

March 12, 1985

DA8/Chairman, Ascent/Entry Flight Techniques

Ascent/Entry Flight Techniques Meeting #14 and #15 Combined Minutes

The 14th and 15th meetings of the Ascent/Entry Flight Techniques Panel were held December 13, 1984 and February 7, 1985 respectively. NASA Headquarters, Draper Laboratory, and Rockwell Downey Corporation participated via teleconference. Combined in this set of minutes is a summary of both of these meetings.

1. Launch Window for STS 51-F - DM6/E. P. Gonzalez

Enclosure 1 describes the STS 51-E launch window. The window opens with the TELESAT 34A cutout and closes with the TELESAT SA closing. An extra 30 minutes could be gained if the TELESAT SA requirement was relaxed and the TELESAT 23A closing were used.

2. STS 51-E Abort Regions - DM6/B. D. Perry

Enclosure 2 describes the abort boundaries for STS 51-E. There is no press-to-ATO boundary on this flight.

3. Deorbit Opportunities for STS 51-E - DM6/E. P. Gonzalez

Enclosure 3 contains the deorbit opportunities for STS 51-E. The EOM is scheduled on rev 64 2 hours and 30 minutes after sunrise at KSC. There is a backup opportunity to EDW on rev 65. For EOM +1 and +2 there are two rev's to KSC with a backup to EDW will be provided.

4. CG's for STS 51-E - MDTSCO/P. M. Kulesa

Enclosure 4 contains the CG's and mass properties for the nominal and abort/no deploy cases. The nominal Xcg is 1090.7 inches at E1 with a vehicle weight of 195,880 pounds.

5. Consumables for STS 51-E - MDTSCO/P. M. Kulesa

Enclosure 5 contains the OMS/RCS propellant requirements summary and margins for STS 51-E.

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6. PTI schedule for STS 51-E - EH24/L. B. McWhorter  
RCS Critical Cue Card - DF6/F. E. Trlica

The aero test program has been extended and I-loads are in place for flights STS 51-E, STS 51-D, STS 51-B, and STS 51-G. The program will fill in the data lost on STS 51-G and STS 51-A and try to reduce the uncertainties in the up elevator data base. The CG box has been opened up from Xcg 1076.7 to 1109 and Ycg +1.5. This flight will have 11 PTI's starting at a QBAR=16 and ending at M.96 (enclosure 6). There will be three fuel checks during entry Q=1, M=19.1, and M=13.7. For a CG aft of 1088 the fuel requirements at E1 is 1355 pounds. PTI's will require 508 pounds and usage without PTI's is 608 pounds. Valid data for this flight requires a Xcg between 1085 and 1098.

7. Elevon Schedule and Bendig Filter Requirements for STS 51-E -  
EH24/L. B. McWhorter

For STS 51-E the elevator schedule is based on the following Xcg at El: Xcg >1092 use alternate schedule. The alternate schedule requires more up elevon than the nominal schedule and will be required for all abort cases and non deploy cases.

8. Speedbrake Monitoring Techniques - DF6/F. E. Trlica  
Landing Energy Predictions for STS 51-E and Subs - DM5/J. V. West  
STS 51-E Tal Short Touchdown Potential - Rockwell/D. Gavert

The approach/land smart speedbrake mods have been implemented on 01-5. This modification will base speedbrake retraction commands upon closed-loop computations of touchdown dispersions. The touchdown energy is normalized by accounting for vehicle weight, winds, and atmospheric density conditions. The outer glide slope reference speed is increased to 290 KEAS. Some speedbrake may be carried to touchdown in high energy situations. Two discrete speedbrake adjustments will be made, one at 3000 feet and one at 500 feet AGL. The 500 foot adjustment should be a minor tweak of the 3000 foot setting unless a significant wind shear has been detected. A short field landing option will be selectable on spec 50. An item (39) will initialize to "short" in MM 304 if TAL has been declared. The short field options will target EAS to be 195 kts at 1750 feet X-distance as opposed to 195 kts at 2750 feet in the nominal option. The BFS outer glide slope reference speed has been raised to 290 KEAS to match the BFS.

Since the smart speedbrake depends on air data for adjustments, the GNC's recommend manual speedbrake if the air data is not incorporated by 5000 feet AGL.

Mr. West described the energy predictions the FDO's would provide for the smart speedbrake. A speedbrake setting for 3000 feet AGL and touchdowns distance will be passed to the crew for all landings. The short field option and normal option will be evaluated to not violate the current flight rules for rollout margin and to land 1000 feet past the runway threshold.

