



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: June 18, 1990

In reply refer to: A-90-83 through -85

Honorable James B. Busey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

During the past 16 years, the National Transportation Safety Board has issued over 40 safety recommendations to the Federal Aviation Administration (FAA) pertaining to the aviation hazard of low altitude windshear or the related concern about the timely detection of severe weather. The most significant of these recommendations resulted from the following accidents:

Ozark Airlines FH-227B at St. Louis, Missouri,
July 23, 1973;

Iberia Airlines DC-10 at Boston, Massachusetts,
December 17, 1973;

Eastern Airlines B-727 at JFK Airport, New York,
June 24, 1975;

Allegheny Airlines DC-9 at Philadelphia, Pennsylvania,
June 23, 1976;

Southern Airways DC-9 at New Hope, Georgia,
April 4, 1977;

Air Wisconsin SW-4 in eastern Nebraska,
June 12, 1980;

Pan American World Airways B-727 at Kenner, Louisiana,
July 9, 1982; and

Delta Air Lines L-1011 at Dallas-Fort Worth, Texas,
August 2, 1985.

The safety recommendations addressed the need to develop or improve (1) the capability for detection of low altitude windshear in terminal areas; (2) the ability to forecast the occurrence of low altitude windshear; (3) the ability and procedures to communicate the existence of low altitude windshear and other severe weather hazards to pilots; (4) air carrier training programs

that effectively stress the hazards associated with windshear encounters, including simulator demonstrations of windshear penetration; and (5) airplane instrumentation to aid pilots in the detection and avoidance of and successful escape from windshear encounters.

The FAA's windshear-related activities since the mid-1970's and the elements of the Integrated Federal Aviation Administration (FAA) Windshear Program Plan issued in 1986 have addressed nearly all of the actions recommended by the Safety Board. Consequently, all but 16 of the safety recommendations have been classified as "Closed" by the Safety Board. The 16 safety recommendations held in an "Open" status have been addressed by the FAA and the Safety Board on a piecemeal basis by letters that generally discussed only one or two of the specific recommendations. In some cases, the final evaluation of the FAA's response to a recommendation has been held "Open" pending the completion of FAA's intended action or a research and development program. Because of the related subject matter, the Safety Board has evaluated activity on the 16 safety recommendations concurrently, based on the known FAA actions to date. This letter summarizes the results of the evaluation and reports the current classification of the 16 recommendations.

The Safety Board's evaluation considered the FAA's actions and progress in seven programs. A summary of the evaluation follows:

Next Generation Weather Radar (NEXRAD).--This Doppler weather radar--to be purchased by the FAA, the National Weather Service, and the military--will, when installed, substantially improve the detection of hazardous weather including precipitation, hail, windshear, and turbulence over the continental United States and selected areas in Alaska, Hawaii, and the Caribbean. Data from the radar network will be provided to a central weather processor for dissemination to meteorologists, air traffic controllers, air traffic managers, and, ultimately, to pilots. According to 1987 schedules published by the FAA, the first NEXRAD was to have achieved operational status in mid-1989. The Safety Board understands that the implementation schedule has been deferred until 1990. The deferment resulted from problems identified during testing of the pre-production model in 1989. We understand that these problems are being corrected and that the first unit will be deployed at Oklahoma City this fall with full program implementation spread over the next 5 years.

Terminal NEXRAD.--Of the NEXRAD units acquired by the FAA, 17 were to have been configured for operational use at major terminal facilities to alert radar and tower controllers to the presence of hazardous weather, particularly microburst windshear, in the airport area. These installations were to have been an interim measure pending the implementation of the Terminal Doppler Weather Radar (TDWR) system, which is designed specifically for the terminal area environment. Because of production delays, however, which would result in the overlap with TDWR installations, the FAA has cancelled the Terminal NEXRAD program.

TDWR.--The Safety Board understands that the FAA has contracted for delivery of 47 TDWR systems, with implementation of operational units scheduled to begin in 1993. The TDWR has been proven an effective system for the detection and warning of hazardous windshear conditions in the airport

terminal area. However, not all major air carrier airports are scheduled to receive a TDWR system. The Safety Board believes the FAA should consider the purchase and implementation of additional units at major air carrier airports not scheduled to receive TDWR and that are susceptible to low altitude windshear conditions.

