternate elevon schedule (with heavy weight body bending filters) for all entries with payload attached.
- f. Baselined one of the two required crew charts for onboard ascent OMS target selection. CB is to recommend choice on the other (STS-9 and 11).
- g. Determined all entry cg's for STS-7 and 9 within placard limits.

1. Ascent Software Differences from STS-6 - RIC/B. Schletz

The purpose of this review was to identify whether any of the approved software change traffic would affect either FDF or basic techniques for ascent. The following is a description of only the significant part of the discussion.

- a. STS-7 - Although a CR to provide "wings level" TAL was implemented for the BFS (only) for STS-7, no differences will be observable to the crew because on STS-7 the TAL site lies on the groundtrack. A "small" (1 or 2 degree) attitude offset might exist momentarily if a BFS engage occurs.

Another change which reduces the q alpha transient for engine outs around 60 seconds was also described. Fading logic was added which was said to accomplish an approximate 50 percent reduction in the expected pitch transient.

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- b. STS-8 - TAL wings level capability is to be added to the BFS, again no big deal, since TAL is to go to Dakar, thus no yaw steering. ŠA change to cause the center SSME to be commanded parallel in pitch for second stage allows a 600 lb. performance improvement. The engines will again go unparallel at approximately MECO -60 seconds (based on a mass I-load). Just after staging, a 4-5 degree attitude transient at about 1.deg/sec results as the center SSME pitch is adjusted. An I-loaded discrete is available to inhibit this function (for vehicle 103) because the aft heat shield on the vehicle may not be qualified.

New guidance logic to adapt the level to which the SSME's are throttled back in the thrust bucket will show up for the first time for STS-8.

A manual procedure to keep the MCC abort region determinator (ARD) corrected for its lack of adaptive throttling will be used for STS-8. The ARD will be automated for STS-9 and subsequent. We must come up with appropriate means to handle stuck throttle cases and how to adjust the pitch profile for them.

Action: 04/22-001 - FM4/M. Henderson (STS-8) - Provide sensitivities and options for handling stuck throttle cases for STS-8 and subsequent considering "new" adaptive guidance scheme. Due: June 3, 1983, AEFTP

c. STS-9 - An ascent guidance onboard display cue has been added. (to the BFS only) to show whether guidance has converged (both nominal and BFS). Also the capability to force the BFS into the flyback phase of RTLS guidance was also added. On tap, (but not approved yet) is a CR to change the initial commanded guidance roll rate to 15 deg/sec.

Since STS-9 is the first flight where energy is required out-of-plane to achieve TAL, the "wings level" software change previously discussed will first be an operational factor for that flight. The optimum time to achieve the roll has not been picked, so MPAD was asked to come back with a story.

Action: 04/22-002 - FM4/M. Henderson - Provide recommendations for optimum time to roll heads up for TAL. Due: June 3, 1983, AEFTP

The time selected has ET heating implications.

d. STS-11 - There were no new software changes identified for STS-11. Although Mr. Henderson mentioned they are working on development of a winter I-load set.

e. RTLS Improvement Software Changes - MPAD has several proposed improvements, all of which need to be considered with how they might drive MCC software design.

f. New GN&C Flight Software Changes - RIC/J. D. Townsend

Mr. Townsend related several changes to us; the only significant one to the flight invokes a sequencing change that automatically stops the RTLS RCS 4 jet dump if it is not completed before moding to MM603. (Approved for STS-7.)

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Action: 04-22-003 - DF6/R. Fitts (STS-7) - Assure that dump monitor cue card accommodates new flight software that stops 4 + X RCS dump if in 603 before dump is complete.Š

2. OMS Targeting Options - FM4/M. Henderson

The targets available for OMS-1 and 2 for ascent for STS-7, 8, and 11 are the same that have been used to this point in the program. However, for STS-11, a pre-MECO OMS dump for ATO of fixed duration is added so that greater than a 55 nmi altitude after OMS-1 is protected. This means we should (and will) add a ground call that lets the crew know a pre-MECO dump is no longer necessary to achieve an ATO orbit.

For STS-9, three more targets are available (ATO, AOA, AOA's) covering 270 to 470 fps underspeeds. These are all shown in enclosure 1.

Also a pre-MECO ATO dump is required for STS-9 to ensure a water impact for the

ET. The dump is of variable length depending on V EOUT. Thus a "no dump ATO" or equivalent call is also needed for STS-9.

The request to baseline Torrejon as the TAL site for STS-9 has been forwarded to Headquarters. Also available in the onboard targets is a manual TAL capability to Frankfurt.

3. Onboard Ascent Targeting Procedures - DH3/C. Lewis

The FDF contains a set of charts that the crew would use if data from the MCC were not available to select OMS 1 and 2 targets. For STS-7 and 8 no changes to the charts are required because targeting options and philosophy remain the same as for STS-6. Since STS-11 has a fixed pre-MECO OMS-1 dump, dual delta V of OMS-1 scales will be added to cover both "dump" and "no dump" cases.

Since STS-9 will dump a variable amount of OMS pre MECO for ATO, Mr. Lewis developed and presented a new set of charts to cover that case. The proposal would use remaining OMS and OMS-1 delta VTOT and target Hp to pick OMS-1 targets. (Problems with the OMS gauges are expected to be resolved by STS-9.) An alternative is available that would use percent OMS and current Ha. The main differences are that the former is a little harder to use because it takes three inputs, but accommodates dispersions whereas using Ha takes only two inputs, but does not accommodate errors in gamma. Mr. Lewis recommended we baseline the use of percent OMS versus Hp for the OMS-1 target selection, but we delayed the decision until the crew has a chance to evaluate the choice.