Rockwell has found a problem with the I-loads for STS 51-E that did not update the vehicle weight for the TAL propellant dumps. The current I-load assumes a landing weight of 249K pounds in place of the 242K pounds that

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results from the 2000 pound RCS dump and 5000 pound MPS dump. This causes an error in landing energy of -200 feet in touchdown energy since vehicle weight is used in the smart speedbrake logic. For a Dakar TAL using the short field option of 1750 feet minus the displaced threshold of 540 feet and 200 feet I-load error placed the vehicle near the 1000 foot threshold limit. The current flight rules still apply and the short field option will be evaluated on day of launch with the 200 foot bias.

- §9. Vent Door Software Update - DF4/R. L. Lofton

The entry vent door software has been changed in the 01-5 software release. In MM301, approximately TIG -25 minutes the crew closes the doors per nominal procedures using a single item entry. The new software will close all 18 vent doors and then automatically open left doors 1 and 2 and left doors 8 and 9. These four doors will provide pressure relief if a leak develops prior to entry interface. At MM304 the four doors are automatically closed until all doors are opened in MM305. If a leak were to develop in MM304 only the four doors 1 and 2, 8 and 9 would be opened by the crew instead of all 18 doors with the past configuration. The doors are opened for non isolated OMS or RCS oxidizer or OMS helium leaks to provide over pressurization protection.

A problem was discovered with the BFS software during SAIL testing. The BFS will not accept two consecutive close commands. If on the BFS and the nominal procedure was implemented to close the doors at TIG -25 minutes all doors would close then 1 and 2, 8 and 9 would reopen. They would not close automatically at MM 304 and will not accept a close command. The BFS will work if the doors are opened then closed. If the doors are closed with the PASS computers and the BFS is subsequently engaged, automatic door closing on the BFS will occur at MM304 since the BFS does not count the PASS close commands in the consecutive logic. Once the BFS is in MM304 doors 1 and 2, 8 and 9 can be opened but not closed. Further analysis on the software is presently underway but a procedure change to handle the BFS closing needs to be evaluated. The current plan is to add a note to the TIG -25 minute closing, to not close the doors if on the BFS and let them close automatically at MM304. The BFS sequence will work if the doors are opened then closed. Rockwell has an action to provide the impact of entering with the four doors open.

Action: 12/11-001 - DF4/D. P. Huntsman - Determine procedure to close vent doors 1 and 2, 8 and 9 for entry in the BFS.

Action: 12/11-002 - Rockwell/R. Young - Impact of entering with doors 1 and 2, 8 and 9 open.

#### 10. APU EGT Rules - DF4/D. P. Huntsman

APU exhaust gas temperature is no longer considered to be a valid shutdown parameter for the APU's. The EGT limits of 11600F/12600F have been removed from the Shuttle Operations Data Book and the C&W and FDA limits will be removed. For STS 51-E the C&W alarm will be inhibited at KSC and the FDA limits will be TMBU'ed from the MCC. Permanent hardware and software changes are in work. The only failure mode that the transducers would protect against was a cracked gas generator housing which would allow the

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hydrazine to spray and burn in the duct. The maximum temperature that could be attained and the APU still run was stated to be 15600F. Rockwell also stated this would not cause a duct burn through. The flight rules and procedures have been modified for STS 51-E and subsequent flights to remove EGT as a criteria for shutting down or delaying the start of an APU.

#### §11. Vent Door Postlanding Requirements for STS 51-E - DF4/R. L. Lofton

Normally the doors are configured to the purge position approximately 15 minutes post wheel stop using the OPS 9 thermal control sequence. Left and right doors 1 and 2, 8 and 9 go to the purge position and all others go closed. KSC plans to do a sniff check at vent door 3 anytime a payload with hydrazine is still onboard. If the presence of hydrazine is detected at a concentration less than 20 PPM or H2 at less than 1 percent the convoy Commander will ask us to reopen left or right vent door 6 by a RTC. If a concentration of hydrazine above 20 PPM or ~2 greater than 1 percent all doors will be left open. For landings at EDW or NOR the doors will remain open if any concentration is observed since we do not have RTC capability at those sites. The RTC commands are currently under testing at SAIL since the vent door rechannelization modifications have been implemented to cover the psychotic GPC failures.

#### 12. MPS Vacuum Inerting DTO for STS 51-D - DF4/J. L. Borrer

The purpose of DTO 0408 is to, (1) verify the effectiveness of dumping MPS propellants through the fill and drain valves and vacuum inerting simultane-

ously, with no ullage burn, (2) duplicate the procedure that is in a software change proposal scheduled for 01-7 (STS 61-A), and (3) develop a data base for CG predictions on heavy weight vehicle missions for RTLS and TAL aborts.