ASR-9.--The ASR-9 (Airport Surveillance Radar) will replace existing air traffic control surveillance radars at about 113 terminal facilities. Although the primary function of the ASR-9 is the detection and tracking of aircraft, the radar is designed to detect and display areas of precipitation. Moreover, the system is able to distinguish between six levels of precipitation intensity, enabling controllers to select hazard thresholds that can be used for control decisions and the issuance of pilot alerts. Although the ASR-9 in its present configuration will not detect windshear directly, these new radars will substantially improve the opportunity for avoidance of hazardous microbursts in those areas of the United States where such microbursts are generally associated with intense precipitation.

The ASR-9 delivery and installation programs have fallen behind schedule. The Safety Board understands, however, that 9 systems have now been commissioned and that 22 others have been installed and should be commissioned shortly. The Safety Board has also followed the 1989 test program at Kansas City involving an ASR-9 prototype enhanced with a modular Doppler package developed by Lincoln Laboratory. According to the FAA, the test was successful, and a quasi-operational test using an enhanced ASR-9 will be conducted in Orlando, Florida, starting sometime in the fall of 1990. The modular enhancement enables the ASR-9 to detect low altitude windshear independent of precipitation and, with the appropriate algorithms, could be used to augment the information available from the TDWR and to provide windshear detection capability at airports not scheduled for a TDWR system. In addition, because the Terminal NEXRAD program, which was to provide interim windshear detection and warning at airports prior to delivery of the TDWR, has been cancelled, the Safety Board believes that a properly configured ASR-9 could be used as an interim system at airports that are scheduled at a later date to receive a TDWR. The Safety Board encourages the FAA to continue this development program.

Low Level Windshear Alert System (LLWAS) Enhancements.--The Safety Board's recommendations have addressed the recognized limitations in the six-sensor LLWAS; specifically, the inability of the system to display windshear directly in a format needed to provide pilots with understandable and meaningful information on the runway wind component and the inability to record windshear data for purposes of accident/incident investigation and climatic analysis. The Safety Board understands that 104 LLWAS systems (of 110 planned systems) are in current operation. All but 2 systems are of the original six-sensor configuration, although 58 of the six-sensor systems have been enhanced by improved algorithms and a data-recording capability. The FAA's plan to upgrade all systems to this Phase 2, enhanced configuration was deferred from 1989 to 1990.

The LLWAS at Denver Stapleton Airport and New Orleans International Airport have been enhanced to a Phase 3 configuration, with the installation of additional wind velocity sensors to provide the level of data necessary to

present windshear data in terms of magnitude, location on airport, and directional component-oriented speed differentials. The improved controller display and formatted message to be transmitted to pilots have been successfully demonstrated during tests and operational use at Stapleton since 1987. The Phase 3 LLWAS may already have prevented an accident when a pilot was prompted by a controller windshear message to initiate a go-around to avoid a low altitude encounter with a hazardous microburst. The Safety Board was pleased when the FAA stated in a recommendation response letter, dated May 26, 1988, that a program had been established to upgrade all current LLWAS to the Phase 3 configuration. The FAA, however, subsequently changed the scope of the plan to enhance only 17 of the 110 LLWAS to the Phase 3 configuration. The Safety Board urges the FAA to reevaluate this position to enhance only 17 of the 110 LLWAS to the Phase 3 configuration.

Windshear Training Aid and Related Rulemaking.--The Windshear Training Aid was completed under an FAA contract by a consortium of aviation organizations in February 1987. The Windshear Training Aid presents an effective means of training flightcrews to minimize the windshear threat through avoidance, cockpit recognition, and recovery techniques. The Training Aid consists of the Pilot Windshear Guide, Windshear Overview for Management, Windshear Substantiating Data, Example Windshear Training Program, and two training videos. More than 1,200 copies of the Training Aid have been distributed to U.S.-registered operators regulated by Part 121 of Title 14 of the Code of Federal Regulations (CFR), scheduled operators regulated by 14 CFR 135, FAA operations inspectors, and other industry groups.

