

National Aeronautics and
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Reply to Attn of: DA8-08-041

TO: Distribution

FROM: DA8/Chairman, Ascent/Entry Flight Techniques

SUBJECT: Ascent/Entry Flight Techniques Panel #238 Minutes

Agenda

Two items were on the agenda.

- 1) Edwards Temporary Runway Brake Energy Recommendation -
- 2) MILA Forward Link Transition from NSAP to NTR - DD/B. Foster

A/E FTP #238 Executive Summary:

The A/E FTP reviewed two topics on January 22, 2008. The first topic was a final review of the flight rule limit that will be used to evaluate the no-drag chute brake energy on the Edwards (EDW) temporary runway for heavyweight vehicles. The limit was increased from 42 Mft-lb to 52 Mft-lb. This limit conservatively protects against a tire fire limit in the event that the drag chute is not available during rollout. The braking procedure that is found in several ascent/entry checklists will also be modified to reflect a more straight-forward braking technique. These updates clarify when a nominal braking profile or maximum braking profile should be used, which was not always apparent with the old braking procedure. This procedural update is a generic update that will apply to all runways. The second topic that was reviewed concerned a proposal to transition the forward link network circuits at the MILA Tracking Station from the legacy NASA Information Systems

Networks (NISN) Service Assurance Plan (NSAP) system to the updated NSAP Technology Refresh (NTR) system. The A/E FTP approved a transition plan that will begin with STS-122 and end with STS-124, which will incrementally transition both the primary and backup circuits to NTR.

1) EDW Temporary Runway Brake Energy Recommendation

USA/ presented data that addressed the action from A/E FTP #236 to determine EDW temporary runway availability as a function of a given brake energy limit. The presentation focused on the effects of density altitude and vehicle weight on the expected brake energy. The premise of the presentation was based on the 52 Mft-lb brake energy recommendation that had been previously presented at A/E FTP #236 as well. The 52 Mft-lb recommendation protects for a 3-sigma variance from the tire fire limit of 70 Mft-lb with a 99'th percentile k-factor applied to it to correct for the sample size of data. Normally, Entry Flight Design Level B constraints require 95'th percentile k-factors to protect similar entry-related parameters; however a more conservative stance was taken. This 52 Mft-lb limit also protects for 1-sigma variances from axle damage that is expected to occur when heat soaks back into the landing gear axle structure and exceeds 450 degF, which correlates to a brake energy of 60 Mft-lb.

In previous temporary runway studies, significant amounts of work had been performed using high density altitude conditions to understand the effects on brake energy. High density altitude conditions produce higher touchdown groundspeeds, which was assumed to produce the highest initial energy conditions for the rollout phase. This conclusion changed slightly when runway availability percentages were examined using both high density altitude conditions and low density altitude conditions on a month-to-month basis. When design headwind/tailwind profiles that push touchdown performance to the flight rule limits, the runway availability percentages are at their lowest when the density altitudes are low. This result is counter-intuitive, but correct because the percentages were developed considering both the headwind and tailwind profiles, which implies both ends of the runway were considered. A low density altitude environment will allow a stronger headwind before violating minimum touchdown energy requirements, which helps increase the runway availability percentages when compared to a high density altitude environment. These headwind cases are not concerns for high brake energy conditions.

Another significant conclusion from the density altitude study was that the brake energy never exceeded the 52 Mft-lb limit. The highest brake energy that was experienced was approximately 48 Mft-lb. This result shows that other touchdown performance parameters will exceed flight rule limits before the brake energy limit is exceeded. The study assumed a 228,000 lb vehicle, which is the heaviest end-of-mission weight (STS-125) that is expected throughout the remainder of the program.

A second study looked at the touchdown weight that would exceed the proposed brake energy limit of 52 Mft-lb. Both historical winds experienced for actual EDW landings and design wind profiles using high density altitudes were used for this study. The historical winds were no concerns from a weight perspective and suggested touchdown weight could increase well above 228,000 lb before brake energy or rollout margin is a concern for the temporary EDW runway. The design wind profiles using a high density altitude environment showed that the flight rule limit for rollout margin would be violated well before brake energy becomes a concern.

Decision: The A/E FTP accepted the no-drag chute 52 Mft-lb brake energy recommendation for the EDW temporary runway. It is acknowledged that there is conservatism imposed by this limit, but the remaining shuttle manifest is not expected to exceed the vehicle mass property assumptions that were used to derive this limit. Other touchdown performance violations are also expected if brake energy violations above 52 Mft-lb are observed. In the unlikely event that a higher brake energy limit is required to avoid a flight rule violation or to avoid an undesirable landing at the third priority landing site (Northrup), the flight rule rationale will reflect the assumptions used to derive the limit and other existing controls that are available post-landing to mitigate brake energy concerns. This no chute brake energy limit will only be used on the EDW temporary runway for heavyweight vehicles in conjunction with the delayed braking technique where the braking initiation cue will be 4000 ft remaining from the runway threshold.

In place of USA/, USA/presented a second topic that discussed a generic rollout braking technique. As a natural progression from the significant amount of work performed at the Ames VMS session in October of 2007 to validate the delayed braking technique for the EDW Temporary runway, improvements to the generic braking technique were developed.

