



National Transportation Safety Board

Washington, D.C. 20594
Safety Recommendation

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In reply refer to: A-97-84 through -95

Honorable Jane F. Garvey
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

About 1638 eastern daylight time, on October 19, 1996, a McDonnell Douglas MD-88, N914DL, operated by Delta Air Lines, Inc., as flight 554, struck the approach light structure and the end of the runway deck during the approach to land on runway 13 at the LaGuardia Airport, in Flushing, New York. Flight 554 was being operated under the provisions of 14 Code of Federal Regulations (CFR) Part 121, as a scheduled, domestic passenger flight from Atlanta, Georgia, to Flushing. The flight departed the William B. Hartsfield International Airport at Atlanta, Georgia, about 1441, with two flightcrew members, three flight attendants, and 58 passengers on board. Three passengers reported minor injuries; no injuries were reported by the remaining 60 occupants. The airplane sustained substantial damage to the lower fuselage, wings (including slats and flaps), main landing gear, and both engines. Instrument meteorological conditions prevailed for the approach to runway 13; flight 554 was operating on an instrument flight rules flight plan.

The National Transportation Safety Board determined that the probable cause of this accident was the inability of the captain, because of his use of monovision (MV) contact lenses, to overcome his misperception of the airplane's position relative to the runway during the visual portion of the approach. This misperception occurred because of visual illusions produced by the approach over water in limited light conditions, the absence of visible ground features, the rain and fog, and the irregular spacing of the runway lights.

Contributing to the accident was the lack of instantaneous vertical speed information available to the pilot not flying, and the incomplete guidance available to optometrists, aviation medical examiners (AMEs), and pilots regarding the prescription of unapproved MV contact lenses for use by pilots.¹

¹ For more detailed information, read Aircraft Accident Report—"Delta Air Lines Flight 554, McDonnell Douglas MD-88, N914DL, Descent Below Visual Glidepath and Collision with Terrain, LaGuardia Airport, New York, October 19, 1996" (NTSB/AAR/97/03).

The Safety Board sought to determine why the descent rate of flight 554 continued to increase until a safe landing could no longer be achieved. The Safety Board analyzed the visual cues in the airport environment, including the airport lighting system and the effect of the weather at the time of the accident, the effect of the captain's vision limitations, and the first officer's actions and input to the captain during the last 10 seconds of the flight.

The pilots performed the instrument approach and landing in low clouds, moderate-to-heavy rain and fog (which obscured the visual approach slope indicator [VASI] lights and the runway environment), and in limited light conditions. In addition, the pilots indicated that when they descended out of the clouds, the airplane was positioned over the waters of Flushing Bay (which appeared gray), with no visible structures to aid in visually judging distance and/or altitude. Although the weather conditions were sufficient for the approach to be made safely, the low overcast cloud layer and heavy rain and fog encountered by flight 554 during its approach to runway 13 degraded visual cues that the captain might otherwise have used to gauge the airplane's rate of descent/descent path during the visual portion of the approach.

According to the Federal Aviation Administration (FAA) Aeronautical Information Manual (AIM), visual illusions that might lead a pilot to perceive that the airplane is higher or more distant from the runway than it is during an approach can result from the following conditions:

- an absence of ground features [as when landing over water]
- rain on the windscreen
- atmospheric haze/fog
- terrain with few lights to provide height cues

The Safety Board notes that all of these conditions were present when the pilots of Delta flight 554 descended out of the overcast cloud layer and the captain transitioned to visual conditions. According to FAA and medical publications² on the subject of visual illusions, these conditions could result in improper perception of altitude and descent path; specifically, a pilot might perceive the altitude to be higher than the airplane's actual altitude, especially during periods of reduced visibility, when other visual cues are not available.

Irregular Runway Light Spacing

In addition to the above conditions, the runway 13 edge lights were spaced irregularly—most of the lights were spaced at intervals less than the maximum interval of 200 feet set forth in Advisory Circular (AC) 150/5340-24—and the departure end of runway 13 was obscured by rain and fog, so the pilots were visually presented with a foreshortened runway. Pilots who are accustomed to operating into airports at which runway lights are spaced at consistent 200-foot intervals might perceive their distance and angle to the runway differently when presented with runway lights spaced at shorter, irregular intervals.

² FAA AIM and Fundamentals of Aviation Medicine.

