

FROM: DA8/Chairman, Ascent/Entry Flight Techniques

SUBJ:Ascent/Entry Flight Techniques Panel Meeting #19 Minutes

The 19th Ascent/Entry Flight Techniques Panel was held at JSC on February 21 and 25, 1986. Rockwell-Downey participated via teleconference.

Summary

a. CB presented a review of the Ames NWS/braking simulations, models and simulator fidelity along with a number of recommendations concerning future tests and improvements. Additionally, new rules were proposed with respect to crosswind limits, wet runways, and braking/rollout margin evaluations. These will be reviewed by DF, engineering personnel, and the Program for their concurrence.

b. CB proposed two additional NWS DTO's on an opportunistic basis, i.e., if we are landing at EDW anyway, to verify GPC NWS at high speed on a hard surface runway, and DIRECT NWS, first on a lakebed and then on the hard surface runway. Techniques supports these DTO's and the DTO rules will be updated and reinstalled in the FDF.

c. MLS and TACAN ground equipment appear to be adequately redundant. The full up MLS system is fully redundant with auto switchover capability for failures. The TACAN system has some single point failures but alternate TACANS are available. It should be noted that MLS JR's will not be redundant.

d. Prelaunch hold time based on IMU capability can probably be increased to 135 minutes from a nominal TO time (165 minutes total time from OPS 1). Some studies and RH changes will be required.

e. Prelaunch software modifications are being planned to G9 and G1 which should alleviate the IMU hold time constraints.

f. Based on 4 and e above, it is questionable whether all the real-time analysis software programs to evaluate IMU hold capability (like used on STS 51-L) are required.

g. A new bodyflap/elevator trim software modification has been proposed for 01-12 which nominally does away with crew procedures concerning elevon schedule selections. The whole CG range would be accommodated with the "alternate schedule" available if needed for DTO or other purposes. Flight Techniques endorses this change.

h. The FDO's proposed a new rule on end-of-mission CG management priorities. Further discussion and review will be required.

i. FWD RCS DTO plans are still in the mill. Until at least some of the DTO has been accomplished, however, FWD RCS dumps during aborts (RTLIS and TAL) to reduce down weight will not be planned.

j. Prelaunch commanding and TMBU requirements have been greatly reduced, primarily by requesting appropriate software changes.

1. Ames NWS/Braking Simulation Results - CB/F. L. Culbertson

Mr. Culbertson reviewed the Ames simulations of NWS/braking capabilities along with their results and some concerns over the testing and various models involved. Even though the tests indicate that the NWS system should be acceptable, a better tire model and anti skid model need to be agreed upon and implemented so that a more accurate set of data may be obtained during the next series of tests. These tests should provide more data on NWS, the proposed DTO's, crosswind capability, tire failure cases, etc., with the "new" tire model. If any auto braking type tests are to be done, the anti skid model must be made accurate. Two new NWS DTO's were proposed which would be done on an opportunistic basic, i.e., if we were landing at EDW anyway for some reason. One would provide an evaluation of the NWS GPC mode at high speeds on a hard surfaced runway, and the other would test the MANUAL mode (with the parabolic transducer) first on the lakebed and then on the hard surfaced runway. The testing of the MANUAL mode would be the higher priority DTO. These DTO's were accepted and will be pursued for Program approval. All crews would receive sufficient training to accomplish the DTO's should we land at EDW. NWS DTO rules will be reviewed and returned to the FDF. Based on various simulation runs and flight experience to date, several flight rules changes were proposed: These included limiting crosswinds for RTLs/TAL/AOA to 10 kts, not landing on a wet ungrooved runway, and limiting the brake energies used in determining rollout margins to the flight experience numbers which are much lower than spec and the numbers we have been using. We are presently using 55 million ft-lbs for aborts and 42 million ft-lbs for EOM as the limits on single brake energy for rollout margin evaluations. The proposed rules would reduce these limits to 41 million ft-lbs and 34 million ft-lbs respectively. The rules also take into account the use of actual crew procedures. All of these rules changes will require the concurrence of not only OF and the engineering community but also the Program.

Action: 02/21-001 - DF4/A. L. Schmitt, ES6/C. C. Campbell - Provide a coordinated, engineering and program approved set of flight rule inputs concerning (1) use of wet ungrooved runways, (2) a crosswind limit of 10 kts, and (3) the determination of brake energy to be used in the rollout margin rules. Update the SODB as appropriate.

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Action: 02/21-002 - DM5/J. V. West - Once the numbers to be used for brake energy have been agreed upon, evaluate their impact on rollout margins.

Action: 02/21-003 - ZS8/G. Rigdon - Determine impact of reducing crosswind limits to 10 kts on launch probability. Consider RTLs, TAL, and AOA sites throughout the year.

Action: 02/21-004 - ES6/C. C. Campbell - Determine If it is possible to make the anti skid model more accurate for future Ames testing and if not, which future Ames tests would be invalidated or suspect.

Action: 02/21-005 - DF4/A. L. Schmitt - Review and update the NWS DTO flight rules and provide to DA8.