The final rule issued on September 22, 1988, to amend 14 CFR Parts 121 and 135 to require windshear training for air carrier flightcrew members is responsive to Safety Board recommendations.

Flight Instrumentation.--The rulemaking action of September 22, 1988, will also require airborne low altitude windshear warning and flight guidance equipment in airplanes operated under Part 121. This equipment will provide warning of windshear conditions and provide flightcrews with escape guidance information. The Safety Board fully concurred with the issuance of this rule noting that reactive warning devices with command guidance are available and will introduce a major safety advancement to the avoidance of windshear accidents. On August 18, 1989, the FAA issued a Notice of Proposed Rulemaking which, if adopted, will relax the required installation schedule and provide exceptions to the requirement for escape command guidance on certain older airplanes. The Safety Board opposed some of the provisions of this proposed rulemaking in a letter dated September 29, 1989, to Rules Docket No. 19110. The Safety Board strongly urges the FAA to consider the Board's comments during the final rulemaking deliberation process.

The Safety Board's evaluation of the FAA activity summarized above has resulted in the following classifications of the 16 safety recommendations: 9 are hereby reclassified as "Closed--Acceptable Alternate Action," 4 remain classified as "Open--Acceptable Action," and 1 is reclassified as "Closed--Unacceptable Action." The basis for each classification follows.

A-74-13

Develop and install terminal air traffic control radar capable of locating severe weather and displaying convective turbulence. This radar should be used to vector aircraft around severe weather.

The TDWR and ASR-9 programs satisfy the intent of this recommendation. The FAA contracted for delivery of 47 TDWR systems, with implementation of operational units scheduled to begin in 1993. About 9 ASR-9s are currently in operation at airports throughout the United States. The FAA, however, plans to commission an additional 104 systems over the next several years. (Recommendation A-74-13, issued April 18, 1974, is reclassified as "Closed--Acceptable Action.")

A-77-63

Expedite the development and implementation of an aviation weather subsystem for both en route and terminal area environments, which is capable of providing real-time display of either precipitation or turbulence, or both and which includes a multiple-intensity classification scheme. Transmit this information to pilots either via the Controller as a safety advisory or via an electronic data link.

The NEXRAD program combined with enhanced Center Weather Service Units in the Air Route Traffic Control Centers will satisfy the intent of this recommendation for en route traffic. The TDWR and ASR-9 programs will provide for the real-time detection of precipitation and windshear in the terminal area. (Recommendation A-77-63, issued September 27, 1977, is reclassified as "Closed--Acceptable Action.")

A-83-19

Study the feasibility of establishing aircraft operational limitations based on the data available from the Low Level Windshear Alert System.

The activities of the TDWR/LLWAS working group, which was coordinated by the National Center for Atmospheric Research, have been responsive to the intent of this recommendation. Safety Board technical personnel who participated in this government/industry group concur with the view that the rapid change of wind velocities produced by a convective microburst would make a real-time pilot assessment of hazard level meaningless when based on a published aircraft performance limitation. In fact, such knowledge could instill false confidence by a flightcrew. The Safety Board agrees with the training philosophy that all microbursts above the alarm threshold of detection equipment should be avoided. (Recommendation A-83-19, issued March 25, 1983, is reclassified as "Closed--Acceptable Action.")

A-83-20

Make the necessary changes to display Low Level Windshear Alert System wind output data as longitudinal and lateral components to the runway centerline.

The Safety Board acknowledges the successful demonstration of the enhanced LLWAS at Denver Stapleton Airport. The enhanced LLWAS uses a display in the air traffic control tower to provide controllers with runway-oriented wind components and with microburst and windshear warnings. The FAA intends to modify 17 systems to this configuration. The Safety Board understands that about \$50 million would be required to upgrade the remaining systems to the expanded sensor network needed to provide component wind analysis. The Safety Board urges the FAA to review other airports served by air carrier aircraft in microburst-probable areas to establish priorities for additional installations. Particular consideration should be given to those airports not scheduled for TDWR coverage. (Recommendation A-83-20, issued March 25, 1983, is reclassified as "Closed--Acceptable Action.")

