

DA3-83-22 (FT)

May 27, 1983

TO: Distribution

FROM: DA8/Chief, Ascent/Entry Flight Techniques

SUBJECT: STS-7-11 Ascent/Entry Flight Techniques Panel Meeting #1 Minutes

The first meeting of the Ascent/Entry Flight Techniques panel was held on Friday, March 18, 1983. NASA Headquarters, Draper, DFRC, and Rockwell participated via teleconference.

#### Summary

- a. Recommended EDW as AOA prime site for STS-7 and NOR as weather alternate. Subsequently program approved EDW as prime, but not NOR as alternate. Alternate remains KSC.
  - b. Reviewed, modified and baselined mission rules for concrete landings.
  - c. Same for night landings.
  - d. Recommended carrying a spare HUD for night landing flights. Program Office has approved for STS-8 only
1. Vehicle Differences from STS-6 (Entry) - Rockwell
    - a. Hardware and Specifications - Deleted
    - b. Software, PASS, and BFS - RIC/M. Mazur

A summary of the entry software CR's for STS-7 through STS-9 are shown in enclosure 1.

#### 2. STS-7 Landing Opportunities - FM5/J. Harpold

The STS-7 landing opportunities based on an April 20 launch date are shown in enclosure 2. The nominal EOM landing is on rev 96 (flight day (FD) 7) at KSC with a crossrange of 232 nmi at about a half-hour after sunrise. There is a one rev KSC backup landing opportunity on rev 97 with a 667 nmi crossrange. The weather alternate on FD 7 is at Edwards on rev 98 with a 732 nmi crossrange, which is too large to permit the entry DTO's. Good KSC and marginal Edwards opportunities exist on FD's 8 and 9. Any Orbiter maneuvers designed to decrease crossrange will also cause earlier landings, which are already marginal at Edwards from a lighting standpoint. However, a June launch as is now planned, improves the lighting situation. Any slip in launch time gives approximately a 1:1 slip in landing time. Northrup will not be activated as a weather alternate site for STS-7, but will be

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considered a contingency site. The AOA prime landing site was originally KSC (vehicle weight of 229K lb.) with Edwards as the backup. There was some concern expressed about having KSC as prime AOA for such a heavy landing weight on the first landing at KSC. Subsequent to the meeting the AOA sites were swapped. Edwards is now the prime site, with KSC the backup. One concern expressed about a June launch was that the SCA would be at the Paris Air Show and thus unable to support the mission. However, since the launch date has subsequently slipped, the SCA will be back in time and this

concern has gone away.

a. KSC Weather Criteria - CB/R. Bridges

There are no recommended changes to the weather criteria for KSC landings as currently stated in the flight rules. There was some concern expressed about the probability of having > 0.5 cloud cover during June.

b. Thunderstorm Avoidance - DH3/W. Bolt

The following alternatives for dealing with thunderstorms in the KSC area at the planned time of landing were discussed:

(1) Pre-deorbit

- o Select HAC
- o Redesignate to alternate landing site or delay to a backup landing opportunity (could be 24 hour waveoff)

(2) Postdeorbit

- o Select HAC after blackout
- o Redesignate to alternate landing site (e.g., Jacksonville, Tampa, Orlando)
- o Ground Controlled Approach (GCA) around the storm
- o Fly through the storm

It is doubtful that selecting the HAC predeorbit would be useful because of the amount of time that would elapse before landing and the usual unpredictability of thunderstorms. We will waveoff one day if the next day's weather is predicted acceptable. If it is not, the Orbiter will come in to EDW. Postdeorbit, selection of the HAC would have to wait until after blackout. Of the three alternate landing sites listed, Orlando is the best choice with a range difference of 50 nmi short along the ground track, while Tampa range difference is 100 nmi along the ground track, and Jacksonville is about 100 nmi crossrange. Targeting to the latter would require careful phasing of the roll reversals. An Orlando landing designation could probably wait as long as until Mach 8, whereas Tampa would have to be chosen sooner. However, it was decided that the site redesignation is not a realistic or desirable option. It might be better to challenge the weather.