Action: 04/22-004 - CB/D. O'Conner - Provide CB recommendations on preference for Ha or Hp charts for selection of OMS targets.

If OMS-1 was ATO, a graph for OMS-2 selection was proposed which uses OMS percent remaining and current Hp. Techniques agreed with and accepted the proposal.

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4. Ascent/Entry DTO's that Affect Crew/MCC Techniques -LM/R. Ramsell

Mr. Ramsell presented the enclosed matrix (enclosure 2). There were no particular surprises, but we did determine that the 5 fps + X after ET SEP is not required for STS-8 because the cameras have been removed for ET photography since it is launched at night. For STS-9, it was pointed out that approximately 125 lbs of RCS propellant could be saved and applied to on-orbit use if the ET photography DTO could be deleted.

Action: 04/22-005 - DH3/P. Collector - For STS-8 only, delete post ET SEP 5 fps +X maneuver since ET photography is not required.

Action: 04/22-006 - LM/R. Ramsell- For STS-9, provide recommendation to retain/delete ET photography (a savings of approximately 125 lbs RCS). If retention, provide priority based on propellant usage of other flight activities. Due: June 3, 1983, AEFTP

The crosswind landing DTO is unscheduled, but if conditions are met we have agreed to continue to try to get it. (This is highly unlikely unless landing happens to be on a lakebed, in the daylight.)

Note that no further braking tests were proposed.

5. STS-9 and 11 EOM Landing Opportunities - FM5/J. West

The landing opportunities for STS-9 are enclosure 3. Planned landing will

occur on rev 145 (day 10) at 45 minutes after sunrise with crossrange of 688 nmi. A one orbit backup rev is available 2h + 17m after sunrise with a crossrange of 214 nmi. Should we pick a descending rev. about 30 ft/sec more delta V is required for deorbit. Max. vehicle capability for crossrange for STS-9 is 747 nmi for PTI's and 790 nmi without entry PTI's.

The STS-11 landing opportunities were presented, but they did not include recent trajectory changes, so they need to be reworked. Crossrange capabilities are 708/751 nmi with/without PTI's maximum.

6. Abort and EOM Landing Sites Proposal - DH3/W. Bolt (enclosure 4)

Mr. Bolt presented MOD's proposed criteria for selecting landing sites for missions through STS-11. Most criticized was our choice of 210K lbs as the upper weight limit for crosswind DTO or a concrete landing. Admitting that we had been arbitrary (somewhat) we agreed to go back to the drawing boards. Of paramount importance here is an early determination of nominal braking procedures.

7. Ferrying and Turnaround Impact for FWD RCS PROP

Deferred until next meeting.

8. STS-7-11 CG Placards - RIC/C. Unger

The placards proposed by Mr. Unger are the same as were used on STS-6 except a modification was allowed because the bent airframe assumptions can be halved since there was no evidence of same on STS-6. Thus both OV-099 and 102 have the same placard criteria. Enclosure 5 is the new placard along with

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expected cg's for STS-7 and 9. The forward cg limit is still 1083 inches, but is now determined by the M = 1.7 inch stability limit. Increasing the minimum limit to 16 degrees has allowed the static limits to far exceed the CEI spec X and Y cg limits. Therefore, aft X and Y are now constrained by specification, forward X by the M = 1.7 stability. Review of STS-6 and 8 aero data has the potential to allow the forward limit to be expanded even further. (Next stop, 1/4 Hz oscillation limit). A speedbrake deflection DTO is in the discussion stages for STS-9 to better understand the 1/4 Hz phenomenon. Aft hinge moment limits (for example GRTLS at 1117 inches) can be defined, but thermal studies for the body flap and elevons can no longer be done (contractual reasons). Previously, RIC has evaluated control surface temperatures for all aft cg flights with their weights and elevon schedules. As can be seen from the enclosure, no combination of retained payloads exceeds cg limits for STS-7. Also no exceedances are expected for STS-9.

9. Bending Filter Recommendations - RIC/P. Hamilton

Mr. Hamilton's recommendations for STS-7, 8, and 9 were as follows:

| | STS-7 | STS-8 | STS-9 | STS-11 |
|--------------|--------|--------|-------|--------|
| P/L Deployed | EITHER | EITHER | N/A | EITHER |
| Not Deployed | EITHER | HEAVY | HEAVY | EITHER |

Note that the STS-8 mission studied was the IUS/TDRS baseline.

10. Entry Elevon Schedules - Proposal - EH2/M. Contella

Mr. Contella's recommended elevon schedule selection was as follows.

(Remember, elevon and bending filter are selected by single item entry):

| | STS-7 | STS-8 | STS-9 | STS-11 |
|--------------|-------|-------|-------|--------|
| P/L Deployed | NOM | NON | N/A | NON |
| Not Deployed | MOM | HEAVY | HEAVY | MOM |

Flight Techniques baselined the "heavy" (alternate) bending filters and elevon profiles for all payload attached cases through STS-11. This minimizes procedure changes between missions and is always conservative with respect to body flap temperatures. Also, small exceedances of shaping temperature limits are alleviated, so specific studies are not needed. Baselineing this way does cost the aero folks 1 degree up elevon data in the high Mach region for the specific mission that enters with the payload attached.

The cue cards contain a check of the filter selection if aerosurface oscillations are evident during entry. (Which could occur on STS-8 and 9 if the "wrong" (nom) filter is selected.) This check is not needed for STS-7.

Action: 04/22-006 - CB/B. O'Conner - Update entry cue card for aerosurface oscillation case such that card will generically cover all missions. Not mandatory for STS-7.