DA8-89-19 (FT) May 5, 1989

TO: Distribution
FROM: DA8/Chairman, Ascent/Entry Flight Techniques Panel
SUBJECT: Ascent/Entry Flight Techniques Panel Meeting #55 Minutes

The 55th Ascent/Entry Flight Techniques Panel (A/E FTP) was held at JSC on March 31, 1989. Rockwell-Downey and KSC participated via teleconference. Any questions or comments should be directed to DA8/N. W. Hale, Jr. at 713-483-0693 or FTS 525-0693. The following items were discussed with the decisions made and actions assigned as noted.

Overall Summary:

a. The use of the mid elevon schedule for STS-30 has been minimized and this should virtually eliminate SSME nozzle overtemperature concerns for this flight.

b. Landing DTO priority for STS-30 is:

1. Crosswind (either lakebed or concrete).
2. High speed lakebed nosewheel steering (NWS).
3. Low speed concrete runway NWS. No braking DTO's will be performed.

c. There are no vehicle differences that would change the minimum angle-of-attack flown to maximize range capability in a contingency situation.

d. It appears that the thermal conditioning required prior to payload bay door closing can be significantly reduced, but in flight tests will be required to confirm it.

e. The current procedure to leave the ET umbilical doors open postlanding to 110 +/- 30 degrees is acceptable and KSC paperwork will be changed to properly reflect this.

Detailed Minutes:

1. Action Item 87/08/28-003: Minimum Safe Hp For Post STS-26 Flights - DM3/C. W. Sparks

Deferred to the April A/E FTP.

2. STS-30 Overview Concluded

a. Abort Propellant Dumps-Timers, INH/ENA, etc. - DM3/T. H. Robertson

For RTLS and TAL the OMS/RCS abort interconnect will be enabled, for ATO and post-MECO TAL dumps the interconnect will be inhibited. Complete dump timer information is enclosed.

b. Elevon Schedule vs CG - DM3/K. D. Walyus

The elimination of the cryo offload for cycle 2A moves the X cg 2 inches forward. For nominal end-of-mission and AOA, the aft elevon schedule will be used. For TAL, the mid elevon schedule will be used.

c. Launch Window - R16C/L. C. Turner

The Magellan launch window is included in the enclosure. It should be noted that for flight design purposes the TAL lighting limit is sunset plus 10 minutes. Flight rules allow landing at sunset plus 15 minutes; therefore the windows that close on TAL lighting (April 28 to about May 8) are actually 5 minutes longer than shown.

TAL Effects From Launch Time - R16B/M. L. West

Most of the no-comm performance boundaries vary by launch time. It was agreed that for changes of more than 200 feet per second, MCC would advise the crew of changes to the two-engine TAL (Moron or Ben Guerir) opening boundary, the press-to-ATO boundary, and the press-to-MECO boundary. The update will be made just prior to picking up the countdown at the end of the T-9 minute hold, and will be penciled in by the crew on their cue card.

STS-30 Drainback vs Performance Gain During Launch Hold - R16B/M. Fatehi

LOX drainback amounts to 19 lbs/second after T-4 minutes 55 seconds. Drainback also causes cooling in the SSME's which will violate temperature constraints between 3 and 7 minutes after the planned T-0. At the rate that performance is improving in the early part of the STS-30 launch window, the loss due to drainback is effectively canceled out, so the launch constraint becomes the engine temperature (engine start box). However, later in the window when performance is not increasing (very late it decreases) there will be very limited hold time available. See enclosure.

d. STS-30 Cycle 2 Launch Time Effect on Stuck Throttle - R16B/M. L. West

There is negligible effect of RTLS and Banjul performance based on launch time since these sites are not affected significantly by changes in launch geometry. Evaluation of Ben Guerir and Moron are in work and will be addressed at a splinter FTP. Enclosed is a chart for the start of the launch window showing that with an engine with throttles stuck at 65 percent, there is no good-engine-out RTLS window and the TAL boundaries are significantly delayed. With one SSME stuck at a throttle level below 70 percent, there is a negative ascent performance margin, so a TAL about would be required.

g. Detailed Entry Runway Priorities, HAC Toggle Status - DM3/K. D. Walyus

On an AOA to KSC - which would only be done if both Edwards and White Sands were unavailable - direction of the first roll reversal changes through the launch window - roll left at the start of the window and right at the close. A HAC double toggle is required for at TAL to Banjul no matter if a redesignation was performed or not; procedures have the crew double toggle for all TAL sites. The runway DTO priorities are: (1) Crosswind test (preferably on the lakebed since higher crosswinds can be tested), (2) High speed lakebed NWS test (note that the low speed lakebed test was accomplished on STS-27), (3) Low speed concrete runway NWS test. The crosswind test and the NWS tests can be accomplished on the same landing. No further tests will be performed on the beryllium brakes presuming that they will be replaced this fall with the carbon brakes.

h. STS-30 Late TAL to Hoedspruit Status - R16D/C. G. Troeger

Hoedspruit is not within crossrange as a downrange abort site until about 45 minutes into the launch window, and the window does not extend that late until about May 3. To lengthen the Kinshasa window, an RCS only (OMS engines off) dump will be performed if the MECO velocity is between 25.0 kfps and 25.3 kfps. Since AOA-shallow capability commences at 25.1 kfps, Kinshasa fills what would normally be a gap with the only drawback that the entire OMS propellant dump probably will not be completed.

