

National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center
Houston, Texas
77058

Reply to DA8-88-56 (FT)

June 23, 1988

TO: Distribution
FROM: DA8/Chairman, Ascent/Entry Flight Techniques Panel
SUBJECT: Ascent/Entry Flight Techniques Panel #45 Minutes

The 45th Ascent/Entry Flight Techniques Panel FTP meeting was held at JSC on June 17, 1988. Rockwell-Downey participate via teleconference. Any questions or comments should be directed to DA8/R. D. Dittmore at 713-483-5417 or FTS 525-5417. The following items were discussed with the decisions made and actions assigned as noted.

Overall Summary:

a. First day primary landing site (PLS) flight rules were reviewed. The FTP accepted a proposed change to the GNC rules agreeing to a first day PLS for 3 accelerometer assemblies (AA), rate gyro assemblies (RGA), or elevon/bodyflap position feedbacks failed. The previous rule had specified a first day PLS for 2 failures.

b. Rockwell-Downey informed the FTP that the longer the landing gear isolation valves remain open, the greater chance of brake contamination occurring prior to touchdown. Consequently the FTP agreed to close landing gear isolation valve 3 prior to entry interface (EI) (it is now opened at EI-13 minutes) and allow the software to command the valve open at nose gear touchdown. Landing gear isolation valve 1 and 2 openings were not changed.

c. The preliminary Ames test matrix was reviewed. The FTP recommended the addition of two more cases to the single APU test matrix in order to concentrate on Orbiter capability with crosswinds less than 12 kts and light turbulence (i.e., focus Ames testing on verifying the conditions where a single APU entry is thought to be acceptable rather than identifying conditions where it is unacceptable).

d. Rockwell-Downey proposed declaring the forward RCS propellant tank failed for ET separation if the propellant quantity decreased to less than 52 percent (pressure/volume/temperature - PVT calculation) prior to MECO. Existing flight rules allow use of the FRCS for mated coast and ET SEP as long as the propellant quantity is greater than 0 percent and the tank pressure is greater than 190 psia. Several actions were assigned to better understand the analysis and assumptions used in the analysis.

e. Rockwell-Downey reported that at least 5 feet clearance exists (likely 8 feet) between the Orbiter and the ET during ET separation under worst case 17 inch disconnect fail open conditions. As a result, the FTP

determined that procedural changes to include an evasive maneuver at ET SEP for a 17 inch disconnect valve failed open were not required. Additionally, software changes to annunciate the specific valve failure and provide an automatic evasive Y translation were determined to be not required.

Detailed Minutes:

1. Review of First Day PLS Flight Rules

a. GNC - DF6/J. M. Webb

Mr. Webb proposed a flight rules change for next PLS and first day PLS to incorporate the philosophy of declaring a next PLS/first day PLS if the next failure prevents a safe entry. Because of the redundancy management capabilities, several of the GNC systems can be zero fault tolerant for entry while still maintaining a single fault tolerant capability during orbit ops. For example, with only 2 RGA's remaining, entry is zero fault tolerant for RGA failures. The next RGA failure during entry will result in the software averaging a good RGA with a bad RGA input, resulting in loss of control. However, if the next RGA failure occurred while still "on-orbit", software capability exists to deselect the "bad" RGA and "prime select" the good RGA for entry. Entry remains zero fault tolerant for the next "on-orbit" RGA failure.

The FTP agreed with the following:

	MDF	Next PLS	First Day PLS
Rotational Hand Controller	2 ch fail, same side	5 ch fail (IFM option)	no action
Speedbrake/ Thrust Controller	4 ch fail	5 ch fail (if ADTA fail)	no action
AA, RGA, or Elevon/BF Feedbacks	2 fail	3 fail	3 fail

For the RHC and SBTC, the current rule requires a next PLS for 4 channels failed (i.e., zero fault tolerant for entry). As mentioned above, the next failure during orbit ops can be deselected to allow entry with 5 channels failed and remain zero fault tolerant. Mr. Webb pointed out that for the loss of all RHC capability, autoland is the only recourse. With 5 RHC channels failed, the FTP agreed that the runway selection criteria should include the landing aids required to support autoland (i.e., HIS).

The speedbrake is controlled by software during entry/landing and is not normally required in the manual mode. Hence no requirement exists for manual speedbrake control unless air data is not available for the software to issue the proper speedbrake commands during entry.

