

FROM:DA8/Chairman, Ascent/Entry Flight
Techniques

SUBJ:Ascent/Entry Flight Techniques Panel Meeting #20 Minutes

The 20th Ascent/Entry Flight Techniques Panel was held at JSC on April 4 and 8, 1986. Rockwell-Downey participated via teleconference.

Summary

a. Operations on a single APU appear to be marginal and additional testing is required to verify this capability. The possibility of flight rule changes exists depending on test results. The Program agrees that this testing should be accomplished, and Initial test cases and variables have been provided to Rockwell and R&E so that a test matrix can be generated.

b. A quick review of the impact of reducing brake energy numbers to those proposed at the last Flight Techniques meeting (42 million ft-lbs for aborts, 34 million ft-lbs for EOM) indicated that the probability of launching or landing would be severely reduced. (You need a headwind of 8-12 knots.)

c. Several new ETR TAL sites have been proposed to augment Dakar. The list has been reduced to the Moroccan sites of Agadir, Ben Guerir, Casablanca, and Marrakech. The present plan is to have one of these sites serve both high and low Inclinations along with the other two sites already used. Evaluations of these sites for a final selection is still underway.

d. OMS ballast management rules were reviewed and approved. These should preclude the downweight issue that arose on STS 51-F. Some additional work is required on our CG management rule.

e. Flight Techniques does not support the dumping of AFT RCS to reduce downweight for nominal EOM cases. New propellant management rules should keep this from becoming a problem. Abort cases and those related propellant dumps required are another subject.

f. It is proposed that IMU prelaunch hold capability should be sufficient until the G9/G1 software change. Ne may be able to increase the hold time from -0 to 135 minutes from the present 90 minutes, and continue to use our existing Techniques of delaying the start of gyro calibration in G9 or recycling prior to the end the launch window. DA8 has a memorandum to the Program concerning this topic which is presently in the review cycle.

g. RHC and SRB RGA fixes for the MDM A/D conversion failure are in work. The SRB RGA fix is closing in on a hardware/software concept which uses four SRB RGA's with the capability prelaunch to substitute a standby RGA for any failed RGA. The RHC proposed fix is still under review.

1. Single APU Operations - DF6/J. W. Bantle, EN2/N. G. Law

Mr. Bantle indicated that operations on a single APU are marginal. Specific concerns include (1) the increased probability of pilot-induced oscillation (PIO's) during landing, (2) reduced elevator control authority for slapdown, (3) reduced lateral control authority for crosswinds, (4) the loss of NWS and

half braking for the loss of APU's 1 and 3, and (5) the landing surface (lakebed vs concrete). DF6 recommended reevaluating single APU operations. Subsequent to the Flight Techniques meeting this subject area was presented to the Program and It was decided that single APU operations should be restudied. A meeting was held to review Mr. Law's data and recommendations and come up with a proposal on what additional testing or evaluation should be done. Mr. Law agreed with DF6 that single APU operations are marginal and that systems margins are lower than originally thought. Just how much lower would require a rerun of all the old simulation cases. Mr. Law also suggested that several areas be stressed for training. These included (1) the effects of limited brake authority, (2) the effects of the loss of NWS, (3) the effects of rate limiting on control before main gear touchdown, particularly in turbulent conditions, (4) the effects of rate limiting on derotation control, and (5) the effects of CSS vs auto mode.

Mr. Law also proposed that the flight rules should be changed such that for the loss of the first APU you would land at the first EAFB/KSC/VAFB MLS runway (subject to landing conditions). This effectively makes the loss of a single APU a next PLS case. He also proposed reducing the landing weight and moving the CG aft and using the auto mode if rate saturation/PIO conditions appear during single APU operations.

Action: 04/04-001 - DF6/J. W. Bantle, EH2/N. G. Law - Provide proposed flight rule changes if required.

it was also decided that R&E and Rockwell should generate a test case matrix that would allow us to verify single APU operations. Based on the discussion it was decided that a standard EOM type entry from the HAC intercept on down should suffice for looking at a TAL, AOA, or EOM with of course the appropriate variable changes expected for those cases. The RTLS is a different matter and should be studied more completely. Rockwell and R&E will generate a test matrix for review.

2. Proposed Brake Energy Reduction Evaluation - DM5/J. V. West

Mr. Nest presented a review of the possible impacts associated with reducing the acceptable brake energy numbers from 55 million ft-lbs and 42 million ft-lbs, for aborts and EOM respectively, to 42 million ft-lbs and 34 million ft-lbs. As can be seen from the charts in enclosure 1, this would be very restrictive. Assuming a 42 million ft-lbs number for TAL aborts, you would need at least an 8 knot headwind with no crosswind. Mr. West also addressed how the real-time brake energy assessment is performed and the factors taken into account. The simulation generates total brake energy and is initiated at 10,000 ft. Balloon winds and atmospheric data are used along with the real-time mass properties. The simulation takes into account the various dynamics effects on landing energy and uses the checklist braking procedures. The acceptable total energy then is determined by considering left/right unbalance vs crosswind with a 60/40 inboard/outboard brake unbalance assumed. Mr. Nest concluded that the brake energy evaluation method is a good one and takes into account all significant parameters and flight experience, but it was noted that to be accurate, the model must have good wind and atmospheric data.