The Safety Board concludes that the irregular and shortened runway edge light spacing and degraded weather conditions can result in a pilot making an unnecessarily rapid descent and possibly descending too soon, especially in the absence of other visual references or cues. Therefore, the Safety Board believes that the FAA should identify Part 139 airports that have irregular runway light spacing, evaluate the potential hazards of such irregular spacing, and determine if standardizing runway light spacing is warranted.

Delta's Flightcrew Procedures

The first officer told Safety Board investigators that he believed that Delta's manuals did not contain clearly defined guidance regarding pilot-not-flying (PNF) duties during a Category I (CAT I) ILS approach once the pilot flying (PF) established ground contact. The first officer indicated that during the approach to runway 13, he followed his own "unofficial" procedures; he primarily monitored the cockpit instrumentation, provided the captain with feedback based on that information, and glanced outside occasionally to monitor the approach visually while the captain flew the approach primarily using outside visual references. The Safety Board notes that after the captain (PF) reported that he had the approach lights in sight, there were several occasions when the first officer (PNF) attempted to provide the captain with useful feedback, which was not specifically required by Delta's manuals, before the airplane struck the runway deck. The Safety Board concludes that during the visual portion of the approach, when the captain was primarily relying on visual cues, the first officer, who was primarily monitoring cockpit instrumentation to gauge the airplane's position with regard to the runway, provided input to the captain that surpassed what was set forth in the guidance available to the pilots at that time.

When the first officer observed "sink's seven hundred" in an attempt to provide the captain with useful vertical speed information during the approach, he unintentionally provided the captain with misleading vertical speed information because of the 4-second lag time inherent in the vertical speed indicator (VSI) as it was installed in the airplane. Use of radar altitude would have been more useful, and more correct. If Delta's manuals had contained either specific PNF callout instructions using radar altimeter information (e.g., altitudes of 300, 200, 100, 50, 40, 30, 20, 10...), or a specific scan policy to ensure that someone was focused on airspeed, altitude and approach profile, the first officer probably would have provided the captain with information that would have been useful in determining the airplane's position (and rate of change of position) relative to the runway. Therefore, the Safety Board concludes that the Delta manuals were not sufficiently specific regarding PNF duties during CAT I ILS approaches after the PF establishes visual contact with the ground. (The Safety Board recognizes that Delta is revising PF/PNF CAT I ILS duties listed in its manuals and related pilot training to include specific scan policy guidance.)

In addition, Delta's manuals did not specify operational criteria for a stabilized approach, nor did they contain procedural guidance for pilots to follow if an approach became unstabilized. The guidance and definitions that did exist regarding stabilized approach criteria and procedures were either unclear or difficult to locate (the only guidance pertaining to "unstabilized approaches" was located in the Supplemental Information section, under "Wind shear

Guidance"). Further, the manuals did not contain specific, accessible procedural guidance about what action a pilot should take if an unstabilized condition developed during an otherwise stabilized approach. However, the captain flew a stabilized approach until about 1 second before he reported that he had the approach lights in sight (by which time the airplane had deviated more than 1 dot above the electronic glideslope), and then he promptly began to take corrective action. Therefore, the Safety Board concludes that although Delta's manuals did not adequately specify operational criteria for a stabilized approach, the lack of guidance in this area did not contribute to the accident.

The Safety Board notes that Delta personnel had discussed the lack of adequate information concerning stabilized approaches before the accident, and revisions to the manuals were being prepared when the accident occurred. Delta's revised manuals now contain more thorough information and criteria concerning stabilized approaches. However, the Safety Board is concerned that if Delta's manuals contained inadequacies in these "safety of flight" areas other air carriers' manuals might also be inadequate. Therefore, the Safety Board believes that the FAA should require all 14 CFR Part 121 and 135 operators to review and revise their company operations manuals to more clearly delineate flightcrew member (PF/PNF) duties and responsibilities for various phases of flight, and to more clearly define terms that are critical for safety of flight decisionmaking, such as "stabilized approach."

Availability of Information About the Hazards of Monovision Contact Lenses

The AME who examined the captain reported that he was unaware that the captain used MV contact lenses; he indicated that it would never have occurred to him that the captain might use MV contact lenses, because the captain's vision did not indicate the need for MV contact lens correction. The Safety Board concludes that AMEs need to know if pilot examinees are using contact lenses, and currently no process is in place to ensure that AMEs are provided with that information. Therefore, the Safety Board believes that the FAA should revise FAA Form 8500-8, "Application for Airman Medical Certificate," to elicit information regarding contact lens use by the pilot/applicant.

