

DA8/Chairman, Ascent/Entry Flight Techniques

Ascent/Entry Flight Techniques Meeting #16 Minutes

The 16th meeting of the Ascent/Entry Flight Techniques Panel was held on May 23, 1985. NASA Headquarters, DFRC, and Rockwell-Downey participated via teleconference.

1a. PTI Schedule for STS 51-G and STS 51-F - EH2/L. B. McWhorter

The PTI schedules presented for STS 51-G and STS 51-F (enclosure 1) are identical and the same as the schedule that was to be performed on STS 51-B. There are 11 PTI's loaded however, the first has been I-loaded out because of its potential interference with the first roll maneuver and with guidance which will be initiated at a lower Q-bar (7-8 PSF). The crew will see the first PTI come up on the display and remain until Q-bar equals 35 PSF at which time software will switch to maneuver 2. The remaining PTI's will continue as scheduled. Some concern was expressed that the crew may need a reminder not to expect a PTI #1 maneuver. A note will be added to the checklist as a reminder.

For STS 51-F at the end of PTI #3, a manual body flap pulse has been added. Basically, at the end of the elevon kick between M=19 and M=17, the crew will select CSS in roll and yaw, manually drive the body flap, center the error needles and then go back to auto. The procedure is to be verified in the SES prior to being approved for flight.

It was also pointed out that the PTI's for STS 51-F that will be actually flown will not appear in the training loads (contains STS 51-D PTI's) until the final load, 3 weeks prior to launch. The crew and flight control teams will not have the opportunity to train with the proper PTI's for these flights.

Action: 05/23-001 - EH2/L. B. McWhorter - Evaluate STS 51-F body flap pulse DTO and determine that no failure cases exist that would prevent recovery thus causing a potential safety hazard.

Action: 05/23-002 - DF6/R. E. Yakovetsky - Add crew takeover criteria to flight rules.

-1-

1b. RCS Critical Cue Card - DF6/R. E. Yakovetsky

The issue presented was to decrease the "No Yaw Jet" redline by 40 pounds because of DAP gain changes. Forty pounds of propellant was allocated to protect for a 1/4 HZ oscillation. This is no longer a concern. Additional propellant is available because of the rudder becoming effective at M=4.2 Instead of M=3.2.

Mr. Yakovetsky agreed to change the RCS critical cue card for STS 51-F to reflect these changes.

Reference enclosure 2 for supporting data.

2. Elevon Schedule and Bending Filter Requirements for STS 51-G and STS 51-F  
- DH2/L. B. McWhorter

The STS 51-G elevon schedule (see enclosure 3) shows the "nominal" elevon position is equal to 0 degrees from El until M15 then goes to 2 degrees down until M=.9. The alternate schedule is the same as an STS 51-A. It starts at 4 degrees up at El and increases to 6 degrees up at M=12, where it remains until M=8, then returns back to 4 degrees up until M=3.5 and then ramps to 8 degrees up until M 1.5. From M 1.5 to M=.9 it ramps down to 2 degrees and remains constant.

The "nominal" schedule will be used for c.g.'s aft of 1088 inches. Since both STS 51-G and STS 51-F have c.g.'s forward of 1088 the "alternate" schedule will be used. The Aero folks prefer the alternate schedule for PTI's to verify the forward c.g. box with uncertainties.

The STS 51-F elevon schedule (see enclosure 4) will be the first time that the "operational" schedule has been flown. This will be the baseline schedule for STS 51-I, STS 61-A, and STS 61-B. The basic difference in this schedule is that the elevons are commanded up 7 degrees whereas on STS 51-G they are commanded up 6 degrees. This additional 1 degree difference allows a 1 Inch difference in c.g. location between the STS 51-G and STS 51-F nominal elevon schedule switch points, i.e., 1088 and 1087 respectively.

This schedule was designed to handle all flights with forward c.g.'s up to 1076.7 Including a 1 inch uncertainty in mass properties.