2. Braking Techniques/Crosswind Rules Updates - ES6/C. C. Cambell

This item was covered under item 1 above.

3. Ground Navigation Aid Operations (TAC/MLS) - TM2/R. D. Simpson

Mr. Simpson presented a description of the ground TACAN and MLS systems covering locations, equipment, redundancy, failure monitoring, and controls. The full up MLS system appears to be fully redundant and contains switchover logic to select the backup system should the primary system fail. Monitoring equipment requires a 2 of 3 failure Indication to effect a switchover. An operator on site can remove power to both units should repairs be required as was done on STS 61-C. TACANS are also somewhat redundant and provide for auto switchover, but depending on the particular model, it could take from 10 seconds to 6 minutes. Certain models have two motors to drive the antenna but if either fails, the unit will not operate properly. Procedural aspects of ground navigation systems operations will be discussed at a future meeting since we are not only interested in the equipment, but how the folks operate it, what they do for various failure cases, who they notify, etc. We believe that the LSO Is our interface with the outside world, but how the problems are relayed to us and/or possibly the STA pilots is something we would like to know.

Action: 02/21-006 - TM2/R. D. Simpson - Provide a briefing at the next techniques meeting on specific operational procedures used by ground navigation system personnel.

4. IMU Hold Time Extension - DF6/R. S. Galvez, EH5/M. E. Jones

DM5/E. E. Smith led off the discussion of IMU hold capability with a summary of previous analyses on IMU hold capability. Originally five cases were studied with hold times of 0, 45, 90, 135, and 180 minutes. A covariance matrix was generated based on accumulated navigation and environmental errors from the time of release to El. Monte Carlo analyses were then performed to determine the constraint for launch with the driver being skipout protection. The results established 90 minutes as the program constraint for steep AOA (shallow AOA was not protected). Since that time, entry guidance software has been modified to initiate active guidance at a drag of about 3.0 ft/sec/sec instead of 4.0 ft/sec/sec. This modification reduced targeting sensitivity to dispersions and improved skipout protection which should mean an increased launch hold capability for AOA. Integration of the guidance change with previous analysis data seems to indicate that an increase from the 90 minute hold time up to 135 minutes is possible. Some changes to RM I-loads and monitor procedures would be required, but skipout protection would still exist. Mr. Jones, along with Messers Lecher, and Thibodeau provided us with insight into the activities presently underway to increase IMU hold time or eliminate it as a constraint. There is a rather large effort underway to provide a real-time analysis capability which would allow you to develop an IMU hold time predictor. This real-time capability would be used each launch to predict IMU hold times based on an evaluation of accelerometer and gimbal angle data. To perform this function would require software development, computer hardware, interfaces for real-time telemetry data, additional personnel, and a great amount of verification and simulation testing. This real-time assessment/prediction capability will not be required, and will not work, when the software in G9 and G1 is modified to allow IMU gyrocompassing

to continue across the G9/G1 transition and on until the release command is given at about T-26 seconds. This software change is currently being worked. It would seem that if we could extend the IMU hold time to 135 minutes from the nominal TO, and use the additional techniques of delaying the start of the gyro calibration in G9, or recycling early enough to allow the latter part of a 3 hour launch window to be supported, that this software development/real-time predictor work could be terminated at least from the standpoint of using it as a hold time predictor for launch. The new G9/G1 IMU software modification would allow a launch basically anytime within the given launch window. DG6/R. S. Galvez reviewed the present IMU hold/recycle timelines as well as IMU RM and proposed GNC IMU monitoring techniques. There seems to be no reason not to pursue increasing the IMU hold time to 135 minutes even though some RM limits and monitoring techniques changes will be required. We should also run this back through the design evaluation cycle and perform some additional Monte Carlo runs.

Action: 02/21-007 - MDAC/T6B/M. McCulloch - Provide IMU RM data/I-loads to accommodate an increase in IMU hold time of 135 minutes.

Action: 02/21-008 - DF6/R. S. Galvez - Develop necessary IMU monitoring techniques to support the G9/G1 software changes.

Action: 02/21-009 - DM/J. C. Harpold - Perform an evaluation of the 135 minute (165 minutes total) IMU hold time capability from the standpoint of RTLS, TAL, and AOA. Additionally, investigate the extra hold capability or improvement which could be obtained if a new vehicle state vector could be uplinked post-MECO based on tracking from MIL/BDA.

5. Bodyflap/Elevator Trim Logic Update - EH2/L. B. McWhorter

Mr. McWhorter presented a new proposal which would eliminate the need for mission unique elevon schedules except in specific DTO cases. The proposal, which is being pursued for 01-12, would provide the flexibility to fly any CG within the design specification limits without requiring the crew or the ground to determine the CG and pick an appropriate elevon schedule. The approach looks at the current bodyflap position feedback and the trim elevon position computed by the DAP to determine if the bodyflap should be moved in order to better balance the longitudinal trim tasks between the two surfaces. Groundrules used in the design were that (1) the bodyflap should be kept between 5 degrees up and 15 degrees down above Ms, (2) the elevon trim position should be restricted to be between the generic FWD and AFT schedules, (3) the GRTLS should not be changed (one schedule used for all configurations), and (4) the capability should be maintained to use a specific schedule if required for test or other purposes. Test case runs indicate that the proposed change works and provides results consistent with those observed using the current bodyflap logic. No flight testing would be specifically required after the change, but we should consider providing the crew with data on the expected activity so that they can monitor the elevon/bodyflap for proper operation. Additionally we should establish what the alternate elevon schedule should become.