A-83-21

Use the data obtained from the Joint Airport Weather Studies (JAWS) Project and other relevant data as a basis to (1) quantify the low-level windshear hazard in terms of effect on airplane performance, (2) evaluate the effectiveness of the Low Level Windshear Alert System and improvements which are needed to enhance performance as a windshear detection and warning system, and (3) evaluate the aerodynamic penalties of precipitation on airplane performance.

The Safety Board is reclassifying this recommendation based on the rationale cited for closing Safety Recommendations A-83-19 and -20 and the FAA's coordinated program with the National Aeronautics and Space Administration (NASA) to evaluate the aerodynamic effects of heavy precipitation on airplane wing lift and drag characteristics. The Safety Board believes that the tangible results from this program will be incorporated into the Windshear Training Aid to provide a higher safety margin to aircraft encountering microburst windshear. (Recommendation A-83-21, issued March 25, 1983, is reclassified as "Closed--Acceptable Action.")

A-83-22

As the data obtained from the Joint Airport Weather Studies (JAWS) Project become available (1) develop training aids for pilots and controllers to emphasize the hazards to flight from convective weather activity, (2) develop realistic microburst wind models for incorporation into pilot flight simulator training programs, and (3) promote the development of airborne windshear detection devices.

A-83-25

Recommend to air carriers that they modify pilot training on simulators capable of reproducing windshear models so as to include microburst penetration demonstrations during takeoff, approach, and other critical phases of flight.

A-85-26

In cooperation with air carriers and manufacturers, develop a common windshear training program, and require air carriers to modify airline training syllabi to effect such training.

A combination of actions and programs are responsive to these recommendations: the distribution of the Windshear Training Aid, rulemaking to mandate air carrier windshear training programs, required installation of windshear passive warning or active detection devices, and the NASA program to develop look-ahead technology for airborne windshear detection. (Recommendations A-83-22 and -25, issued March 25, 1983; and A-85-26, issued April 15, 1985, are reclassified as "Closed--Acceptable Action.")

A-86-66

Issue an Air Carrier Operations Bulletin to direct Principal Operations Inspectors to review those sections of company operations manuals and training curricula pertaining to thunderstorm avoidance procedures to verify that flightcrews clearly understand the policy that no aircraft should attempt to land or take off if its flight path is through, under, or near (within a minimum specified distance) a thunderstorm.

Air Carrier Operations Bulletin No. 7-76-3, issued May 2, 1988, emphasizes to operations inspectors the need to ensure that air carrier training programs and operations manuals contain thunderstorm avoidance policies, incorporate meteorological training, and stress the proper use of airborne weather radar. The bulletin satisfies the recommendation. (Recommendation A-86-66, issued September 3, 1986, is reclassified as "Closed--Acceptable Action.")

A-86-67

Issue an Air Carrier Operations Bulletin to direct Principal Operations Inspectors to require that company operations manuals and training curricula caution pilots not to use flight director systems during an inadvertent windshear encounter unless such systems incorporate windshear logic.

The Windshear Training Aid, which will be the basis for air carrier windshear training curricula, includes discussion about the incompatibility of the pitch command logic in some flight director systems with optimum windshear escape maneuvers. Furthermore, required windshear warning devices with optimum escape command guidance will eliminate the potential for windshear accidents caused by inappropriate flight director pitch commands. (Recommendation A-86-67, issued September 3, 1986, is reclassified as "Closed--Acceptable Alternate Action.")

A-86-72

Require that all personnel engaged in weather coordinator duties attend the formal Weather Coordinator Training Course offered by the Federal Aviation Administration Academy, and expand that course to include training in the interpretation of weather echo intensity levels as depicted on remote weather radar displays.