Additionally, the captain and the optometrist who prescribed the MV contact lenses for the captain were not aware that the use of MV contact lenses by pilots performing flying duties was not approved by the FAA. This is consistent with the information obtained during a Safety Board investigation into a general aviation accident that involved MV contact lens use.³ The Safety Board concludes that information concerning the possible hazards of MV contact lens use is not well disseminated among optometrists and the pilot population.

Because the information available to optometrists and pilots is insufficient, the Safety Board believes that the FAA Civil Aeromedical Institute should publish and disseminate a brochure containing information about vision correction options, to include information about the potential hazards of MV contact lens use by pilots while performing flying duties and to emphasize that MV contact lenses are not approved for use while flying.

³ For additional information on the general aviation accident, see the Safety Board's report, CHI96LA089.

The Safety Board is aware that since this accident, Delta Air Lines has alerted its pilots and medical personnel to the hazards of MV contact lens use by flightcrew members. The Safety Board believes that the FAA should require all 14 CFR Part 121 and 135 operators to notify their pilots and medical personnel of the circumstances of this accident, and to alert them to the hazards of MV contact lens use by flightcrew members. Additionally, the Safety Board believes that the FAA should require all flight standards district office air safety inspectors and accident prevention specialists to inform general aviation pilots of the circumstances of this accident and to alert them to the hazards of MV contact lens use by pilots while flying.

Non-Instantaneous Vertical Speed Indicator

During the final 12 seconds before impact, the airplane's rate of descent, which had been averaging about 700 feet per minute, began to increase. At 1638:26, as the first officer called out a sink rate of 700 feet per minute (based on VSI information), the airplane was actually descending about 1,200 feet per minute. Had the first officer seen a descent rate of 1,200 feet per minute, he would likely have been alarmed and immediately indicated that to the captain. However, by 1638:33, when the first officer stated "nose up," he had undoubtedly transferred his focus to external cues; thus, the first officer never saw cockpit instrumentation indicate an excessive rate of descent. (This is consistent with the first officer's postaccident statement.) The Safety Board concludes that the lag time in the display of vertical speed information in the VSI installed in the accident airplane limited the first officer's ability to provide the captain with precise vertical speed information during the critical final seconds of the approach, and therefore contributed to the accident.

The Safety Board notes that several Delta check airmen and flight instructors interviewed during the investigation stated that they believed that most Delta line pilots were unaware that the vertical speed information presented by the VSIs in the MD-88 was not instantaneous. If Delta's MD-88 pilots were unaware that the VSIs in the MD-88 presented them with non-instantaneous vertical speed information, the Safety Board considers it likely that pilots with other air carriers/flying other aircraft might also be unaware of the nature of the information (instantaneous or non-instantaneous) provided by the VSIs in their airplanes. The Safety Board is concerned that a pilot who is unaware that the VSI in his/her airplane does not provide instantaneous vertical speed information might be misled into believing that the airplane's sink rate is appropriate when it is not (as occurred with the first officer in the accident airplane). Therefore, the Safety Board concludes that pilots need to be aware of the type of vertical speed information provided by the VSI installed in their airplane, and to understand the possible ramifications of that information. Therefore, the Safety Board believes that the FAA should require all 14 CFR Part 121 and 135 air carriers to make their pilots aware (through specific training, placards, or other means) of the type of vertical speed information (instantaneous/non-instantaneous) provided by the VSIs installed in their airplanes, and to make them aware of the ramifications that type of information could have on their perception of their flight situation.

VSI's can be rewired to provide instantaneous vertical speed information in airplanes that are equipped with an inertial reference unit (IRU). The Safety Board notes that Delta is replacing the attitude/heading reference system (AHRS) units installed in the MD-88 fleet with IRUs, and will have the capability of upgrading the timeliness of the vertical speed information displayed on airplanes equipped with IRUs. The Safety Board believes that the FAA should require all 14 CFR Part 121 and 135 operators to convert, where practical, the non-instantaneous vertical speed instrumentation on airplanes that have IRUs installed to provide flightcrews with instantaneous vertical speed information.