3. New TAL Site Study Results/Status - TM2/R. D. Tuntland

Mr. Tuntland presented a review of the alternate TAL site study which has been in work since post STS 61-C. The study had looked at a number of African sites and reduced the number to five for further consideration. Primary concerns centered around weather and reporting capability, performance as both a high and low Inclination TAL site, and site facilities (runways, buildings, security, etc.). Additionally, Mr. Tuntland stated that Miramar is being considered for augmentation since its use as a WTR RTLS site could reduce TAL exposure to Easter Island. Also presented was a proposed implementation plan for STS augmented landing sites which is included as enclosure 2. It should be noted that the enclosure represents only an initial cut at desires and costs. Both will have to be refined. Flight Techniques felt that barriers should be considered for Dakar, Easter Island, and Hao since the runways are fairly short (11,000 ft). Additionally, the use of Miramar to reduce the WTR TAL exposure (-15 seconds) should be reconsidered especially if an MLS has to be placed there. A new MLS Jr. would be about 4.5 million dollars, but we probably could use one from the EDW lakebed. It is felt that whatever we do, another MLS Jr. is not warranted at this time. Since all the relevant abort site data was not ready at Flight Techniques time, a splinter meeting was held to review in more detail the proposed five final sites before presenting the story to TA/L. S. Nicholson. The five sites reviewed were Dakhla in the Spanish Sahara, and Agadir, Ben Gueir, Casablanca, and Marrakech, all in Morocco. When the weather story is looked at closely, Dakar does not look as bad as some of the other sites. Also Marrakech has much better weather than Casablanca and is closer to the 280 inclination. The runway at Marrakech, however, is only about 10,000 ft as compared to 12,000 ft at Casablanca. Ben Guerir is an old abandoned SAG base near Marrakech with basically no facilities but it had a 14,000 ft runway. Performance impacts of using these out of plane sites was not available so DM was asked to look at Marrakech as a high and low inclination site. It was decided and later supported by Mr. Nicholson that we should attempt to get as much information about all the sites except Dakhla, which was deleted from the list due to security reasons. We will attempt to get the personnel in Morocco who flew with CB/K. J. Bobko during the Casablanca evaluation to look at the other sites and provide us with a data pack on each one. Once this has been done, JSC and KSC personnel should visit the recommended sites. The specific navaid requirements for STS augmented sites have been reviewed by Ca and their comments provided to Mr. Tuntland.

4. OMS Ballast Management/CG/Landing Weight Rules - DM3/J. K. Patterson, DF6/R. D. Jackson, DM6/P. J. McCoy

Mr. Jackson presented the DF6 X-CG ballast computation groundrules as well as the vehicle downweight computation. Mr. Patterson then presented the proposed rule which covers these items. It appears that all disciplines are now in sync with respect to OMS ballasting and the downweight problem which occurred on STS 51-F should be precluded. Given the initial conditions of (1) M3.5 vehicle weight, (2) M3.5 mass properties, (3) FRCS dump to 0 percent, (4) ARCS usage as redlined, and (5) OMS usage to the unusable quantity, if the X-CG is <1076.7, ballast is required. It should be noted that (1) ARCS usage for entry is equal to the flight rule redline, and (3) OMS unusable is defined as hardware trapped plus the propellant required to protect for dispersions. Ballast requirements will be recalculated in real-time to account for changes in non-propulsive consumables or changes in the usage rate of the propulsive consumables. Actions used by the PROP officer

to minimize downweight include dumping the FRCS to 0 percent, managing the ARCS close to the mission completion redline, and seeing to it that post deorbit burn OMS quantity is no more than 5 percent, unless X-CG ballast is required.

The rule dealing with how the EOM CG will be managed was reviewed again (it was first reviewed at the last Flight Techniques meeting) and several modifications were proposed. This rule should be evaluated by Rockwell once we are content with it.

Action: 04/04-002 - DM6/G. T. Oliver - Provide modified EOM CG priority rule to DA8.

