FLIGHT SAFETY FOUNDATION
Accident Prevention
Vol. 54 No. 12 For Everyone Concerned with the Safety of Flight December 1997

MD-88 Strikes Approach Light Structure in Nonfatal Accident

The collision occurred on a daylight, visual approach over water to Runway 13 at LaGuardia Airport, New York, New York, U.S., when visual illusions and the pilot's monovision contact lenses caused him to misperceive the aircraft's altitude and rate of descent, the report said.

FSF Editorial Staff

The Delta Air Lines McDonnell Douglas MD-88, after completing an instrument landing system (ILS) distance measuring equipment (DME) approach in high winds and instrument meteorological conditions (IMC), was on a visual final approach to Runway 13 at LaGuardia Airport, New York, New York, U.S. At an altitude of about 61 meters (200 feet) above ground level (AGL), the aircraft's sink rate began to increase rapidly. Before the captain, who was the pilot flying (PF), could slow the descent, the aircraft struck an approach light structure at the end of the runway deck.

The aircraft skidded on its lower fuselage and nose landing gear about 824 meters (2,700 feet) on the runway before coming to rest facing downwind. The aircraft sustained damage to the fuselage, wings, main landing gear and both engines. There was no postaccident fire.

The accident occurred in daylight at about 1638 hours local time on Oct. 19, 1996. Three passengers reported minor injuries. None of the other 55 passengers or three crew members aboard Flight 554 was injured.

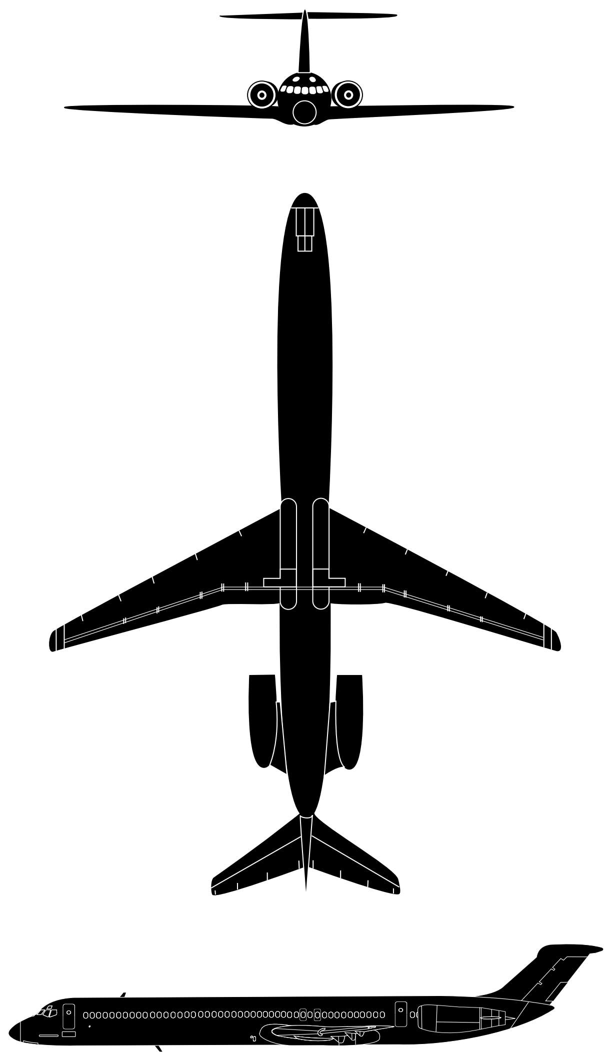
The final accident investigation report of the U.S. National Transportation Safety Board (NTSB) cited the probable cause of the accident as "the inability of the captain, because of his use of monovision [MV] contact lenses, to overcome his misperception of the airplane's position relative to the runway during the visual portion of the approach. This misperception occurred because of the 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 and pilots regarding the prescription of unapproved monovision contact lenses for use by pilots."

The flight originated in Atlanta, Georgia, U.S., and the accident occurred on the first leg of a scheduled three-leg trip for the flight crew of the MD-88.

According to the pilots, the takeoff, climb and en route sections of the flight were unremarkable, although the aircraft did encounter turbulence at its cruising altitude of 11,285 meters (37,000 feet).