The bending filter selection/management is basically a simple one. For STS 51-G if it becomes necessary to return any of the payloads, then the (heavy weight) "payload/ascent" filters should be selected. If all of the payloads are deployed then the (light weight) "entry" filters will be used.

In the case of STS 51-F we will want to use the heavy weight "payload/ascent" filters in all cases.

A flight rule has been added to the All Flights Book (reference rule 8-58) that states that the "payload" bending filter will be used for all cases when returning payloads weigh greater than 10,000 pounds.

-2-

3. Dial-a-Site - DM6/N. E. Combs; DM3/J. K. Patterson

Dial-a-site software has been implemented in the 01-6 software. This provides the Orbiter with the capability to land at 16 different sites for STS 51-G. This simplifies the nominal end-of-mission landing procedures, greatly enhances emergency deorbit capability, and provides downrange abort options. There are a total of 15 areas with two runways per area with a primary and secondary TACAN for each runway. The software has six MLS sites loaded for STS 51-G. The software can handle 10 MLS stations. Two different landing site runways and TACANS can reside in the same area. Only runways and TACAN can be uplinked to an area. To support dial-a-site requires changing some of the current procedures.

For ascent a TAL underburn sites and an overburn site is included in the runway site selection. For STS 51-G, a low inclination flight, Amilcar Cabral (AML), serves as TAL underburn site to Dakar if cutoff VI is <22.8K, and Kinshasa (KIN), serves as the overburn TAL site if VI cutoff is >24.3K but AOA capability is not achieved.

Sites other than the prime TAL site are considered contingency abort sites. They require using the manual TAL procedures for completion. All MCC abort criteria is based on the prime abort regions. The contingency abort sites are not exercised in integrated simulations and no weather requirements for launch exist. These sites will be included on the prelaunch weather sheets but, will not be briefed in the prelaunch crew weather briefing.

For orbit operations, landing opportunities for the Emergency Landing Sites (ELS) will be provided onboard by SPOC. The MCC has all the sites loaded in the landing site table and can compute a deorbit target solution. An ELS is available every orbit for an emergency deorbit. Every 12 hours a weather forecast for the landing opportunities for the next 12 hours will be uplinked to the crew. The message will not include the downrange abort sites or any site the weather office does not receive weather forecasts or current weather (see enclosure 5). For STS 51-G this leaves 10 sites which are five additional over the current requirement. The message will cover a forecast for the landing opportunities only during the 12 hour time period. If a site has no opportunities it will not be listed. The FDO will supply the weather office with the landing time for each site during the 12 hour time period. FDO's have an HP program that supplies this data and a printout will be available at the FDO console and on the FD entry board. The message is structured by site and forecast by MET time, not by orbits. This is similar to the STS SIC weather messages. The message will also include any significant NOTAM updates. The LSO will receive a daily status from the FAA. If the runway is closed or TACAN is down, this information will be included at the bottom of the message. No message updates between 12 hour uplink time periods will be required. The change of shift weather briefings will cover the CONUS sites only.

Entry operations become simpler with dial-a-site. Since EDW, KSC, and NOR runways, TACAN and MLS channels are in the table crew procedures do not require any OPS 3 to 2 moding for landing sites and MLS. All EDW runways are not covered in the low inclination table (see enclosure 6) therefore for north winds or energy downmode runway an uplink will be required predeorbit burn. The energy downmode will be uplinked in place of NOR 05 in area 10

-3-

and the north runways, if required, will be uplinked into area 11 in place of Diego Garcia. No uplink will be required for a deorbit underburn on STS 51-G, since NOR runways are already loaded in this landing site table and there is no underburn site for a KSC landing at low inclination. NOR pre-šbank table for nominal end-of-mission will be developed prelaunch. For a high inclination mission one underburn site will be uplinked in area 15. The site will support the planned nominal end-of-mission site. The prebank tables will be developed prelaunch. No weather alternate or real-time flight updates will be made.

#### 4. Aim Point Evaluation - DM5/J. V. West

This item was deferred to a future meeting.

