

# NATIONAL TRANSPORTATION SAFETY BOARD

## WASHINGTON, D.C.

ISSUED: February 27, 1981

Forwarded to:

Mr. Charles E. Weithoner  
Acting Administrator  
Federal Aviation Administration  
Washington, D.C. 20591

SAFETY RECOMMENDATION(S)

A-81-19 and -20

On May 8, 1978, near Pensacola, Florida, a Boeing 727 crashed into the water after receiving a terrain closure "pull-up" ground proximity warning system alert. The company's procedures stated that, upon receipt of the system's visual and aural terrain closure warning, "positive action to alter the flightpath to stop the warning should be initiated immediately." Despite these guidelines, the pilot continued his descent while the ground proximity warning system's terrain closure warning continued unabated for 9 seconds until the flight engineer--on the mistaken belief that he had been ordered to do so--turned the system off and silenced the warning. The investigation showed that, except for a slight decrease in the rate of descent which occurred 7 seconds after the warning began, the descending flightpath remained virtually unchanged throughout the entire 9-second interval that the warning was in progress. The Safety Board believes that had the pilot complied in a timely manner with his company's flightcrew response procedures, the crash would have been avoided.

On April 25, 1980, a Boeing 727, operated by a United Kingdom charter air carrier, crashed into a mountain ridge on the island of Tenerife, Grand Canary Islands, Spain, 5 seconds after the flightcrew received a "pull-up" warning from the ground proximity warning system. After the warning began, the pilot applied the maximum available thrust and attempted to stop the aircraft's descent by reversing the direction of the turn the aircraft was in when the alarm began; however, the pilot failed to rotate his aircraft and initiate a climb. Performance data showed that the ridge could have been cleared if a best angle climb had been initiated when the warning began.

In both accidents, the evidence indicated that the flightcrews were not in visual contact with the terrain.

The Safety Board is concerned that the two accidents may be indicative of a tendency of pilots to question the reliability of the ground proximity warning system and, thus, delay their response to the terrain closure warning, and that some existing flightcrew response procedures do not emphasize either the necessity for an immediate response to the warning or the type of response that will insure that timely and adequate measures have been taken to forestall ground impact. Our concern over the latter area resulted from our examination of the published procedures of 12 air carriers. While 8 of the 12 required their flightcrews to execute an immediate pullup on receipt of the warning, only 5 of these 8 specified the manner in which the maneuver was to

be made with regard to aircraft rotation and thrust application. The published procedures of three of the remaining four air carriers require their flightcrews to "immediately" alter the aircraft's flightpath to stop the warning. Finally, one air carrier's procedure states that when the "pull-up" warning occurs, an immediate pullup will be made unless it is readily apparent that the warning is due to a malfunction or it is clear that a hazardous condition does not exist.

Recently, the Boeing Commercial Aircraft Company's flightcrew training department published "The Delayed Response Syndrome," which discussed the pilot's response to the ground proximity warning system. The paper noted that, although human factors research has shown that, depending on the workload, the normal response time to a critical warning is 1 to 4 seconds (Boeing Document D6-44200, "Human Factors Guidelines for Caution and Warning Systems), data from flight and voice recorders have shown that the response time to a terrain closure "pull-up" warning varied from a minimum of 5 seconds to 15 seconds or longer.

Boeing believes that this delay is attributable to two factors. First, during the early period of ground proximity warning system operations, flightcrews were subjected to frequent nuisance and unwanted terrain closure warnings that reached a level of 1 in every 10 approaches. Consequently, flightcrews began to verify the warnings by flight instrument displays (or visually if in visual meteorological conditions) before applying corrective action.

The situation was compounded by the incompatibility of the early ground proximity warning systems with certain training maneuvers, such as back course, nonprecision, below-glide-slope approaches to displaced thresholds, and demonstrated approaches that intentionally exceeded the ground proximity systems envelopes. The resultant warnings, which occurred during these maneuvers, further compromised the system's credibility.

Secondly, most of the terrain warnings occurred while the aircraft was operating under radar control. Understandably, some time would be required to recover from the mental impact of such a warning under these conditions, especially if doubts concerning the system's credibility still lingered. Interestingly, in the accidents cited one aircraft was operating under radar control and the other had been cleared by a controller to enter a holding pattern and was trying to do so. The Safety Board believes that the accidents tend to validate the rationale concerning the existence of a "delayed response syndrome" within the pilot community to this type of warning, and, therefore, corrective action should be taken to counteract and eliminate any resistance to a ground proximity system terrain closure warning.

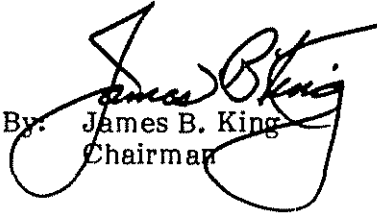
The Safety Board believes that conditioned responses are not generally acceptable in the cockpit. In most instances, some analysis of the situation is desired or required, but the criticality of ground impact demands an instant response to a warning of its imminence, rather than an analysis of the validity of the warning and the reliability of the system supplying the warning. The desired response to this type of warning should be set forth precisely, and it should require the immediate application of the maximum available thrust and rotation of the aircraft to achieve best climb performance. The Safety Board believes these procedures are now necessary, especially since design improvements of the ground proximity warning system have virtually eliminated nuisance warnings.

Therefore, the Safety Board recommends that the Federal Aviation Administration:

Instruct all air carriers to include in their flightcrew procedures instructions which require an immediate response to the ground proximity system's terrain closure "pull-up" warning when proximity to the terrain cannot be verified instantly by visual observation. The required response to this warning should be that the maximum available thrust be applied and that the aircraft be rotated to achieve the best angle climb without delay. (Class II, Priority Action) (A-81-19)

Instruct air carriers to include in their initial and recurrent simulator training curricula situations involving radar controlled as well as noncontrolled flight wherein ground proximity warning system alarms are given and flightcrew response to those warnings system alarms are evaluated. (Class II, Priority Action) (A-81-20)

KING, Chairman, DRIVER, Vice Chairman, and McADAMS, GOLDMAN, and BURSLEY, Members, concurred in these recommendations.

  
By: James B. King  
Chairman