The FAA has taken action to expand the guidance pertaining to Center Weather Service Unit (CWSU) staffing contained in FAA Order 7210.38, the agreement with the National Weather Service regarding CWSU staffing, and the inclusion of definitive instructions in the CWSU Station Duty Manual. The Safety Board accepts these actions as meeting the intent of this recommendation. These actions should ensure that fully trained meteorologists are available to the FAA weather coordinator any time that severe weather is known to be occurring or is expected to occur. (Recommendation A-86-72, issued September 3, 1986, is reclassified as "Closed--Acceptable Alternate Action.")

The Safety Board acknowledges that current FAA programs are addressing the actions described in the following four safety recommendations. The completion of the programs necessary to bring the recommended equipment and procedures to operational status, however, remains in the future. The Safety Board is thus retaining these four recommendations in an "Open--Acceptable Action" status pending further progress and evaluation of the FAA programs.

A-80-118

Expedite the development of an integrated weather radar/air traffic control radar single video display system capable of providing multiple weather echo intensity discrimination without derogation of air traffic control radar intelligence.

The intent of this recommendation was to provide controllers with sufficient information on their video display to keep aircraft out of severe convective weather both en route and in the terminal area. The ASR-9 has the capability of providing this level of information in the terminal area. The Safety Board understands, however, that demonstration tests of systems to provide weather information on Air Route Traffic Control Center displays have met with limited success and that the FAA has no current plans for achieving this objective until the implementation of the Advanced Automation System in the late 1990's. (Recommendation A-80-118, issued November 18, 1980, is classified as "Open--Acceptable Action.")

A-83-15

Record output data from all installed Low Level Windshear Alert System sensors and retain such data for an appropriate period for use in reconstructing pertinent wind shear events and as a basis for studies to effect system improvements.

The Safety Board understands that about 43 of the LLWAS purchased from Climatronics have not yet been modified to record wind velocity data. Although the FAA expected to have interim recording capability by June 1989 for all LLWAS, staff has indicated that this enhancement will likely be accomplished in early 1990. The status of the recommendation will be evaluated when the Safety Board is notified that all LLWAS have been modified. (Recommendation A-83-15, issued March 25, 1983, is classified as "Open--Acceptable Action.")

A-83-18

Evaluate methods and procedures for the use of current weather information from sources such as radar, Low Level Windshear Alert Systems, and pilot reports as criteria for delaying approach and departure operations which would expose the flight to low altitude penetration of severe convective weather.

The Safety Board acknowledges the actions described in the FAA's May 26, 1988, response to this recommendation and generally concurs with the position that the weather data provided to tower controllers from existing systems may not be adequate for controller decisions regarding the continuation or delay of airport operations. The Safety Board believes, however, that ASR-9, TDWR, and Phase 3 LLWAS should provide sufficient information to derive definitive criteria for ceasing runway operations. Many representatives of the steering group, which included FAA personnel, who analyzed the occurrence of a microburst at Stapleton Airport on July 11, 1988, during the TDWR/LLWAS demonstration program have expressed such views. The Safety Board believes that further study is required by the FAA. Further, the Safety Board would welcome a more comprehensive briefing on the controller procedures and responsibilities associated with use of the ASR-9 weather channels. (Recommendation A-83-18, issued March 25, 1983, is classified as "Open--Acceptable Action.")

A-83-23

Expedite the development, testing, and installation of advanced Doppler weather radar to detect hazardous wind shears in airport terminal areas and expedite the installation of more immediately available equipment such as add-on Doppler to provide for detection and quantification of windshear in high risk airport terminal areas.

The TDWR testbed demonstration programs have provided a high level of confidence that the technical obstacles to a terminal Doppler radar are solvable, yet the operational development of the TDWR may not be completed for 5 years. Further, the Safety Board believes that the FAA should pursue development of an ASR-9 modular enhancement that will provide a Doppler wind measurement capability to that system. This enhancement is especially important since the Terminal NEXRAD Program has been cancelled. The enhanced ASR-9 might be made available for interim use in locations scheduled for late installation of the TDWR and for permanent use at locations not scheduled for TDWR. (Recommendation A-83-23, issued March 25, 1983, is classified as "Open--Acceptable Action.")