Special Airport Designation

The first officer told Safety Board investigators that he believed that LaGuardia should be designated an FAA special airport; he specifically cited the approaches to runway 31—which require maneuvering the airplane at high bank angles close to the ground—and runway 13—which require landing over water, a 250-foot decision height, and an offset localizer—as being worthy of special pilot qualification requirements; the Safety Board also received other anecdotal comments concerning designating LaGuardia a special airport. Because of the northwesterly prevailing winds and other operational considerations, runway 13 is used less frequently than the other runways at LaGuardia; the pilots of Delta flight 554 had not performed the approach to runway 13 in inclement weather conditions, and the first officer indicated that he was not aware that the runway extended on a pier over the water.

Although 14 CFR 121.445 contains a description of the special pilot qualifications necessary for special airport operations, and AC 121.445-1D contains a description of the special pilot qualifications required for operating in and out of special airports, a list of designated special airports, and brief remarks to describe the “special” feature(s) of each designated special airport, there are no published criteria or procedures for special airport designation. In addition, the information provided in AC 121.445-1D’s remarks section is general, and does not provide operators with detailed information as to the justification for special airport designation, nor does it describe specific approaches, runways, hazards, or obstacles. The Safety Board concludes that the FAA’s current guidance on special airports contained in AC 121.445-1D is not sufficiently specific about criteria and procedures for designation of special airports; therefore, the FAA’s current guidance might not always be useful to air carriers operating in and out of (existing or potential) special airports.

The Safety Board is aware that the FAA met with industry representatives in October 1996 to develop a list of factors—based on accident histories, human performance concerns, runway anomalies, etc.—to use in determining criteria for classification of special airports. However, the Safety Board is concerned that the FAA has apparently not made any progress in developing such criteria since that meeting. Therefore, the Safety Board believes that the FAA should expedite the development and publication of specific criteria and conditions for the classification of special airports; the resultant publication should include specific remarks detailing the reason(s) an airport is determined to be a special airport, and procedures for adding and removing airports from special airport classification.

The Safety Board is also concerned that if an airport is designated "special" because of a specific approach or runway configuration (i.e., the ILS DME approach to runway 13 at LaGuardia) a pilot who satisfies the special pilot qualification requirements by landing and departing on a different runway at that airport might not have appropriate familiarization with the special features of that specific approach or runway configuration and therefore might not adequately satisfy the intent of the special airport regulation. The Safety Board concludes that the present requirements for special airport pilot qualifications might not be sufficient to ensure that pilots who are so qualified have been exposed to the runways and/or approaches at those airports that make the airport "special." Thus, the Safety Board believes that the FAA should develop criteria for special runways and/or special approaches giving consideration to the circumstances of this accident and any unique characteristics and special conditions at airports (such as those that exist for the approaches to runways 31 and 13 at LaGuardia) and include detailed pilot qualification requirements for designated special runways or approaches. Also, the Safety Board believes that once criteria for designating special airports and special runways and/or special approaches have been developed, the FAA should evaluate all airports against that criteria and update its special airport publications accordingly.

Flight and Cabin Crew Evacuation Actions

The Safety Board considers that in general, the crewmembers' responses after the airplane came to a stop were commensurate with the circumstances of this accident. First, the crewmembers assessed the condition of the airplane and reviewed their options; then, when the captain was informed that there was a smell of jet fuel fumes in the passenger cabin, he promptly commanded an emergency evacuation. The Safety Board concludes that the flightcrew coordination appeared adequate, and the decision to evacuate the airplane was appropriate and timely. Further, the Safety Board concludes that the flight attendant in charge, who began shouting evacuation commands within 2 seconds of the evacuation order, reacted to the evacuation command promptly and assertively, in accordance with Delta's flight attendant manuals and training. All passengers were successfully evacuated through the L-1 door, with minimal evacuation-related injuries. Although under other circumstances the decision to use only one exit may have critical consequences, in this case the decision to use only the L-1 door did not have adverse results.

The cockpit voice recorder transcript indicated that while the evacuation was being conducted at the front of the cabin, the two flight attendants in the aft cabin remained on the interphone trying to obtain additional evacuation instructions for at least 38 seconds after the captain issued the evacuation command. About 40 seconds after the evacuation was commanded, the first officer (who had been assisting with the evacuation at the L-1 door) responded on the interphone to the aft flight attendants' inquiry, with instructions to evacuate "forward," and the aft flight attendants began to participate in the evacuation. Because the airplane was carrying a light passenger load, with most of the passengers seated in the front half of the cabin, by the time the aft flight attendants began evacuation actions, most of the passengers had exited or moved toward the first-class cabin area.