The current braking procedure specifies braking will occur after the runway midfield point and after the groundspeed has decreased below 140 knots. If the vehicle has passed the 5000 ft remaining point without the groundspeed having decreased below 140 knots, the crew will implement a maximum braking profile that achieves deceleration rates at or above 9 ft/sec². If the pre-deorbit brake energy predictions indicate a flight rule violation, the crew may be directed to delay braking to 120 knots, yet still adhere to the 5000 ft remaining point to apply the maximum braking profile. The drawbacks to this procedure concern the reference to the runway midfield point, which is meaningless, and no procedural guidance on whether to apply nominal brakes or maximum brakes whenever the groundspeed is between 140 and 120 knots at 5000 ft remaining.

A similar, yet simplified, braking procedure was developed to eliminate the issues identified above. The procedure now specifies to initiate braking at either 5000 ft remaining or 120 knots groundspeed, whichever comes first. If at 5000 ft remaining the groundspeed is above 140 knots, maximum brakes are required. If the groundspeed is less than 140 knots at 5000 ft remaining, then a nominal braking profile may be used. This procedure still protects the flight rule requirement of 1500 ft of rollout margin remaining from the end of the usable overrun. Historical braking data for end-of-mission indicates that the crew nominally applies brakes at 100 knots, with a drag chute normally present, which suggests there is sufficient margin in this technique. The new braking procedure is shown below:

Decision: The A/E FTP accepted the recommendation to simplify and modify the generic braking procedure. This procedure resides in multiple checklists and all of them will be modified to reflect the new braking procedure. The procedure will be targeted for STS-124 and subsequent missions.

Action:

1. DM4/G. Pogue - Implement a 482 to all of the appropriate checklists to incorporate the new braking procedure for STS-124 and subsequent missions.

2) MILA Forward Link Transition from NSAP to NTR

DD/ presented a recommendation to transition the MILA tracking station forward link network from the legacy system, known as the NSAP system, to the NTR system. The MILA return link is already on NTR and has been in that configuration since STS-117. The NTR project has been in work since STS-121 and has transitioned NASA circuits throughout the continental United States. The backbone of the NTR system exists around a “triangle” between the Goddard Space Flight Center (GSFC), the White Sands Complex (WSC), and the Johnson Space Center (JSC) with dedicated circuits extending from this backbone to Kennedy Space Center (KSC), Marshall Space Flight Center (MSFC), Wallops (WLPS), and the Jet Propulsion Laboratory (JPL). The NTR system, in laymen’s terms, has larger bandwidth capacity than NSAP circuits, with the capability to route failed circuits to alternate circuits automatically based on designated priorities. The forward link extending from MILA to KSC is one the last remaining circuits left to be transitioned to the NTR system.

Bill proposed an incremental ramp-up plan that will transition the primary MILA forward link circuit to NTR after STS-122 has reached orbit. The backup MILA forward circuit will remain on the legacy NSAP system. The on-orbit phase is a very low risk configuration since two-way forward/return links will be established with MILA during crew sleep periods. If the NTR performs in an acceptable fashion during the mission, the entry phase of STS-122 will be flown with the primary MILA circuit on NTR. During the following mission, STS-123, the same NTR/NSAP primary/backup configuration will be used; however, this configuration will be resident throughout the entire mission including the prelaunch period. On STS-124, both the primary and backup circuits will utilize the NTR circuits.

FLIGHT CONDITIONS	MANEUVER
V < 120 KGS or 5K' remaining	BRAKE as required (8-10 fps ² , -0.25 to -0.3G)
* If 5K' remaining and V > 140 KGS – MAX BRAKING *	
V = 60 KGS	DRAG CHUTE JETT pb – push (JETT1,JETT2 It on)
V = 40 KGS	BRAKE < 6 fps ² (-0.2G) (Antiskid cutout)

The risk associated with the NTR system stems from its susceptibility to sustain “hits”, or transient losses of data partitions that are being transmitted on the circuit, based on service interruptions in any part of the circuit. This NTR susceptibility seems to be much higher than what the legacy NSAP system exhibited. This susceptibility becomes critical during the critical phases of the mission such as prelaunch, where Launch Commit Criteria (LCC) could hold a launch if network circuit hits cause the onboard Network Signal Processor (NSP) to lose frame sync with the ground, or during launch/entry where communications with the orbiter are mandatory.

There are risk mitigation factors that are currently in place to protect against untimely hits to the network during critical periods. First, the backup circuit will remain on NSAP during the first two flights of the ramp-up plan and can be invoked using a documented procedure within a minute under optimal conditions. Second, the network freezes the NASA-owned network component which can minimize the susceptibility of the MILA forward link and the MILA return link to perturbations elsewhere in the network. This mitigation technique cannot protect against network perturbations caused by non-NASA entities. Third, the STS-122 ramp-up proposal will include a review after the on-orbit portion of the mission to review performance before the entry critical phase will be accomplished on NTR.

Decision: The A/E FTP agreed to implement the NTR to NSAP MILA forward link transition plan for STS-122. It is fully expected that both the on-orbit and the entry phase will be supported in the NTR configuration. The ramp-up plan that encompasses three flights, STS-122, STS-123, and STS-124, was accepted. A review of the system performance will occur in between each flight to ensure no changes are required to the ramp-up plan.