3. Leaking Tire Flight Rule, Lessons Learned from STS-27, Minimum Generic Tire Pressure - ES6/C. C. Campbell

There is not currently any work in progress to lower the old minimum main tire pressure limit from 325 psia. The "diamond" nomographs will be presented at the April FTP. The history and troubleshooting of the STS-27 leaking tire was presented; the cause was an improperly installed inflation plug. Changes that have been made to the tire assembly procedures and leak checks were presented.

4. Aft RCS Entry Redlines Update - EH2/M. M. Hammerschmitt

Deferred to the April FTP.

5. Alpha Stretch Vehicle Differences - ES3/D. M. Curry

The OV-104 Chin panel has a single pressure measurement which has a struc tural factor of safety of 1.2. However, it turns out that this is a single flight limit since the failure mode is a compression crack and the panel remains in place even at much a much more stringent thermal environment. This is because the highest aerodynamic loading is seen during first stage and so the chin panel is greatly overdesigned for the entry environment. Therefore the OV-104 chin panel is not thought to be an area of concern for low alpha stretch techniques. The OV-102 SEADS nosecap is thicker RCC than the other vehicle nosecaps, but is honeycombed with columbium metal pressure port tubes. Columbium is certified to a 2900 degree one flight use vs the RCC 3100 degree limit but analysis shows that since the OV-102 nosecap is thicker, the entry temperature peak is about 200 degrees lower than experienced on other vehicles. Therefore, the OV-102 nosecap can effectively be treated the same as the nosecaps on the other vehicles, which are estimated to be take the thermal environment down to 31 degrees alpha.

6. Cryo O2 Ascent/Entry Leak Procedure - DF7/F. A. Oullette

This item was initiated by a System Division activity report which stated that this procedure did not work when the crew attempted to use it in simulations. This presentation showed that in the reported case, the failure was not correctly modeled and thus the crew did not have the proper cues to perform the procedure. Subsequently, the malfunction has been properly modeled and repeated use of this leak procedure has been performed by multiple crews including the ones with the initial report, and no problems have been encountered. Therefore, no further action on this procedure is required.

7. Action Item 88/12/13-001: Deorbit Prep PTC Requirements and Payload Bay Door Closing Constraints Flight Rule 2-41B in Light of Flight Results

The current flight rule for high beta angle (greater than 45 degrees) flights is that 10 hours of passive thermal control (PTC) is required to condition the payload bay doors for closure prior to deorbit. On STS-27, 1 hour of top sun was followed by 3 hours of PTC was analyzed, considered acceptable for thermal conditioning, and door closing was successful with this regimen.

RI-Houston/ZC01/J. T. Taylor - The constraints listed in the flight rules and SODB have been somewhat alleviated in the last few years. Part of the original thermal conditioning constraint was a TPS constraint -- that has now been reduced to about 4 hours of PTC. Also, the thermal effects on the payload bay doors have been reduced since certain parts of the mechanism have been redesigned to allow for more clearance for thermal expansion. The criteria for the maximum thermal expansion that will allow door closure is a temperature difference between the sill longeron and the bottom bondline. During OFT this limit was 60 degrees F or less. With the new mechanical design, analysis indicates that temperature differences of up to 355 degrees may be allowable. (Note that the STS-27 real-time estimate of this temper ature difference being 65 degrees was in error by 5 degrees, so on STS-27 the old temperature limit was not in fact violated). However, no organization is willing to sign up to the new temperature difference without an in flight test to check if the mechanical clearances work as the analysis indicates. An additional complication is the fact that OV-102 Columbia has no working sill longeron temperature measurements.

The flight data indicate that in tail sun (of which 3 hours prior to deorbit is required to condition the radiators for entry), the temperature gradient increases about 5 degrees/hour which is equivalent to approximately 1/2 hour of PTC. With the TPS conditioning limit requirement of 4 hours PTC and the 1-1/2 hours to alleviate the tail sun temperature effects, it looks as if the new limit could be 6 hours PTC vs the 10 hours currently in the flight rules.

RI-D/FA/A. Richardson discussed the mechanical changes that have been made to the payload bay doors. The panel lug on the bellcrank at the end of the aft breather panel has been moved to increase clearance by about 0.39 inches as shown on the enclosure.

