



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: August 17, 1993

In reply refer to: A-93-97 through -103

Mr. David Thompson
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On February 9, 1993, about 0930 eastern standard time, the launch sequence for an Orbital Sciences Corporation (OSC) Pegasus expendable launch vehicle (ELV) was aborted by the National Aeronautics and Space Administration (NASA) range safety officer, in accordance with a previously established launch constraint. Several seconds later, the launch sequence was reinitiated by the OSC test conductor, and the missile separated uneventfully from its carrier aircraft. The ignition and staging of the Pegasus and its subsequent deployment of two satellites into low earth orbit were also uneventful. There were no injuries to personnel involved in the mission and no damage to mission assets.¹

The Safety Board investigated this anomaly, at the request of the Department of Transportation, in accordance with a Memorandum of Agreement dated June 5, 1989.

The Safety Board's investigation uncovered numerous deficiencies in the premission planning, organization, and approval processes, as well as last-

¹For more detailed information, read Special Investigation Report--"Commercial Space Launch Incident, Launch Procedure Anomaly, Orbital Sciences Corporation, Pegasus/SCD-1, 80 Nautical Miles East of Cape Canaveral, Florida, February 9, 1993" (NTSB/SIR-93/02)

minute improvisations during the launch countdown activities. The Safety Board believes that these deficiencies stemmed from the overall lack of clearly delineated command, control, and communications assignments on the part of the key participants.

For example, no formal launch readiness reviews were held that were attended by all key launch team participants. Separate launch readiness reviews, or their equivalents, were held by OSC, the U.S. Air Force's Eastern Range (ER) and NASA's Dryden Flight Research Facility (DFRF) and Wallops Flight Research Facility (WFF). However, since these reviews apparently focused on each organization's separate role in the launch, little or no direct communication took place between organizations, and the total effectiveness of the readiness review concept was thwarted. This situation is illustrated by the ER's restrictive Special Rule Number One,² which had ramifications that were not fully understood by either the ER, OSC or WFF prior to the rule's acceptance. DFRF, which is an organization that could have understood the ramifications of the rule, was not consulted before the rule was accepted and was unaware of the rule before the ELV was deployed.

By all accounts, the sole dress rehearsal before the launch was disjointed and abbreviated, did not take into consideration various abort scenarios, and, most importantly, did not confirm the lines of authority and responsibility of team members. Further, the dress rehearsal was concluded early because of launch and flightcrew rest requirements. The irony of these rest requirements became evident after sleep researchers concluded that the average total sleep received by the key individuals in the 26 hours prior to the launch was 3.7 hours. Moreover, a cumulative sleep loss in the 48 hours before the launch could have created major degradations in waking performance and alertness, according to the researchers. Therefore, the Safety Board believes that the probability was high that fatigue from disrupted circadian rhythms and sleep loss adversely affected the performance of some critical personnel during the launch.

In addition, intercom channel assignments were not well planned, standard intercom protocol was not followed, and no common intercom channel was considered primary by personnel in the mission control facility. The OSC test

²A rule establishing that a flight termination system dropout during the last 6 minutes prior to the launch was cause for a mandatory abort.

conductor and DFRF's ground-to-air communications coordinator (NASA-1), who were the individuals most involved in proceeding with the launch during the period of maximum confusion, were not monitoring channels 1 and 10, which were the channels most involved with range safety. Further, the WFF personnel having the overall safety responsibility for the launch (with the exception of WFF's range control officer) were not monitoring intercom channels 4 and 12, which were the channels most involved with the operation of the NB-52B launch platform. The Safety Board believes that the true decision makers should be allowed access to, and input concerning, real-time information, rather than receiving second-hand information, or, in some cases, none at all.

Also contributing to the overall confusion surrounding the launch was the absence of common launch documents and launch checklists. For example, the NB-52B's safety-related launch altitude limitation of 43,500 feet was included in WFF mission constraint documents but not in OSC documents. Moreover, OSC documents contained altitude restrictions that conflicted with each other, allowing key parties to operate on different assumptions about the correct launch parameters of the Pegasus ELV.

Although the actual launch of the Pegasus was not hazardous, it occurred under unsafe conditions that included general communications confusion and a lack of clear lines of authority and responsibility in the mission control room. This situation could have led to an accident or the unnecessary destruction of the ELV. If, because of the confusion, the Pegasus had been intentionally destroyed by WFF's range safety officer shortly after its launch, there was no absolute guarantee that the air space and sea space below would have been clear of ships or airplanes, despite the strong efforts to clear these spaces. Also, there was a potential risk to the NB-52B as a result of the destruction of the vehicle. Further, if the launch had been aborted because of the confusion, the NB-52B would have had to land in a no-flap configuration with the live, 41,000-pound Pegasus under its wing. Although internal safety locks on the Pegasus would have been functioning, the external safety pins that are in place during ferry flights and ground operation had been removed for the launch.

Lessons learned in past years on group interaction, the value of common procedures, fatigue and circadian rhythm awareness, and human ergonomics are being applied by the aviation industry on a daily basis. The Safety Board believes that such applications by the commercial space industry could improve the quality and safety of commercial space operations.

Therefore, as a result of the investigation of this incident, the National Transportation Safety Board recommends that the Orbital Sciences Corporation:

Require, as part of ELV launch planning documentation:

- o Clearly delineated statements of authority for all parties and key individuals involved in the launch, including individuals (or positions) authorized to abort the mission, hold the countdown, or resume the countdown, following a hold. (Class II, Priority Action) (A-93-97)
- o Specific details and criteria for launch readiness reviews and dress rehearsals. (Class II, Priority Action) (A-93-98)
- o Comprehensive, previously reviewed, checklists for the launch, including a provision for ensuring the currency and consistency of each participant's checklist during the dress rehearsal for the launch. (Class II, Priority Action) (A-93-99)
- o Mandatory rest periods before the launch for key participants that provide for an adequate and specified time period for uninterrupted sleep. The quantitative criteria for such rest periods should be developed by appropriate human performance experts to ensure applicability to the assigned tasks. (Class II, Priority Action) (A-93-100)
- o A communications plan that would include, at a minimum:
 1. a provision that interphone or other communication assignments be apportioned to allow decision makers from each party direct access to the decision makers of other parties and that proper radio-telephone communication phraseology are used, and
 2. a provision that key participants in the launch monitor a common intercom channel at an established point in the countdown and that these participants continue to monitor this channel during


the final countdown sequence and after launch.
(Class II, Priority Action) (A-93-101)

- o A safety directive or safety notebook for the launch to emphasize the safety aspects of the launch operation and to clearly list and consolidate mission constraints, rules, and special launch rules, as well as abort procedures. (Class II, Priority Action) (A-93-102)
- o For launches from remote sites or aircraft, a plan to assure that essential communications interruptions resulting from antenna patterns are improbable. Practical consideration should be given for tolerable interruptions that may be associated with transient conditions such as aircraft maneuvers. (Class II, Priority Action) (A-93-103)

Also, the Safety Board issued Safety Recommendations A-93-87 through A-93-93 to the Department of Transportation and A-93-94 through A-93-96 to the National Aeronautics and Space Administration.

The National Transportation Safety Board is an independent federal agency with the statutory responsibility "...to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any actions taken as a result of its safety recommendations and would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendations A-93-97 through A-93-103 in your reply.

Chairman VOGT, Vice Chairman COUGHLIN, and Members LAUBER, HAMMERSCHMIDT and HART concurred in these recommendations.

By: 
Carl W. Vogt
Chairman