As the aircraft neared the New York area, the forecast IMC was encountered . The report said, "Weather observations made at LaGuardia between 1627 and 1651 [from 11 minutes before the accident until 13 minutes after the accident] indicated a broken cloud layer at [244 meters] 800 feet, visibility between



McDonnell Douglas MD-88

The MD-88 is the fifth in a series that began with the MD-80 in 1979. The MD-88 was certified by the U.S. Federal Aviation Administration (FAA) on Dec. 9, 1987.

The twin-turbofan medium-range airliner combines two JT8D-219 engines with an electronic flight instrumentation system (EFIS), onboard wind-shear detection, computer flight management system and greater use of composite structural materials than its predecessors. Other avionics include color weather radar.

The redesigned cabin interior has five-abreast seating, wider aisles and newly designed overhead bins. The cabin seats 142 passengers: 14 in first class and 128 in coach.

The MD-88 has a maximum takeoff weight of 67,810 kilograms (kg) (149,500 lbs.) and a maximum landing weight of 58,965 kg (130,000). It cruises at Mach 0.76 and has a range of about 5,000 kilometers (km) (3,100 miles) with a full load of fuel.

Source: *Jane's All the World's Aircraft*

[0.8 kilometer] 0.5 mile and [1.6 kilometers] one mile in heavy rain and fog or mist and easterly winds at [22 kilometers per hour (kph) to 24 kph] 12 knots to 14 knots."

Beginning about 1610, the pilots began to receive radar vectors for the ILS DME approach to Runway 13 (Figure 1, page 3). They completed the descent checklist and, five minutes later, completed the approach checklist. During that time, the captain briefed the approach; he and the first officer discussed the published three-degree difference between the localizer heading and the runway heading, the location of the point where the final approach course crosses the runway centerline, the unreliability of the ILS glide slope below 61 meters and the missed-approach procedure.

The report said, "They determined that [242 kph] 131 knots would be their target airspeed for final approach to LaGuardia. … At 1633:28, the captain stated, 'Still showing [122 kph] 63 knots [of wind] now.' … The first officer stated, 'Yeah, I guess the wind's gonna blow us over [to the localizer course] … .'"

About 1635, the aircraft intercepted the localizer and glideslope, and LaGuardia air traffic control tower (ATCT) told the accident aircraft, "The wind now one zero zero at one two … one departure prior to your arrival … braking action reported good by [a Boeing 737] … low-level wind shear reported on final by [a 737] … ."

The landing gear was extended, and the captain called for the before-landing checklist. LaGuardia ATCT advised the pilots that the runway visual range (RVR) at touchdown was 915 meters and that RVR on rollout was 671 meters (2,200 feet).

"At 1636:25, the first officer announced, 'Before landing check is complete … not cleared to land yet,' " said the report.

As the aircraft began its descent from 915 meters (3,000) feet on the ILS DME approach, it was in clouds and experiencing light to moderate turbulence. At that time, LaGuardia ATCT reported winds out of the east at less than 25 kph (15 knots) and steady.

At 1637:08, the ATCT cleared a Trans World Airlines (TWA) aircraft for takeoff on Runway 13. A few seconds later, the pilots of the TWA aircraft advised the ATCT that they were "rolling," and at 1637:22 the ATCT cleared the accident aircraft for landing on Runway 13.

Shortly thereafter, the crew of the TWA aircraft advised the ATCT that they were aborting the takeoff. The ATCT advised the TWA aircraft to clear the runway as soon as possible.