The Safety Board also evaluated activity on the 16th safety recommendation:

A-86-71

Develop a position in major terminal facilities, to be staffed with National Weather Service meteorologists or Federal Aviation Administration personnel trained for meteorological observations, to be the focal point for weather information coordination during periods of convective weather activity that adversely affects aircraft and air traffic control system operations.

The FAA's response to this recommendation, dated January 7, 1988, cited several programs that will, when implemented, provide weather information to terminal area and tower controllers in an understandable format so that a separate weather coordinator position within the facilities would be unnecessary. The programs cited were the Graphic Weather Display System (GWDS), the ASR-9, and NEXRAD. The Safety Board has been unable to determine the procedural use of the GWDS in the terminal facilities or the actual installation schedule of this equipment. Further, the procedural use of the ASR-9 is yet to be well defined, and terminal Doppler systems are still in the future. The Safety Board continues to believe that a weather coordinating function is needed in terminal facilities to provide for accurate weather interpretation and rapid dissemination of information about hazardous conditions that may develop. Our investigation of an incident involving a USAir B-737, flight 105, at Kansas City International Airport on September 8, 1989, determined that critical weather information was not provided by tower or approach control personnel to the crew of flight 105. The incident occurred in a heavy convective rain shower with reduced visibility. The Safety Board believes that had a weather coordination position existed in the tower or approach control facility, the incident might have been avoided. Because the FAA apparently disagrees that a weather coordinator position is necessary and plans no further action, Safety Recommendation A-86-71, issued September 3, 1986, is reclassified as "Closed--Unacceptable Action."

In summary, the Safety Board believes that the FAA's windshear program has been generally well managed and productive. Elements of the program, including the development of ground-based and airborne equipment and the establishment of operational and training requirements, have been well coordinated within both government and industry. During its evaluation of activity related to the 16 safety recommendations, however, the Safety Board determined that additional actions are required by the FAA to ensure maximum protection against the low altitude windshear hazard in the National Airspace System. These actions include expanding the purchase and installation of ground-based windshear detection and warning systems at airports regularly served by air carrier flights. In addition, the FAA should continue the development of the modular windshear detection enhancement to the ASR-9. The enhanced ASR-9 could be used to replace the cancelled Terminal NEXRAD installations at major airports or at other airports scheduled for late installation of the TDWR. The enhanced ASR-9 could also be used as a windshear detection and warning system at airports not scheduled to receive a TDWR system.

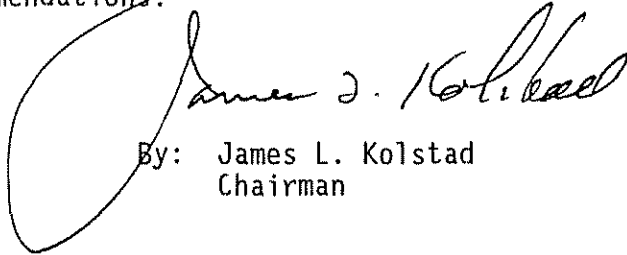
Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Expand the purchase and installation of the Terminal Doppler Weather Radar (TDWR) system at major air carrier airports determined to be susceptible to low altitude windshear conditions. (Class II, Priority Action)(A-90-83)

Develop the modular windshear detection enhancement to the Airport Surveillance Radar (ASR-9) and implement the enhanced ASR-9 at air carrier airports not scheduled for a Terminal Doppler Weather Radar (TDWR) system or as an interim measure at airports scheduled for late TDWR installations. (Class II, Priority Action)(A-90-84)

Upgrade Low Level Windshear Alert Systems (LLWASs) to the Phase 3 configuration at all airports not scheduled to receive a TDWR system. (Class II, Priority Action)(A-90-85)

KOLSTAD, Chairman, COUGHLIN, Acting Vice-Chairman, LAUBER and BURNETT, Members, concurred in these recommendations.

A large, handwritten signature in cursive script, reading "James L. Kolstad". The signature is written in dark ink and is positioned above the typed name and title.

By: James L. Kolstad
Chairman