Problems with the GCA option include the small size of the maneuver footprint (<50 nmi by Mach 2) which is shown in enclosure 3, integration of radar and MCC displays, and interpretation of radar. Also, there is no simulation or practice capability.

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The range differences for changing the HAC at Mach 2 are also shown in enclosure 3. These are viable options at TAEM interface. The last option discussed was the possibility of flying through or near the thunderstorm if necessary. However, we need to know more about this.

Action: 03/18-001 - RIC/K. Lengner - Report results of studies that determined thunderstorm fly-through constraints. Due May 6, 1983, AEFTP

c. Landing Aids - DH3/W. Bolt

There will be C-band coverage from the west coast to landing, and S-band

from about Mach 11. The navigation and landing aids available for STS-6 are shown in enclosure 4. There are no differences in the capabilities of the landing aids at KSC between STS-6 and STS-7. However, the modified MLS antennas will be installed at KSC which eliminate the 50 ft crosstrack polarization error. The antenna for the primary system on KSC 15 has been installed so far, but the backup and KSC 33 antennas will not be installed until September. For STS-7 there will be no MLS ground station at DKR, but it will be installed before STS-8. However, the flight software will not accommodate the DKR MLS until flight 9. There was a discrepancy between the precision approach path indicators (PAPI) lights and software aimpoint on STS-6 due to PAPI light placement at 8040 ft instead of 7500 ft. This has been corrected for STS-7 by moving the runway aimpoint in the flight software by 540 ft so as to be compatible with the placement of the lights.

d. KSC Vehicle Systems Requirements - DF6/D. Whittle

Enclosure 5 shows the proposed (as modified at the meeting) vehicle systems required for KSC landings. It was decided at the meeting that these requirements are appropriate for all concrete runway landings and not just KSC. No special requirements for a "first KSC demonstration" are needed. At least two APU's are needed since the loss of APU's 1 and 3 or 2 and 3 reduces braking torques by half and degrades control capability. For landing on a concrete runway at least one complete set of displays is needed (ADI, HSK, AMI, and AVVI) since KSC has a fairly high probability of cloud obscuration, and attitude and position data should be available. The actual displays needed for any landing depends on weather, winds on HAC, and the landing site (i.e., whether concrete or lakebed). A question raised, was if the weather is close to limits at KSC with weather good at Edwards and no ADI's are operating, then should the Orbiter go to Edwards instead? The rules were modified to show that the display requirements would depend on visibility, winds, and weather aircraft observations.

Action: 03/18-002 - DF6/D. Whittle - Submit systems flight rules for concrete landings as modified by Techniques.

It was decided to add the speedbrake to the concrete landing requirements since the next failure in the FCS could result in an unfavorable energy condition. However, the proposed FCS requirement was deleted because it only applies after deorbit, so no options are available. Also, the AA's, RGA's, and FCS channels have direct effects on controllability. It was decided to NO-GO a concrete landing for the failure of three instead of two MLS.

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For the ground systems requirements, it was decided to remove the requirement for PAPI lights since adequate backup displays are available. For a landing with an undeployed payload, we baselined going to the lakebed at Edwards instead of the concrete runway at KSC. However, subsequent work has indicated we should decide based on rollout margins, so no weight rule will be written for STS-7. There are no changes to KSC surface wind constraints for landing.

3. Night Landing (STS-8) - DH3/T. Brown

a. Landing Aids

To support a night landing, several visual landing aids are available.

These include PAPI's which are used in the same manner as in daylight but with lower intensity; strobe lights; centerline Xenon lights or approach light system for azimuth information; ball/bar system for vehicle/IGS relative position; threshold lighting or reflectors; runway edge lights or reflectors; and Xenon floodlights to enhance the pilot's depth perception. Of these landing aids, only the strobe lights are not mandatory for a night landing. Since the launch is at night (thus a night RTLS or AOA), these aids will also have to be operational for launch. There are spare generators and/or lights available at each site in case of a unit failure. The location of the night landing light system is shown in enclosure 6. One issue raised was whether or not dust kicked up by landing on the lakebed would obscure some of the lights. Based on fly-by tests using the KC 135, some of the lights may need to be moved to avoid dust obscuration. It was estimated that any lights or generators could be repaired/replaced within about an hour. This precludes the need for predeorbit mission rules.