The A, RGA, and elevon/bodyflap position feedback rationale is the same as that already discussed in the first paragraph. Nowever, one question still remains to be resolved concerning AA's. The GMC's accepted the action to

determine whether entry was acceptable with AA input failed to null. Power could be removed from the AA's resulting in the null output condition if entry is acceptable.

Action: 88/06/17-001 - DF6/M. J. Ferring - Determine if entry control is acceptable with AA's failed to null. Report results Jack to the FTP.

Mr. Webb also proposed changing the air data transducer assembly (ADTA) requirements for both MDF and PLS. The FTP did not accept this change, desiring ADTA to remain MDF for two failed and PLS/first day PLS for three failed. Because theta limits could be required if three ADTA's are failed, entering at the first day PLS/next PLS with one ADTA remaining protects against unknowns associated with theta limits (i e. , can i "incorporate last ADTA if "theta limits" is unacceptable) while also maintaining a BFS option (BFS requires ADTA).

b. PROP - DF6/K. A. Chappell

Mr. Chappell I presented two items not currently identified as first day PLS criteria, "OMS crossfeed line failure" and "two jets failed in the same pod, same direction". Actions were assigned to update the sect-on two flight rules first day PLS criteria if the Guidance & Propulsion Systems Branch desires a first day PLS for re conditions mentioned above.

Action: 88/06/17-002 - DF6/L. J. Hautzinger - Determine if loss of the OMS crossfeed line should be a first day PLS. If the answer is yes, submit appropriate flight rule change.

Action: 88/06/17-003 - DF6/L. J. Hautzinger and M. J. Ferring - Determine if two jets failed in the same pod, same direction should be a first day PLS. Review control capability with loss of all pitch jets in one direction on the same pod. Report results back to the FTP.

c. EECOM - DF7/J. S. McLendon

Most of the discussion was associated with the first day, PLS requirement for the loss of O1 MDM OF3. The FTP assigned two actors to better understand the insight lost and options available to stay on-orbit beyond the first day PLS.

Action: 88/06/17-004 - DF7/J. S. McLendon - Verify FMEA/CIL retention rationale includes maintaining insight into the fuel cell in order to protect against the crit 1 H2/O2 crossover concerns. Report results back to the FTP.

Action: 88/06/17-005 - VF5/R. B. Ramsell - Determine the Orbiter Project position and R&E position relating to staying on-orbit with the loss of O1 MDM OF3. Consider the fact that the fuel cell successfully passed the prelaunch N2 diagnostics test.

d. DPS - DF2/G. Araiza

Ms. Araiza accepted the action to add FF/FA MDM requirements to the first day PLS criteria to be consistent with the LRU requirements.

Action: 88/06/17-006 - DF2/G. Araiza - Submit flight rule that updates the first day PLS criteria to include FF/FA MDM requirements consistent with LRU requirements.

e. MMACS - DF4/J. W. Medford

No issues.

2. Max Stretch Capability - DM3/B. K. Joosten

Deferred.

3. Review of Bailout Procedures

CB/S. R. Nagel presented an overview of the bailout environment constraints (enclosure 1) with DF4/E. M. Youmans presenting a review of bailout procedures (enclosure 2). Mr. Nagel mentioned that a problem has been discovered with the bailout software where pitch transients can occur when auto-pitch is selected. Minor transients occur at the higher airspeeds (180-200 kts). However, at the lower airspeeds (160-180 kts), objectionable transients have been noted although still determined to be safe. Mr. Nagel and CB/F. H. Hauck agreed that a fix for STS-26 was not required.

DF7/L. A. Perrine presented the pressure profiles for the cabin, airlock, and ambient pressures for the bailout procedure with cabin venting initiated at 40,000 feet. Ms. Perrine reviewed issues concerning cabin/ambient pressure equalization with 8.0 psia regulator max flow, high N2 concentration from 8.0 psia reg, middeck payload environment, and airlock over pressurization

It was determined that the 8.0 psia regulator had minimal impact on the pressure equalization even with flowing at the maximum rate, although there was some concern identified with the N2 concentration that would exist in the area of the side hatch. However, as long as the crew is not breathing the cabin air, the high N2 concentration does not represent a concern (note that for bailout, procedurally the crew will never breathe the cabin air).