KSC had said that they would like to hear the aim point discussion as soon as possible because they are presently installing a 7500 foot boardwalk to the high wind aim point off the end of runway 33. We are in the process of modifying the high wind aim point and have been trying unsuccessfully to get this to Flight Techniques for several months. This also affects all of our braking discussions. We recognize the impact this will have and we hope to have this on the agenda in the very near future.

5a. MPS Dump DTO Crew Procedures - DF4/J. L. Borrer

Flight Techniques was asked to assess the validity of a MPS dump DTO, that reconstructs the manual TAL dump and inerting, and to address how we would implement it when it is manifested on a flight. An automatic dump will be added to the 01-7 software for TAL MPS dumps. Present thinking is to do it on flight STS 51-F. It has to be done on a direct insertion flight and prior to STS 61-B. Flight STS 61-B would have a TAL landing weight of greater than 240K pounds without an MPS dump capability.

After MECO and ET SEP, the plan is for the MCC to caucus for 2 minutes to determine that there are no open items that must be cleaned up post MECO prior to doing the DTO.

Mr. Borrer presented the procedure (see enclosure 7) pointing out the critical areas. At ET SEP +2 minutes the CDR will cycle the DAP from "manual" then "auto" and do a 10 second +X settling burn (also allows further separation from the ET.

After the +X burn, the PLT starts the procedure and a stop watch. At 30 +-5 seconds elapsed time, he stops the dump and closes the NOV's by placing the six engine power switches to "off." This time period is relatively critical because we are duplicating what the software will do.

For the next 2 minutes the APU's remain powered to allow the engines to be stowed and to maintain hydraulic pressure on the elevons so that the forces on the elevons, caused by the dump, can be analyzed. The 7 minute elapsed time point, simulates the coast period during a TAL abort.

A comment was made in reference to the asterisk call out prior to 7 minutes for LO2 manifold pressure greater than 40 psia. The 40 psia value has not been completely authenticated however, Rockwell reported that 30 psia has

-4-

been evaluated and If the fill and drain valves were open at that pressure, we would experience a 2000 pound force at the valve and 1000 pound force on the wing. The RCS could control these forces. The data relative to 40 psia is forthcoming. The number represented in this call out is one that with an RCS Jet failure or GPC failure, the Orbiter will not experience a control problem. If we found ourselves in the case where the pressure was allowed to rise above 40 psia, we would not open the fill and drains. Rockwell reported that the pressure would vent down through the HPOT seals in 3 hours to the 40 psia level.

The 1 minute interval between the 7 and 8 minutes allows the analysis to separate the force due to LH2 venting from that produced by LO2 venting. The remainder of the procedure simulates the manual TAL procedures.

Flight rules relative to the DTO were presented (see enclosure 8). A rule was added for the case of the loss of an SSME, with or without a guided MECO, we would not do the DTO. Rockwell said that with an SSME failure, we could not perform the DTO satisfactorily. Several questions and data requirements are included in the presentation (see enclosure 9).

Some concern was expressed relative opening the fill and drains with a manifold pressure of greater than 40 psia with the payload bay doors open and the forces imposed on the doors for this case. Rockwell could not supply an immediate answer as to whether this was a viable concern or not.

Since this presentation it has been decided that since this procedure

requires approximately 17 minutes of PLT time and is excessively complicated, It will be deferred in favor of a more concise, less time consuming and less complicated procedure to be discussed at a later meeting. The new procedure will be targeted for STS 51-I and will simulate the software that we will have in 0I-7.

5b. BFS GRTLS LO2 Dump Inhibit - Rockwell/D. Gavert

Mr. Gavert presented Rockwell's concerns for not Inhibiting the auto MPS LO2 dump which is presently in the BFS GRTLS abort software for STS 51-G.

STS 51-D (R) MPS dump DTO sequence resulted in a major roll and yaw attitude perturbation at dump Initiate. The analysis and dump model update has not been completed. For this reason, Rockwell has recommended, anti Flight Techniques concurs, that with the present data base, opening the LO2 fill and drain valves on a RTLS is an unnecessary risk that is not required for the Orbiter landing weights until STS 61-B.