Action: 02/21-010 - DF6/H. J. Clancy, EH2/L. B. McWhorter - Do we need to establish crew monitoring limits for proper operation of the new elevon/bodyflap trim software? If so what are they and what actions

should be taken if the limits are exceeded? What use should be made of the alternate schedule, i.e., no yaw jet?

6. Mass Properties/CG Planning and Management - DF7/B. E. Jones, DM6/G. T. Oliver

Captain Jones reviewed the premission planning sequence with respect to mass property data, who generates it, who gets it, the guidelines on a flight to flight basis, etc. Mr. Oliver presented inflight management of the CG in the form of a proposed flight rule which provided a set of prioritized objectives for managing the EOM CG. There was some disagreement with the order of the list, and a referenced rule (also new) was not provided so that the two rules could be reviewed together. Based on this, it was decided to defer a review of the EOM CG management rule until the referenced rule was also available and personnel had a chance to review both. The primary disagreement on the order of priorities has to do with just where protecting the EOM landing weight should be placed in the list. The proposed rules will be reviewed in a splinter meeting.

Action: 02/21-11 - DA8/A. L. Briscoe - Set up a splinter meeting to review proposed rules 4-72C and 4-72K.

7. FWD RCS DTO Plans - VF5/R. B. Ramsell

Mr. Ramsell stated that there are still plans to perform FWD RCS DTO firings even though we were told during STS 61-C that the down weight problem, which initially brought up dumping FWD RCS, had been solved. Present plans would be to modify upcoming flight software to perform the PTI's as four jet, 4 second burns (like STS 51-L) with the deletion of PTI 1 and PTI 4. Exactly what we do here will not be known until the manifest is established. For the time being, mission designers are not planning to use the FWD RCS dump capability during aborts until such time as the DTO burns have been performed.

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8. Prelaunch Commanding Reduction - DF2/R. E. Castle

Mr. Castle reviewed several aspects of the prelaunch count as well as a proposed standard support plan for ascent/entry communications. Prelaunch commanding has been worked by OF to reduce the number of commands and their time criticality. Changes have been submitted to delete the OPS Recorder LCC requirements and move the recorder commands earlier in the count. Additionally, a CR has been approved which should remove the need for the prelaunch antenna management TMBU. Changes have also been proposed to modify the abort command checks such that the commands will not have to be built, but instead will use the stored commands/abort switches. All of these changes should help reduce command error possibilities. Mr. Castle also proposed that we not support the comm activation procedures which occur early in the count at approximately T-17 hours and instead let KSC perform them. Some air/ground and command interface checks would be performed by JSC when we came in for the prelaunch planning shift. It was felt that the test should be done and that JSC should continue to do it for some time at least. It costs only an INCO and FD above the DE support and provides us with early

insight into any communications problems. A standard set of communications operations for launch and landing were proposed by Mr. Castle and accepted. MIL/PDL handover times also need to be standardized if possible.

Action: 02/21-012 - DF2/R. E. Castle - Determine if the MIL/PDL handover times can be standardized to avoid the throttle change time period and the "go at throttle up" call.

9. Prelaunch Systems TMBU Requirements - DF6/A. J. Ceccacci, DF7/R. J. Rector, DF4/R. K. McCluney

We reviewed the various systems TMBU requirements and the proposed changes to eliminate unnecessary prelaunch commanding. The present TMBU requirements can be eliminated by various software updates with only two exceptions, and one of those can also be fixed by a software code change which has been written as a CR. Software changes have been approved to set the APU EGT FDA to off scale high and the APU N2 MASS to reflect a fuel load of 325 pounds. They should be changed in OI-7C. Additionally, a software CR has been written to adjust the N2 MASS to reflect a WSB H2O load of 118 pounds. The last change could take somewhat longer than OI-7C to fix, and so a TMBU may be required here for a couple of flights. Without the TMBU, the onboard computation would have too large a bias. The EECOM's were requested to seek software changes for the backup emergency DP/DT and cabin pressure FDA limits. This should avoid nuisance alarms during ascent. The last set of TMBU's considered were the BFS RCS quantity TMBU's. It was decided that a quantity TMBU was not required if the loaded quantity was within 3 percent of the actual quantity. This will provide adequate leak protection and still reduce requirements to send BFS RCS quantity TMBU's.

Action: 02/21-013 - DF7/R. J. Rector - Update the software FDA limits for backup emergency DP/DT and cabin pressure so that TMBU's will not be required.

Action: 02/21-014 - DF6/A. J. Ceccacci - Provide a new flight rule on updating the BFS RCS quantities.