5. RCS Dumps to Reduce EOM Landing Weight - DA8/A. L. Briscoe

Briscoe reviewed the status of where we stand with respect to FWD and AFT RCS dumps to reduce EOM downweight. FWD dumps to 0 percent pre El will continue to be done as in the past. Other than this, no other FWD dumps will be done (the abort dump timer will be set to zero) until the FWD RCS DTO has been accomplished. It was also pointed out that a FWD RCS dump in an abort case would still leave approximately 800 lbs of FWD propellant onboard. With respect to the dumping of AFT RCS to reduce downweight, discussions have been ongoing since October 1985 and it is now time to bring things to a halt. Guidance and flight dynamics personnel investigated when we could do such a dump and determined that it could be done the day before entry or as late as 4 revs prior to deorbit TIG. The problem here is you dump before you discover that you needed the extra RCS. Further discussion at Techniques and splinter meetings resulted in an agreement to dump AFT RCS only if an appropriate pad (say 1,000 lbs) was provided. When this is compared to the nominal EOM AFT RCS usually available above the redline, no dump would be performed. Other factors also would tend to say we should not dump the AFT RCS. Performing such a dump would create additional procedures, rules, operations, orbit changes and additional wear and tear on the RCS system that provides a backup deorbit capability. Additionally, since we do not protect against tank failures it is still desirable to keep as much as possible in each RCS pod to protect against such remote failures as the dual regulator or tank failure. Normal on-orbit AFT RCS and OMS management should reduce the downweight while still maintaining our options. The mission planners and ops personnel have reviewed and agreed on the ballasting/weight calculating procedures and rules to assure that the same assumptions are used. With the above steps being taken, it is felt that we should not routinely plan to dump AFT RCS just to reduce downweight. The door is open, however, to do an AFT RCS dump on the particular day where we have to come home early, we are landing heavy, and the ARCS could provide some real relief with respect to downweight. On such an occasion, however, the dump, if considered, should be limited to an amount which would reduce the weight to <220,000 lbs while protecting entry redlines. A memorandum to the Program will be provided on the above by DA8.

6. IMU Prelaunch Hold Capability Approach - DA8/A. L. Briscoe

The last Flight Techniques meeting reviewed all the activities in work with respect to increasing the IMU hold time capability with the ultimate goal of being able to cover a 3 hour launch window. Based on the data received, it appeared that with some relatively minor analysis, the IMU hold time capabil-

ity could be extended for its present 90 minutes to 135 minutes from a nominal T-0. This equates to a 50 percent increase. It also appeared that the real-time software prediction capability would be only a short term solution until the implementation of the G9/G1 software change to allow IMU gyrocompassing in G1, which allows basically a launch anytime in the window capability. Additionally, present capabilities allow us to support launches early or late in a 3 hour window. Based on the data above a memorandum to the Program has been generated with specific recommendations which basically Include (1) performing the analysis necessary to increase the IMU hold time to 135 minutes, (2) determining if or by how much the 135 minute capability could be augmented assuming the vehicle vector and targeting could be updated, (3) continuing with the development of the G9/G1 IMU software fix, and (4) presuming items 1-3 can be accomplished, stopping development of the IMU real-time analysis programs for extending IMU hold capability. The memorandum is in the review cycle and DA8/G. E. Coen is coordinating this activity.

7. RHC/SRB RGA Proposed Fixes for A/D MDM Failures - DF6/J. W. Bantle

Mr. Bantle reviewed the current status of the MDM A/D conversion failure case and the Impact on RHC's and SRB RGA's. Fixes to cover the RHC's and SRB RGA's have been in work for some time (since STS 61-C). Procedural work-arounds have been Implemented in the case of the RHC's but the SRB RGA's have no comparable solution. The procedural RHC fix does not solve the problem, It only reduces susceptibility to the MOM A/D failure. Procedural mistakes could occur and the crew/ground workload is increased. The procedure basically has you port mode or restrung to recover from the first failure (MOM type failures) which is annunciated to the crew. Additionally, numerous suggestions for software changes to determine MOM health and annunciate/comm fault the MOM have been looked at. Again though, the schemes would not have detected all failures and could have conceivably comm faulted a good MDM. Also some plans did not help the SRB RGA problem. Hardware rechannalization along with associated software changes were considered for both the SRB RGA problem and the RHC's. With respect to the SRB RGA's this concept looks promising (see enclosure 3). The plan would be to use four SRB RGA's with a fifth RGA held as a spare to be substituted prelaunch should any of the original RGA's fail. Detailed hardware rechannalization and the associated software changes have been identified and are currently under analysis. The proposal has been approved at the SIR and is scheduled for the PRCB.

The proposal on how to fix the RHC problem is still under review and more work is required. After considering the hardware rechannalization with associated software type change, a revisit of proposed software only schemes was determined to be a prudent activity. The appropriate folks are now off looking at software fixes again to solve the RHC problem. Both of these issues, the RHC's and SRB RGA's (really the MDM A/D conversion failure) are considered safety of flight and should be fixed prior to the next flight.

8. RTLS ET Separation RCS Jet Requirements - DF6/R. E. Yackovetsky

This Item was postponed until the next meeting.