

July 25, 1983

DA8/Chief, Ascent/Entry Flight Techniques

Ascent/Entry Flight Techniques Panel Meeting #3 Minutes

The third Ascent/Entry Flight Techniques Panel was held on May 6, 1983. Rockwell-Downey, NASA Headquarters, Draper Labs, and DFRC participated via teleconference.

Summary

- a. FRCS dumps will only be done for cg management purposes. They will not be done to facilitate ferry flight.
- b. The cg envelope for the flight rules is Y +-2 inches and X cg from 1108 to 1083 inches. A pitch stability problem at M 5.5 was identified, but it is no problem for STS-7.
- c. Flight test plan PTI's, elevon schedules, alpha profiles, and cg's were reviewed.
- d. There is no need for roll reversal phasing or further studies to determine same because the STS-4 aero update has allowed alpha uncertainties limits to expand.
- e. The postlanding hydraulics load test is deleted (at least thru STS-11).
- f. Rockwell is studying putting the SSME repositioning software in OPS 3 to allow earlier APU power down.

The first four agenda items were all deferred until subsequent meetings:

1. Ascent Mode Boundary Definitions
2. Braking - Recommendation for Operational Profile
3. Standard RCS Redlines
4. Standard Procedure to Determine "NO GO Maneuver" Time
5. Ferrying and Turnaround Impact for FRCS Propellant - KSC/H. Lambert

Forward RCS dumps have been accomplished on all flights, so far. For STS-2, the dump was used to approach a "nominal" cg close to previous flights for data extraction purposes. Emerging in this time frame was a "preference" for always dumping forward RCS for ferrying operations, as was done for STS-4, 5, and 6. Although Mr. Lambert did not attend the meeting, he reported that there is no impact to either turnaround or ferrying operations if the forward RCS is not dumped. Thus forward RCS dumps will be performed only as required to manage the cg. §

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7. CG Placards - EH/L. McWhorter (Enclosure 1)

A simplified cg placard for use in the flight rules was proposed by Mr. McWhorter. There is a forward cg concern, specifically for GRTLS, because

of a potential pitch instability. Since the cg for the STS-7 GRTLS is 2 inches aft of the region of concern, we asked that he tell us the details and identify the missions where some action is required. The action recommended is to go to CSS.

8. PTI Test Plans-ET/D.Cooke

Mr. Cooke reviewed current test plan elevon schedules, PTI's, alpha profiles and CG's out thru STS-17. Of interest for STS-9 is a proposed manual speedbrake sweep to gather data on the quarter hertz oscillation typically seen in roll at M 1.5. A candidate explanation of the oscillation is that shock detachment/center of pressure shifts are occurring as rudder in puts are made. Testing out to 1.5 inches Y cg is planned. Largest Y offset flown so far has been 1 inch on STS-4 and STS-5. Estimates are that STS-7 Y cg will be -1 4 inches. The various alpha profiles and elevon schedules are contained in enclosure 2. A new "nominal" profile (like that flown on STS-6) will be used for STS-8 and STS-11. Proposed elevon profiles are also contained in the enclosure. Techniques has previously baselined which (and when) to use the alternate elevon profiles for STS-7, 8, and 9. Specific PTI maneuver windows and effectors are also enclosed.

9. Entry Wind/Roll Reversal Phasing - MDAC/FM/J. Kirk

Mr. Kirk discussed the results of his study to see if roll reversal phasing should be a consideration on any future flights. Using STS-4 aero data, the alpha errors induced by winds can now be tolerated up to 5 degrees (M 7) and 6.5 degrees (M 6). The yearly worst case winds at KSC, EAFB, NOR, and VAFB were evaluated. None of the winds for all vehicle headings exceeded the new limits. He recommended, and we accepted, not considering roll reversal phasing in the future.

10. Thunderstorm Fly-Through Constraints - Rockwell

Thunderstorms are a phenomenon that are prevalent in the summer afternoons at KSC. Undesirable manifestations of thunderstorms include rain (TPS, structure) hail (TPS, structure, control), severe winds (control, performance), and lightning (structure, critical systems). Statistically, it would be undesirable to always have launch and landing opportunities in the early morning. Other considerations (i.e., payload deploy windows, etc.) also drive launch and landing opportunities. Hence, it is not always possible to have an early morning launch and/or have the limited amount of resulting KSC landing opportunities occur in the morning. Fortunately, STS-7 and 11 KSC landings have early morning opportunities.

Launch Commit Criteria (LCC) is such that the Shuttle will not be launched if there is any precipitation at the launch and abort landing sites and if the nominal or RTLS flight path will carry the vehicle within 2 nm above and 5 nm horizontal distance of an anvil associated with a thunderstorm.