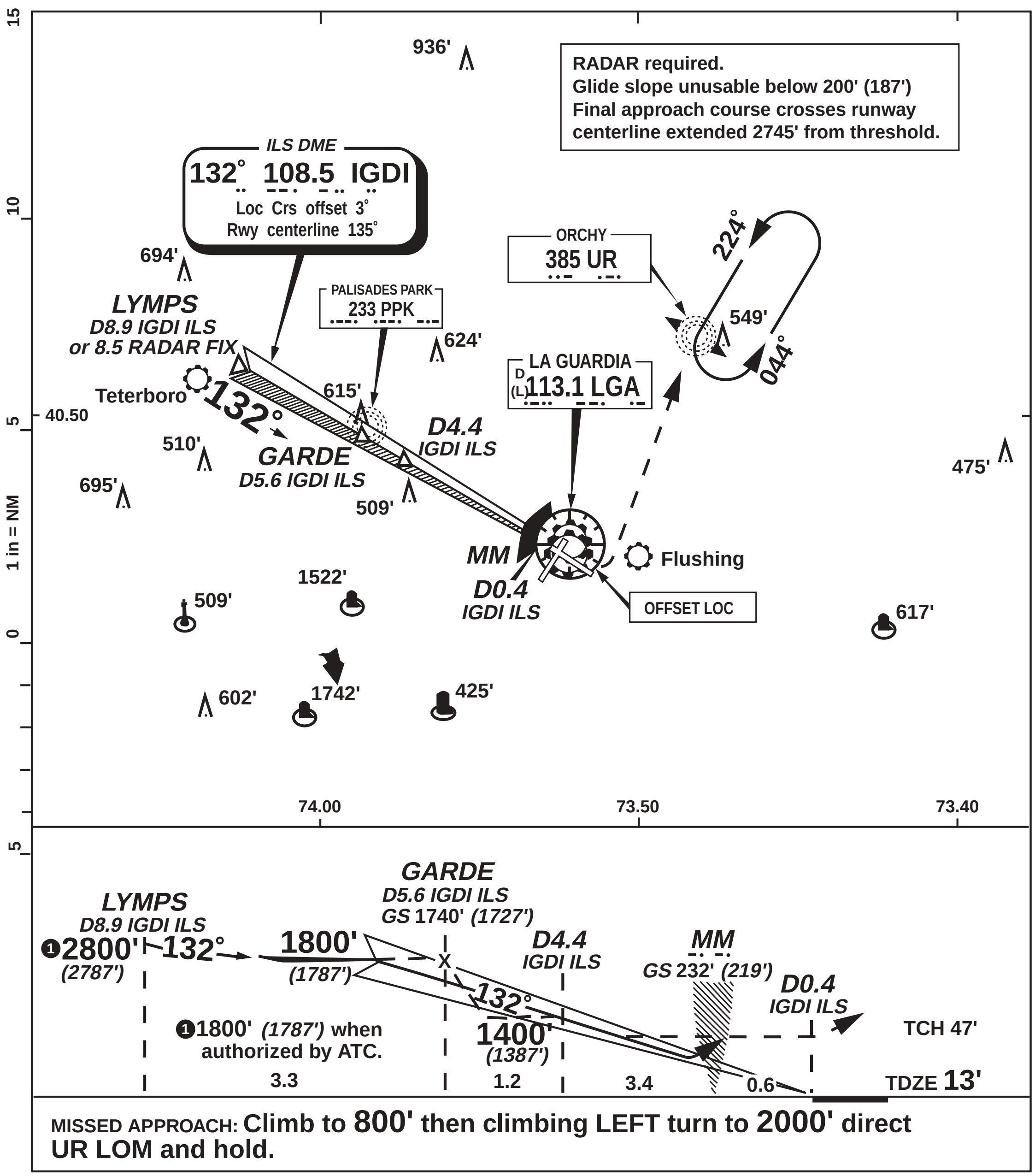
The report said, "LaGuardia responded, ' … if you could expedite, traffic on two-mile final … prevent him from going around.'

"At 1637:52, as [Flight 554] descended through about 150 meters (492 feet) AGL, [the aircraft's] CVR [cockpit voice recorder] recorded an expletive on the captain's channel, and the airplane's descent rate (calculated from FDR [flight data recorder] data) shallowed briefly. During postaccident interviews, the captain stated that at the time of the expletive comment he was concerned that they might have to perform a missed approach because the TWA flight had aborted its takeoff … ."

At 1638:11, the captain stated that he had the runway end identifier lights (REILs) and the approach lights in sight. At that moment, the aircraft was left of course and slightly above the glideslope.