The aft flight attendants stated that they sought further instructions before taking action because they were concerned that the damage to the airplane and the possibility of spilled fuel might affect the usability of their exits. According to the guidance contained in Delta's flight attendant manual, when an evacuation is commanded, flight attendants should promptly assess the condition of their assigned exits, activate exits as appropriate, and issue guidance to passengers. The manual further states that if a flight attendant judges that his or her assigned exit is not usable, the flight attendant should redirect passengers towards an appropriate exit. The Safety Board notes that it was appropriate for the aft flight attendants to evaluate and make a decision regarding the usability of their exits; however, a 38-second delay before beginning evacuation actions may have been critical if more hazardous conditions (e.g., fire) had developed.

Delta's flight attendant manual also indicates that once an evacuation is commanded, flight attendants should begin the evacuation promptly, and "without further communication from [the] cockpit." The Safety Board concludes that the two aft flight attendants did not react promptly or demonstrate assertive leadership, as specified in Delta's flight attendant manuals and training. Therefore, the Safety Board believes that the FAA should require all 14 CFR Part 121 and 135 operators to review their flight attendant training programs and emphasize the need for flight attendants to aggressively initiate their evacuation procedures when an evacuation order has been given.

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

Identify Part 139 airports that have irregular runway light spacing, evaluate the potential hazards of such irregular spacing, and determine if standardizing runway light spacing is warranted. (A-97-84)

Require all 14 CFR Part 121 and 135 operators to review and revise their company operations manuals to more clearly delineate flightcrew member (pilot flying/pilot not flying) duties and responsibilities for various phases of flight, and to more clearly define terms that are critical for safety of flight decisionmaking, such as "stabilized approach." (A-97-85)

Revise FAA Form 8500-8, "Application for Airman Medical Certificate," to elicit information regarding contact lens use by the pilot/applicant. (A-97-86)

Require the Civil Aeromedical Institute to publish and disseminate a brochure containing information about vision correction options, to include information about the potential hazards of monovision (MV) contact lens use by pilots while performing flying duties and to emphasize that MV contact lenses are not approved for use while flying. (A-97-87)

Require all 14 CFR Part 121 and 135 operators to notify their pilots and medical personnel of the circumstances of this accident, and to alert them to the hazards of monovision contact lens use by flightcrew members. (A-97-88)

Require all flight standards district office air safety inspectors and accident prevention specialists to inform general aviation pilots of the circumstances of this accident and to alert them to the hazards of monovision contact lens use by pilots while flying. (A-97-89)

Require all 14 CFR Part 121 and 135 air carriers to make their pilots aware (through specific training, placards, or other means) of the type of vertical speed information (instantaneous/non-instantaneous) provided by the vertical speed indicators installed in their airplanes, and to make them aware of the ramifications that type of information could have on their perception of their flight situation. (A-97-90)

Require all 14 CFR Part 121 and 135 operators to convert, where practical, the non-instantaneous vertical speed instrumentation on airplanes that have inertial reference units installed to provide flightcrews with instantaneous vertical speed information. (A-97-91)

Expedite the development and publication of specific criteria and conditions for the classification of special airports; the resultant publication should include specific remarks detailing the reason(s) an airport is determined to be a special airport, and procedures for adding and removing airports from special airport classification. (A-97-92)

Develop criteria for special runways and/or special approaches giving consideration to the circumstances of this accident and any unique characteristics and special conditions at airports (such as those that exist for the approaches to runways 31 and 13 at LaGuardia Airport) and include detailed pilot qualification requirements for designated special runways or approaches. (A-97-93)

Once criteria for designating special airports and special runways and/or special approaches have been developed as recommended in Safety Recommendations A-97-92 and -93, evaluate all airports against that criteria and update special airport publications accordingly. (A-97-94)

Require all 14 CFR Part 121 and 135 operators to review their flight attendant training programs and emphasize the need for flight attendants to aggressively initiate their evacuation procedures when an evacuation order has been given. (A-97-95)

Also as a result of this investigation, Safety Recommendation A-97-96 was issued to optometric associations.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By:


Jim Hal
Chairman