All parties indicated that on-orbit thermal testing is required before relaxing the thermal conditioning attitude profiles. Therefor, a discussion of these tests has been scheduled for the May A/E FTP.

8. Elevon Selection and Groundrules - RI-D/FB98/D. W. Pearson

This presentation covered preliminary results for STS-30 only and a future presentation will cover the topic generically. The problem is that the SSME nozzle lower outboard steerhorn is sensitive to heat loads with certain elevon/cg combinations. In particular the nozzle does not meet either the SSME ICD or 7700 Vol X requirements on heat rate or heat load during entry. Additional TPS has been installed, but even so, with the worst three sigma entry dispersions the heating limits are exceeded. The consequences of violating the heating limit is that the affected metal will be annealed, lowering mechanical strength, and on the next flight could cause catastrophic engine failure. The nozzle will be upgraded to handle the environment

effective STS-32. This is only an end-of-mission problem and only a problem for the mid-cg elevon schedule. A plot of this is shown on the "ink spot" chart in the enclosure. For STS-30, use of the mid elevon schedule has been reduced from EI cg's between 1094 and 1100 to between 1094 and 1096, thus alleviating the concern for this one flight.

9. The Effect of Selection of Alternate Rev Descent on SSME Nozzle Heating -
RI-D/AC78/R. J. Robinson

This item was canceled from the A/E FTP agenda.

10. High Inclination Rev 2 Shallow vs AOA Steep - DF63/L. J. Hautzinger

This item was canceled from the A/E FTP agenda.

11. OMS Dump Interconnect On/Off Study - R16B/M. Fatehi

This presentation covered the last part of the story on abort dump inter connect requirements that has been on the A/E FTP agenda for the last three meetings. The study confirmed that virtually all ATO dumps should be performed with the interconnect inhibited, but that theoretically there are some very heavy OMS loads that will require interconnect enable.

12. Abort I-load OI-8C Dump Timer Proposal - DF6/J. E. DeTroye

This item was canceled from the A/E FTP agenda.

13. ET Umbilical Door Postlanding Positioning Requirements

This topic was last worked at A/E FTP #5 in September 1983. The minutes of that meeting showed that the ET umbilical doors should be opened to 110 +/- 30 degrees. This allowed for wind loading, GSE jack clearance, minimization of towing loads. Also considered was the fact that the crew has no position indicator for the doors and must manually turn off the drive motor based on watching the time; an envelope much smaller than about +/- 30 degrees may not be operationally feasible without significantly complicating procedures.

KSC/LSOC/D. S. McCann, VF3/C. S. McMillan - The current OMRSD V56 requirement for towing is that the ET umbilical doors must either be closed and latched or in the 90 +/- 10 degree position (hanging straight down). The problem is that the drive linkage mechanism can be overstressed by shocks during the towing process if the doors are at angles significantly greater or lower than the specified limits. The doors are driven by hydraulics and therefore must be positioned prior to APU shutdown or after hooking up hydraulic carts at the mate-demate-device (MDD). Several hours of turnaround can be saved if MDD hydraulics are not required. The doors cannot be latched without ground crew intervention since the motors will not drive them high enough for the latches to catch. A discussion of the possibility of having the crew drive the doors full open and the ground crew assisting to get them latched ensued. The resulting decision was that this was not practical in that the ground crew could be delayed by any number of circumstances, with the APU's off the doors could slump too far to be latched, and then the doors would be in a very bad orientation for towing.

The discussion then centered on why the OMRSD had been changed, since all the structural analysis indicated that the 110 +/- 30 degrees was acceptable. There appeared to be no reason for the change.

> Action: 89/03/31-001: VF3/C. S. McMillan - Revise the OMRSD V56 limit to the old numbers of 110 +/- 30 or provide analysis to demonstrate that the new limits are required. Due by STS-30 launch.

14. No FRCS/No ET Tumble Valve Separation Trajectories - RI-D/C. LaMont

This presentation was not given during the regular meeting time on March 31, but was given during a splinter meeting on April 3. The trajectory results from the new procedure where shown. Clearances were small but positive. Affects on the trajectory included: elastic energy stored in the aft attach system by thermal deformation, impingement of RCS jets on the ET, SSME boil off thrust during mated coast, lightweight ET mass properties, APU thrust, MPS pressure relief, and worst case rates at MECO. Also, variations in the friction coefficient of the aft ET ball attach joints was varied from the nominal expected of .10 to 0.05 and 0.15. The only variable not modeled was propellant slosh but this is not considered significant following a nominal MECO (residuals are much lower than a TAL or RTLS). Since the trajectories showed positive clearances, the procedure printed in the A/E FTP minutes #54 is considered acceptable and the 482 will be recommended to the CPCB for STS-30 and subs.

Original Signed By:
N. Wayne Hale, Jr.

Enclosure