The report said, " … At 1638:13, the airplane was 1.39 dots high on the electronic glideslope and 0.39 dots left of the

Instrument Landing System (ILS) Distance Measuring Equipment (DME) Approach to Runway 13 at LaGuardia Airport, New York, New York, U.S., at the Time of the Accident



Source: U.S. National Transportation Safety Board

Figure 1

Partial Cockpit Voice Recorder Transcript, Delta Air Lines, Flight 554, Oct. 19, 1996

Time	Source	Content
1637:31	**HOT-1**	I got the jet.
1637:33	**HOT-2**	alright.
1637:47	**LGA TWR**	[momentary transmission interference] if you could expedite traffic on a two mile final ah prevent him from going around.
1637:41	**TWA 8630**	twa eighty-six thirty's turning off.
1637:43	**LGA TWR**	thank you very much … and ah say the reason for the abort sir?
1637:48	**LGA TWR**	twa eighty-six thirty just continue down the runway … make the first right turn on taxiway golf right turn on golf please and ah when you get a chance let me know the reason for the abort.
1637:52	**HOT-1**	#.
1637:56	**TWA 8630**	right turn on golf and we're ah looking at an engine.
1637:57	**HOT-2**	two hundred above.
1638:01	**HOT-2**	speed's good sink's good.
1638:05	**TWA 8630**	okay no problem … turn right on golf… hold short of taxiway bravo bravo and contact ground point seven.
1638:07	**HOT-1**	no contact yet.
1638:09	**LGA TWR**	[momentary transmission interference] if you can ah find out exactly what's wrong report the information to the ground controller.
1638:10	**HOT-2**	one hundred above.
1638:11	**HOT-1**	I got the (REIL) .. approach lights in sight.
1638:13	**HOT-2**	you're getting a little bit high.
1638:15	**HOT-2**	a little bit above glideslope.
1638:17	**HOT-2**	approach lights we're left of course.
1638:18	**LGA TWR**	you are cleared to land delta five fifty-four.
1638:20	**RDO-2**	delta five fifty-four cleared to land.
1638:20.6	**CAM**	[sound of GPWS "minimums"]
1638:21.8	**CAM**	[sound similar to that of windshield wipers increasing to full speed]
1638:22.4	**HOT-1**	approach lights in sight.

localizer, at [93 meters] 306 feet AGL. At 1638:18, LaGuardia ATCT stated, 'You are cleared to land, Delta five fifty-four.'"

The first officer acknowledged the clearance to land. At that time, the captain disconnected the autothrottle. Two seconds later, the ground-proximity warning system (GPWS) sounded, announcing arrival at minimum approach altitude. The captain said again that he had the approach lights in sight.

The report said, "The captain began to reduce the engine power [manually], and at 1638:25.6, the first officer stated, 'Speed's good' and then, about one second later, 'Sink's seven hundred.'

"At 1638:30.1, the captain stated, 'I'll get over there,' which he later explained referred to the airplane's alignment with the runway.

"One second later, the first officer stated, 'A little bit slow, a little slow.'

"According to postaccident interviews, the captain stated that the approach seemed normal until about four or five seconds before the initial impact, when 'all of a sudden [the aim] point shifted down into the lights.'

"About 1638:33, as the captain was adding power and pitching up, the first officer stated, 'Nose up,' and then … stated, 'Nose up' again."

One second later, the CVR recorded the sound of the GPWS sink-rate warning, followed by the sounds of the collision with the approach light structure.

The aircraft skidded 824 meters (2,700 feet) down the runway on its lower fuselage and nose landing gear, rotating almost 180 degrees. It came to a stop heading 345 degrees, with the nose gear on the pavement, the left wing pointing toward the runway centerline and the right wing extending over the grassy area beside the runway.

The report said, "According to flight and cabin crew member statements, after the airplane came to a stop, the pilots began to assess the damage to the airplane and determine whether an emergency evacuation was warranted, while the flight attendants picked up their interphone handsets and awaited instructions.

"About 74 seconds after the airplane came to a stop (about 94 seconds after the impact), the captain issued the emergency evacuation command after a nonrevenue Delta pilot and the flight-attendant-in-charge (FAIC) reported that they smelled jet fuel fumes in the cabin. All aircraft occupants exited through the left front door (L-1) slide."

The estimated cost to repair the accident aircraft was US$14 million. Damage to airport property was estimated at US$240,000.