The proposed software change for 01-7 is primarily designed to perform MPS dump and vacuum inerting for RTLS and TAL aborts to take care of heavy weight conditions and to protect the vehicle from hydrogen burning while on the ground.

STS 51-D was selected as a candidate mission to try this DTO because of having a direct insertion ascent thus not requiring an OMS-1 burn. The DTO would begin at MECO +2 minutes and require 3 minutes to complete.

APU's are required because we are opening the main engine oxidizer valves. It was agreed that the ground will determine time for APU shutdown. If the DTO is successfully completed, there will be no requirement to do the standard vacuum inerting procedure called out in the Ascent Checklist. If the DTO is not performed we will still have to do the standard procedures.

During the dump, we will be dumping LOX through the engine and through the LOX fill and drain valves. LH2 will be dumped through the LH2 fill and drain valves and through the LH2 RTLS dump valves. The dump is timed for 3 minutes at which time the crew terminates the procedure per the checklist.

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Flight rules have been written and submitted to the Flight Director's Office and to Rockwell for review. A summary of conditions for which the dump/inert DTO will not be performed is as follows:

- a. For RTLS, TAL, or AOA (due to adding an additional confusion factor into a high activity period)
- b. If an OMS-1 is required.
- c. If malfunction procedure is required.
- d. For electrical sub-bus or control bus failures (would prevent opening the fill and drain valves).

The DTO will still be performed even though the main oxidizer valve on one engine cannot be opened. (The primary reason for the DTO is to observe the dump through the fill and drain valves therefore if one main engine valve cannot be opened, we would still want to do the DTO.)

After the DTO is performed, an additional vacuum inerting procedure will be performed if a pressure rise of greater than 5 psi is detected in either the LH or LO2 manifolds. It will take 24 hours for the ground to detect □

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pressure rise of this magnitude due to nominal transducer drift. This drift has been seen on several missions and is repeatable. We will look at past history data on that specific vehicle to sort out any pressure rise from transducer drift which might take place.

The probability of having to do an additional vacuum inerting on the second day is very small. Rockwell has looked at previous data in which 80 seconds venting through two engines was sufficient to get a good vacuum inerting. We will have 180 seconds with this procedure.

13. MPS TAL and RTLS Vacuum Inerting Procedure - DF4/J. M. Howard

MPS TAL and RTLS vacuum inert procedure is presently in a state of flux while software changes are being made to automate presently manual functions. Concern from an operational standpoint is that considering the long lead times for crew training and in checklist change implementation that confusion will reign if these procedures are not stabilized.

Discussed was a short and long term solution to integrating the dump/vacuum inerting procedures into future software deliveries.

For the short term and prior to 01-7, RTLS and manual TAL will have dump and vacuum inerting automated (manual TAL uses RTLS (OPS-6) software). For auto TAL dump and vacuum inerting will still require a manual procedure. In all cases, postlanding, the fill and drain valves will have to be manually closed to minimize contamination.

The long term approach (01-7 and subsequent) is to automate all procedures for RTLS, and both manual and auto TAL. The dump, vacuum inerting, fill and drain valve closure (postlanding) and the MPS repress will all be automated.

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Automatic RTLS LO2 inerting (CR's 79010 and 79067) is implemented in software build 01-5 for flight STS 51-E. Implementation is again scheduled on 01-6 for flights STS 51-G (BFS only), STS 51-I, STS 51-J, and STS 51-L. For auto TAL, the capability does not become available until 01-7 on flight STS 61-A.

It is recommended that we (1) leave the manual procedure in the FDF for auto TAL except for forward CG critical flights, (2) add RTLS auto 102 inerting for heavy weight flights, (3) freeze the effectivity of CR's 79010 and 79067, and (4) add 102 inboard and outboard valves close to the postlanding checklist (if RTLS).

Subsequent to this meeting, it was agreed that the postlanding checklist procedure should match the software. Therefore, for STS 51-E and subs both LH2 and 102 fill and drain valves will be closed manually.

#### 14. TACAN System Accuracy - FM8/M. N. Montez

Mr. Montez presented a summary of the work that is being done relative to TACAN calibration for those sites potentially used by the Shuttle. Enclosure 7 shows the TACAN error model accuracies to which TACAN sites used by NASA will be calibrated and to which the Air Force and FAA agree they can meet.

T. Cleon LACEFIELD

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