For thunderstorm activity predicted, prior to deorbit, to be in the KSC vicinity at landing, we plan to delay 1 day if KSC weather is predicted to improve and the Orbiter's consumables status permits. If KSC's weather is not predicted to improve and/or the Orbiter consumables/systems status does not permit a delay, that day's opportunity to a secondary-landing site (SLS) (EAFB for STS-7) will be utilized. Postulating the situation where the weather forecast was erroneous and thunderstorms form post TIG, flight rules call for maintaining a 5 nm horizontal or 2 nm above displacement from any anvil associated with a thunder-

storm. In this situation, the only avoidance methods considered are HAC selection and runway redesignation.

RIC/B. L. Giffin addressed the amplitude and statistical frequency of lightning strikes, reviewed LCC and flight rules weather criteria, identified vehicle modifications to accommodate limited amplitude lightning strikes, and reviewed the current status of Orbiter testing.

Twenty KA strikes represent the peak cloud-to-cloud type of strike. Eighty percent of all cloud-to-ground strikes are below 50 KA. When calculating the total probability based on (a) average of strike probability, (b) KSC daytime effective thunderstorm rate, and (c) strike amplitude distribution, it is found that there is a 99.9% probability of not exceeding a 50 KA strike. Criteria for computation of strike probability and resulting probability as a function of strike amplitude level is provided in enclosure 3. Current Orbiter testing is designed to determine Orbiter susceptibility to the aforementioned 20 KA (ascent) and 50 KA (descent) levels. Mr. Giffin identified hardware testing modifications and status thereof (enclosure 3). It was noted to the AEFTP that testing was not complete; hence, the Orbiter is currently considered net to have a lightning strike capability.

11. Postlanding Hydraulics Loads Test - Rockwell

The postlanding hydraulics test was performed on STS-2, 3, 4, 5, and 6 to gather hydraulics main pump and APU gas generator chamber pressure data. The test entailed manually cycling the elevons, rudder, and body flap with system one depressed and then system two depressed. The duration of surface motion is approximately 80 seconds.

RIC/T. Farkas (APU Operations) discussed the test from an APU gas generator standpoint. During the test, gas generator chamber pressure is monitored. Fluctuations of chamber pressure (+ 300 psi), under a high load situation provided by the postlanding test, is indicative of the APU reaching its age life span. Mr. Farkas felt that, with the new APUs on the vehicles, the flight data would be sufficient to status the gas generators. It was not considered necessary to schedule a postlanding loads test on a STS-7, 8, 9, and 11. If flight data indicated an anomaly for a particular APU was reaching its age life, postlanding load test may be recommended in the future.

RIC/H. D. Davis (Hydraulics) discussed the test from a hydraulics main pump standpoint. Mr. Davis felt that the validity of the test was in question because prl does not allow load saturation of the system which was the original intent of the test. Previous flight experience has provided increased confidence in pump operation. Ascent, FCS check-out, and entry data was felt to be sufficient for checking pump operation. Deletion of the loads test from a hydraulics standpoint was recommended.

With agreement by E&D, per Rockwell's recommendation, the postlanding hydraulics loads test will not be planned for STS-7 through STS-11. To cover the situation where there is an inflight anomaly on an APU, the postlanding checklist will retain the procedures with a note indicating that it will be an MCC call.

12. Reduced Postlanding APU Time - ric/T. Farkas

Mr. Farkas addressed the costs associated with postlanding APU run time and proposed some potential changes to reduce run time. Postlanding APU run time has been averaging approximately 18 minutes for STS-2 through STS-6 with two excursions up to approximately 20 minutes. Assuming APU changeout frequency of approximately 20 hours accumulated run time and 65 to 85 minutes prelaunch and flight usage, the 20-minute postlanding run time extrapolates to an approximately 20% reduction in APU usability for flight. Another way to look at it is that an APU may have to be replaced every 11 flights as opposed to every 14 flights. When considering the

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delta costs (KSC and vendor) for APU removal and refurbishment over a 100 missions, Mr. Farkas estimates a 15-million dollar per vehicle cost to the program.

RIC/M. J. Kronfly (Hardware and Software Systems) presented concepts of software options to automate some of the postlanding operations; thereby, reducing APU run time. With the cancellation of the hydraulics loads test through STS-11, the most promising option is to move the SSME repositioning SW into OPS-3.

Rockwell has been supplied our estimates of postlanding run-time saving using OPS-3 software by DH3/S. Grega. The time savings do not appear significant.

Gary E. Coen