Values for the maximum flowrate at vent initiation (14.26 psi/minute) and minimum cabin pressure at hatch jettison (4.5 psia--31,000 feet) were identified. These values have been forwarded to the Program for use in insuring middeck payloads can withstand the bailout environment.

DF4/W. C. Anderson reported that the airlock is capable of withstanding a pressure differential across the airlock hatch of 10 psid (1.4 factor of safety). Because the maximum differential pressure during cabin venting was calculated to be 9 psid, Mr. Anderson felt that a concern in this area does not exist.

Rockwell-Downey has been asked to update the cabin venting analysis with the cabin venting initiated at 40,000 feet (previous venting analysis was completed for 25,000 feet) and to evaluate the effect that the increased delta pressure will have on the vent valve backflow butterfly device. The airlock was not included in this analysis, although all agreed at the FTP meeting that the airlock should be included. As a result, the FTP asked Rockwell to include the airlock and assigned an action to Mr. Ramsell to followup.

Action: 88/06/17-007 - VF5/R. B. Ramsell - Ensure the airlock is included in the Rockwell cabin venting analysis.

4. Brake Contamination

Rockwell-Downey/H. Davis and DF4/R. J. Walheim presented an overview of the brake problems that have been experienced over the last several years and specifically the contamination problems experienced at KSC in the last several months; the objective of the review being to determine the acceptability of the existing landing gear isolation valve management. The FTP met in October 1987 and determined the best approach for managing the LG ISOL VLV's was to open LG ISOL VLV 3 early (EI-13 minutes) and monitor for uncommanded brake pressure as a result of contamination. LG ISOL 2 would open at approximately 10 minutes prior to touchdown with LG ISOL 1 opening at a Vrel 800 fps. Subsequent contamination events at KSC during Orbiter checkout resulted in re-examining the management plan agreed to in October.

Troubleshooting of the KSC problems and laboratory tests revealed that the selector valve problem, thought to be fixed, could be recreated under certain test conditions. However, both Rockwell and Systems Division personnel felt that these conditions would not occur in flight and that the LG [ISOL management should not be established to protect for this occurrence. Most of the occurrences of uncommanded brake pressure have been a result of contamination or "silting" (enclosure 3).

Mr. Davis reported that Oklahoma State University (OSU) had a great deal of experience relating to hydraulic systems and contamination effects. Based on OSU experience, Mr. Davis reported that the longer an isolation valve remains open, the greater probability that contamination may occur. Mr. Davis felt this to be especially true with the hydraulic system at high pressure (i.e., entry). Landing gear isolation valves 2 and 3 are normally open during orbit operations for thermal conditioning purposes. However, because the hydraulic pressure is low (200-400 psi), most of the flow passes through the bypass orifice versus through the selector valve and brake module, minimizing the contamination influence. This particular data relating valve open time and contamination probability was not presented at the October 1987 FTP meeting.

As a result of the new information, the FTP agreed to continue performing the brake circuit card check at EI-13 minutes (open LG ISOL VLV 3 to detect for uncommanded brake pressure as a result of a brake circuit card failure--crit 1). However, instead of leaving LG ISOL VLV 3 open the remainder of entry, the FTP determined to close LG ISOL VLV 3 immediately following the brake circuit card check. LG ISOL VLV 2 and 1 opening times were not changed.

Additionally, the FTP asked the Mechanical & Crew Systems Branch to pursue a software change to command all landing gear isolation valves open at touchdown and to delete the landing gear isolation valve 2 automatic opening at 10 minutes prior to touchdown. A hardware change proposed by the Mechanical & Crew Systems Branch to install a new valve for landing gear deploy, bypassing the landing gear isolation valves and brakes, has the potential to eliminate uncommanded brake pressure concerns (enclosure 4).

Action: 88/06/17-008 - DF4/A. L. Schmitt - Submit a 482 procedure change to close LG ISOL VLV 3 after the brake circuit card check at EI-13

minutes.

