

3. RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board has issued the following recommendations to the Administrator, Federal Aviation Administration:

- "1. Conduct a research program to define and classify the level of flight hazard of thunderstorms using specific criteria for the severity of a thunderstorm and the magnitude of change of the wind speed components ...ea-
sured as a function of distance along an airplane's departure or approach flight track and establish operational limitations based upon these criteria.
- "2. Expedite the program to develop and install equipment which would facilitate the detection and classification, by severity, of thunderstorms within 5 nmi of the departure of threshold ends of active runways at airports having precision instrument approaches.
- "3. Install equipment capable of detecting variations in the speed of the longitudinal, lateral, and vertical components of the winds as they exist along the projected takeoff and approach flightpaths within 1 nmi of the ends of active runways which serve air carrier aircraft.
- *"4. Require inclusion of the wind shear penetration capability of an airplane as an operational limitation in the airplane's operations manual, and require that pilots apply this limitation as a criterion for the initiation of a takeoff from, or an approach to, an airport where equipment is available to measure the severity of a thunderstorm or the magnitude of change in wind velocity.
- "5. As an interim action, install equipment capable of measuring and transmitting to tower operators the speed and direction of the surface wind in the immediate vicinity of all runway ends and install lighted windsocks near to the side of the runway, approximately 1,000 feet from the ends, at airports serving air carrier operations.

- "6. Develop and institute procedures whereby approach controllers, tower controllers, and pilots are provided timely information regarding the existence of thunderstorm activity near to departure or approach flightpaths.
- "7. Revise appropriate air traffic control procedures to specify that the location and severity of thunderstorms be considered in the criteria for selecting active runways.
- "8. Modify or expand air traffic controller training programs to include information concerning the effect that winds produced by thunderstorms can have on an airplane's flightpath control.
- "9. Modify initial and recurrent pilot training programs and tests to require that pilots demonstrate their knowledge of the low-level wind conditions associated with mature thunderstorms and of the potential effects these winds might have on an airplane's performance.
- "10. Expedite the program to develop, in cooperation with appropriate, Government agencies and industry, typical models of environmental winds associated with mature thunderstorms which can be used for demonstration purposeo in pilot training simulators.
- "11. Place greater emphasis on the hazards of low-level flight through thunderstorms and on the effects of wind shear encounter in the Accident Prevention Program for the benefit of genera? aviation pilots.
- "12. Expedite the research to develop equipment and procedures which would permit a pilot to transition from instrument to visual references without degradation of vertical guidance during the final segment of an instrument approach.
- "13. Expedite the research to develop an airborne detection device which will alert a pilot to the need for rapid corrective measures as an airplane encounters a wind shear condition.

- "14. Expedite the development of a program leading to the production of accurate and timely forecasts of wind shear in the terminal area."

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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