The captain, 48, had been hired by Delta in September 1978. He held an airline transport pilot (ATP) certificate with multi-engine land and instrument ratings and was type-rated in the MD-88 and Cessna 500. He had a total of 10,024 hours of flight time, 3,756 hours of which were as pilot-in-command of the MD-88.

The report said, “The captain’s most recent first-class medical certificate was issued on Oct. 8, 1996, and contained the restriction, ‘Must have glasses available for near vision.’ The captain was wearing monovision (MV) contact lenses for vision correction when the accident occurred.”

The captain had been off duty for three days before the accident flight, during which he reported that he had performed routine activities at home and had received his normal amount of sleep. The captain had landed at LaGuardia on several occasions, but only twice on Runway 13, and those were both in visual meteorological conditions (VMC). He had not made an instrument approach to Runway 13 before the accident.

Pilots who had flown with the captain described him as quiet, easy to get along with, and one who operated “by-the-book.” The report said, “A review of Delta’s personnel records for the captain revealed no problems.”

The first officer, 38, was hired by Delta in May 1988. He held an ATP certificate with airplane multi-engine and instrument ratings. He had a total of 6,800 hours of flight time, 2,220 hours of which were as first officer in the MD-88.

The first officer had undergone two days of recurrent simulator training on Oct. 16 and 17, but had otherwise been off duty for the three days prior to the accident flight. He reported that he had received his normal amount of sleep during the period.

The captain described the first officer as very competent and as one who did everything a captain could expect from a first officer, and more. The report said, “A review of Delta’s personnel records for the first officer revealed no problems.”

There were three flight attendants on the accident flight. The FAIC had more than seven years of service with Delta and had completed her most recent recurrent training in October 1996. The other two flight attendants had each been with Delta for about five years. One had completed her most recent recurrent training in February 1996, the other in September 1996.

“According to company records, all three flight attendants had satisfactorily completed Delta’s initial flight attendant training program and were qualified on the MD-88 aircraft,” said the report.

The accident aircraft was purchased from McDonnell Douglas in June 1988. It was powered by two Pratt & Whitney JT8D-219 turbofan engines. A review of the maintenance log revealed no noteworthy discrepancies with the accident aircraft, and the pilots found no maintenance irregularities during their flight

1638:22.9	**UAL 1576**	tower united fifteen seventy-six is with you outside of Garde.
1638:25.6	**HOT-2**	speed’s good.
1638:26.7	**HOT-2**	sink’s seven hundred.
1638:28.2	**LGA TWR**	united fifteen seventy-six LaGuardia tower continue the wind one zero zero at one zero runway one three braking action reported good by a seven three seven.
1638:30.1	**HOT-1**	I’ll get over there.
1638:31.1	**HOT-2**	a little bit slow a little slow.
1638:33.7	**HOT-2**	nose up.
1638:34.2	**CAM**	[sound of GPWS “sink rate”]
1638:34.3	**HOT-2**	nose up.
1638:35.7	**CAM**	[sound of GPWS “sink rate”]
1638:36.5	**CAM**	[sound of impact]
1638:36.9	**CAM**	[sound similar to that of power interrupt to CVR]
1638:37	**LGA TWR**	[continued from previous transmission] yo Bill Bill Bill Bill .. Bill.
1638:38	**CAM**	[sound of tone and aural “landing gear” from CAWS starts and repeats to the end of the recording.]
1638:43	**HOT-1**	#.
1638:44	**HOT-2**	hundred knots.
1638:48	**HOT-2**	sixty knots.
1638:49	**CAM**	[sound similar to that of windshield wipers speed increasing]
1638:51	**HOT-1**	#.
1638:52	**HOT-2**	hang on hang on.
1638:54	**CAM**	[sound similar to that of windshield wipers stopping]
1638:56	**HOT-1**	#.
1638:57	**HOT-2**	okay okay settle down Joe .. its alright it’s alright.
1638:59	**HOT-1**	okay .. let’s see what we got here.
1639:04	**INT/PA-3**	stay in your seats.
1639:05	**INT/PA-4**	hello.
1639:06	**INT/PA-1**	ladies and gentlemen please remain seated at this time.
1639:12	**INT/PA-1**	please remain seated with your seatbelts securely fastened please.
1639:17	**CAM-2**	we need to get out of the airplane I think.
1639:18	**INT/PA-3**	are you alright … stay in your seats.