5. Ames Test Matrix Review - EH2/H. G. Law

Mr. Law presented an overview of the planned testing and schedule. The FTP specifically reviewed the planned single APU testing to ensure that testing was planned to substantiate the belief that a single APU entry is acceptable under low crosswind and light turbulence conditions. Two additional cases were added to test at less than 10 kts of crosswind, light turbulence and 12 kts crosswind, light turbulence. Mr. Law was also asked to coordinate the wind conditions with ZS8/Spaceflight Meteorology Group to ensure the planned turbulent conditions to be tested are reasonable considering the crosswind conditions desired. Ames testing is now scheduled from mid-July to mid-August.

6. FRCS Pre-MECO Minimum Propellant Quantity - Rockwell-Downey/A. K. Griffiths

Mr. Griffiths presented the results of an analysis showing the minimum acceptable forward RCS quantity pre-MECO that will support ET SEP to be 52 percent PVT calculated. Previously, 0 percent was believed to be the minimum quantity. Existing flight rules allow the FRCS to be used for ET SEP as long as the tank quantity is greater than 0 percent and pressure > 190 psia. Loss of the FRCS results in implementing the "no FRCS" ET separation procedure (n/a RTLS).

The analysis assumed that the RCS tank upper compartment screens would breakdown during the boost phase. Additionally, worst case acceleration vector angle, gaging error (1 percent contribution), and maximum propellant slosh (1 percent contribution) were assumed (enclosure 5). Mated coast and ET SEP propellant usage was applied to determine the minimum acceptable propellant quantity that could support ET SEP without RCS jet deselection.

The FTP deferred any decision on the subject. Several actions were assigned to better understand the analysis and risk tradeoffs

Action: 88/06/17-009 - Rockwell-Downey/A. K. Griffiths - Provide the FTP the affect that the acceleration vector angle has on the minimum propellant quantity, worst case versus nominal, for nominal and TAL ET SEP.

Action: 88/06/17-010 - Rockwell-Downey/A. K. Griffiths - Determine the single engine roll control propellant usage from the FRCS and the impact associated with establishing a minimum FRCS propellant quantity. Provide recommendations to the FTP.

Action: 88/06/17-011 - Rockwell-Downey/A. K. Griffiths - Establishing a minimum FRCS propellant quantity greater than 0 percent will increase the use of the "no FRCS" ET SEP procedure. Provide a risk tradeoff assessment between the no FRCS procedure and attempting ET SEP with a propellant quantity less than the recommended minimum quantity. Provide results to the FTP.

7. 17 inch Disconnect Valve Fail Evasive Maneuver - Rockwell-Downey/C. Lamont

No concern exists for a nominal MECO because time is available to manually delay the ET separation and allow residual propellant venting to occur. However, for the intact abort scenarios, ET separation cannot be delayed. For these cases, the thrust associated with venting propellant through the failed open feedline (LH2--7000 lbf/LOX--4700 lbf) impacts directly on the ET resulting in off-nominal separation dynamics.

Mr. Lamont presented the results of an analysis on the ET separation dynamics indicating a high positive pitching moment on the ET due to the thrust acting at the extreme aft end of the ET plus a high rolling moment due to the thrust being offset approximately 70 inches from the XZ plane. The worst case scenario showed the "ET nose rotates upward above the bottom of the Orbiter, but because of roll, passes to one side with marginal clearance."

Mr. Lamont proposed implementing a combined Y and Z translation for the failed open feedline scenarios to increase the clearance between the Orbiter and the ET during ET SEP. Without the Y translation, the clearance was predicted to be approximately 5 feet (further refining will probably show 8 feet) at the closest point. Two and six yaw jet translation options serve to increase the clearance (enclosure 6).

For STS-26, the proposal would involve the MCC to detect which disconnect valve failed and to recommend a direction of translation. The crew would then have to manually translate in the Y and Z directions to increase the separation clearances. In the long term, the proposal is to add software to detect the disconnect failure, annunciate the failure to the crew, and automatically command a combined Y/Z separation translation.

The FTP determined that neither the short term nor the long term "fixes" are required. The probability of a 17 inch disconnect valve structural failure or debris blockage occurring in addition to an ascent abort is extremely remote. No 17 inch valve failures that would have resulted in a failed open valve have been experienced. Even if this remote scenario were to occur, the worst case failed full open valve analysis indicates 5-8 foot clearance. Any failure less than full open will certainly result in increased clearances. The FTP determined that, given the extreme low probability of occurrence, the worst case clearance was acceptable and that no manual or software fixes should be pursued.

Ronald B. Dittmore

6 Enclosures