b. Alternate Options - FM5/J. Harpold

The landing opportunities for STS-8 were presented at the meeting, but are now outdated due to the mission redesign. This topic will be revisited in a later Flight Techniques meeting.

c. STS-8 Weather Criteria - CB/R. Bridges

Although the STS-8 mission has changed since this meeting, the FD 1 and EOM landing opportunities are still at night. Some proposed weather criteria changes for night landings were presented (see enclosure 7). The maximum allowable headwind would be reduced from 25 to 20 knots, in order to achieve a predicted touchdown at least 1000 ft past the threshold using the nominal aimpoint. This is due to the absence of close aimpoint PAPI lights (EOM) or PAPI lights night lighting (RTLS), which would increase the possibility of a short touchdown if the nominal aimpoint is used.

It was also decided to reduce the maximum allowable crosswind (CW) limit from 20 to 10 knots. This is to reduce the workload on the crew, which is already high for a night landing without adding the complexity of landing with a high CW. The CW DTO will not be done on a night landing. If the CW at the PLS is higher than 10 knots, then runway selection would be downmoded according to the following priorities:

- (1) EDW 17
- (2) EDW 22
- (3) Delay 24 hours (if weather predicted to improve)
- (4) NOR 17

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There is also an additional visibility criteria for a night landing. The standard visibility of 7 + nmi (EOM) would remain, but with the provision that any blowing dust, sand, fog, haze, etc., would be of a low enough level to prevent attenuation of night lighting to an unacceptable level. The acceptability of the dust level for the actual night landing would depend on STA evaluation prior to landing.

d. Vehicle Systems Requirements - DF6/H. Clancy

One of the main concerns about a night landing is the work load on the pilot (CDR), and this should be reduced to a minimum. For this reason the visual landing aids mentioned earlier are essential. The MLS is also required, as this provides an accurate altitude determination to alleviate any concerns about loss of depth perception. The MLS is currently checked at L-1 day 20 hours, and powered off. It is also checked during OPS -8 FCS check-out on-orbit. MLS is not essential for daylight landings, and the current mission rules do not require either MLS LRU's or ground station. It was proposed for night launch/landing missions to make two of three MLS a requirement for the LCC, and possibly leave the MLS powered up during launch. It was also proposed to add to the mission rules a requirement for all four KSC and both EDW MLS ground stations as a prelaunch nav aids requirement. We modified the rules to state a requirement of one of two MLS to the targeted runway, for both RTLS and AOA. There is no need to add MSL failure of the Priority Flight Rules since they are covered by IMU rules for DPS failures, and the radar altimeter provides the same precision altitude from 5000 ft.

Another proposed requirement for night landing is the HUD, which significantly reduces crew workload and reduces the chance of dark adaptation problems. Currently the HUD's are last checked at L-18 hours and then powered off until the FCS check-out during OPS-8 on-orbit. The HUD check-out at L-18 is considered to be adequate, and there is no need to add them to the LCC (there is no way to check them closer to launch). A flight rule change was proposed to make the failure of a HUD reason to invoke the priority flight. However, this proposed change was rejected - losing a HUD will not invoke a priority flight. The current rules also state that if the left (CDR's) HUD is failed, swapping with the right HUD will be considered. However, because of the risk involved in losing both HUD's while trying to effect a swap, it was decided to leave well enough alone. It is better to let the pilot land the Orbiter with a good HUD, than to risk having no HUD's at all. However, it is the recommendation of the Ascent/Entry Flight Techniques panel that a spare HUD be carried onboard for STS-8 and subsequent night landing flights. Program approval for carrying on spare HUD on STS-8 (only) has been obtained.

Action: 03/18-003 - DH3/W. Bolt - Update mission rules night landing criteria. STS-8 and subs.

Action: 03/18-004 - DF6/H. Clancy - Submit rules as amended by AEFTP for night landing.

4. GC Placards - RIC

Deferred to next meeting.

S. Alternate Elevon Schedule and Bending Filter Recommendations - RIC

Deferred to next meeting.