Two options exist for inhibiting the dump. One method is to have the crew close the fill and drain valves 2 minutes prior to lift off. This is not acceptable because of the potential for impact to KSC prelaunch or launch abort activities. The other option is to software patch an inhibit in the BFS to bypass the auto dump initiate. Flight Techniques concurs with the latter. A CR has been written and has been forwarded to MG.

-5-

6. Review Backup Hp Requirement - DM3/J. K. Patterson

Mr. Patterson presented a proposal to delete the requirement to compute backup Hp for EDW EOM landings. The backup Hp data protects for an OMS tank failure during the deorbit burn such that the burn can be terminated at a point where a nominal entry can be made into the underburn site, in this case NOR.

It was decided to retain the backup Hp capability for the near term and possibly revisit this when we return to KSC as EOM.

7. Deselection of Elevon Feedbacks for MDM Failure - DF6/R. E. Yakovetsky

This agenda item addressed recovery from a specific 2 failure case where the crew lost control in a simulation when they experienced a FA MDM 1/0 error and an AOA power supply failure while attempting to recover the MDM by port moding. It was agreed that the probability is probably very low that such a failure would occur, but in any case the procedures should protect against a loss of control where practical.

It was agreed to modify the I/O error procedure, after step 3, for the first comm fault, (1) do I/O reset, (2) take the FCS channel off and, (3) deselect the elevon feedbacks (so that RM does not take action on it)

A 482 will be written to implement this in the checklist.

8. Review Manual Backup Procedures for Weight on Wheels - DF6/R. E. Yakovetsky

The manual procedure for setting the WOWLON logic at main gear touchdown were reviewed. The crew is concerned that in some cases they might not be able to tell exactly when main gear contact was made and to push the SRB SEP PBI early, or while the aircraft is airborne after a bounce, is unsafe. The procedure is a backup to a potential single point failure in the WOWLON

logic for the auto system. If the auto system fails to get the WOWLON signal it will not go into the flat turn logic (will try to use aileron to steer laterally) will not derotate at the proper time or rate (it will derotate almost immediately, as it attempt to maintain sink rate), and will not do load relief after nosegear contact. The CSS slapdown modification incorporated for STS-9 per CB request for more authority during derotation is also set by the WOWLON flag. The July 1983 Ames tests showed no FCS problems becoming airborne with ground FCS. Past Rockwell FSL runs determined that a delayed depression of the SRB SEP switch did not cause any significant problems. Therefore, crew can depress the button when they are sure that the main gear is firmly on the runway or take the action when the vehicle begins to derotate.

9. New Decent/Entry/Landing (DEL) Pad - DM6/G. T. Oliver

The new DEL pad changes were presented (see enclosure 10). Basically the changes are: (1) add runway area, (2) change D=4 to close loop guidance (CLG) initiate, (3) add call outs for RCS downmoding, aim point selection and speedbrake setting at 3K feet. These changes will be implemented for STS 51-G.

-6-

10. Single Engine TAL Capability Extension - DM3/D. L. Bently

The STS 51-G crew asked if there was some way we could extend the single engine TAL capability now that we have Amilcar Cabral (Cape Verde) in the software. It turns out that we can backup single engine TAL capability about 350 fps. This equates to moving the call 6 seconds earlier. The factor that determines whether or not we can continue is the minimum droop altitude that occurs during single engine powered flight. A Rockwell analysis performed a few years ago showed that 265K feet is the minimum altitude we can go to during powered flight and that ET rupture would occur shortly after separation.

Action: 05/23-003 - Rockwell/R. Rahn - Talk with Rockwell/R. Fields who did the original analysis and verify the validity of 265K feet as being the minimum altitude allowed for powered flight.

The proposal made by Mr. Bently is that we change the basis on which we make the single engine TAL call from, when the MCC predicts then Orbiter will reach the "RV" line to, when they will reach 265K feet altitude during powered flight. It was pointed out that there presently does not exist a way in the control center to predict when the Orbiter will violate the 265K foot point.

The decision was not to change the single engine TAL call.

T. Cleon Lacefield