1639:21	**CAM-2**	get **.
1639:22	**CAM-1**	yeah … do that.
1639:24	**CAM-3**	you alright?
1639:26	**INT/PA-3**	I'm just waiting for someone -
1639:26	**INT/PA-1**	ladies and gentlemen please abort a-
1639:29	**HOT-1**	let's evacuate.
1639:32	**INT/PA-3**	@.
1639:33	**HOT-1**	well hold hold on a minute.
1639:33	**INT/PA-4**	yeah.
1639:34	**INT/PA-3**	stay away from the back.
1639:35	**INT/PA-4**	I'm fine I'm fine.
1639:35	**RDO-2**	tower delta five fifty-four.
1639:41	**INT/PA-3**	[unintelligible] stay in your seats … stay seated.
1639:46	**RDO-2**	tower delta five fifty-four.
1639:48	**LGA TWR**	delta five fifty-four emergency vehicles are responding sir * * can you respond?
1639:52	**RDO-2**	yes we're gonna evacuate the airplane and ah we'll try and get everyone off the front of the plane on the ah runway.
1639:56	**CAM-1**	(start) the evacuation checklist.
1639:59	**LGA TWR**	no problem at all evacuate at your discretion sir .. the vehicles are responding on *.
1640:01	**CAM-1**	let's evacuate the airplane.
1640:02	**CAM-?**	[male and female voice simultaneously] smelling fuel.
1640:03	**INT/PA**	[sound of cabin chime]
1640:03	**CAM-1**	pardon?
1640:04	**INT/PA-3**	[unintelligible] are you alright?
1640:05	**CAM-2**	we need to get out.
1640:05	**CAM-1**	evacuate the airplane.
1640:06	**CAM-2**	okay.
1640:10	**INT/PA-1**	ladies and gentlemen we're going to evacuate the airplane .. please follow the flight attendants' instructions right now.
1640:12	**CAM-3**	release your seatbelts get up get out .. release your seatbelts get up get out .. release your seatbelts get up get out.
1640:15	**INT/PA-4**	do you want to go forward or backwards?
1640:18	**CAM-1**	evacuation checklist.
1640:19	**CAM**	[sound similar to door opening

from Atlanta to New York. There were no known malfunctions of aids to navigation or of internal or external communications.

The report said, "[Flight 554] was equipped with a traffic advisory/vertical speed indicator (TA/VSI) which displayed vertical speed information with a permitted lag time of up to four seconds.

"According to the manufacturer, the TA/VSI unit could be rewired to display real-time (instantaneous) vertical speed information to the flight crew if an inertial reference unit (IRU) was installed in the airplane. Although Delta was replacing the altitude/heading reference systems (AHRSs) with IRUs throughout the MD-88 fleet, at the time of the accident, the accident airplane's AHRS had not been replaced.

"Several of the MD-88 check airmen and flight instructors interviewed during the investigation stated that they believed that most Delta line pilots were unaware that the VSIs in the MD-88s were not instantaneous."

LaGuardia Airport elevation is seven meters (22 feet) above sea level. Runway 13/31 is 11,263 kilometers (7,000 feet) long, 241 meters (150 feet) wide and has a grooved surface of asphalt and concrete.

The approach end of Runway 13 extends on an elevated deck above Rikers Channel, a part of Flushing Bay. The runway extension comprises concrete and asphalt laid on steel piers. The approach lights, on stanchions in the water, extend farther into the bay.

Because of the prevailing northwesterly winds at LaGuardia (and other operational considerations), Runway 13 is used less frequently than the other runways: 4, 22 and 31. Runway 13 was equipped with high intensity runway lights (HIRL), runway-centerline lighting, REIL, medium-intensity approach lights, runway alignment lights and visual approach slope indicator (VASI) lights.

The ILS DME instrument approach to Runway 13 has six components: glideslope, localizer, DME, approach lighting system, marker beacons and compass locators. The electronic glideslope is not useable below 200 feet AGL because of signal irregularities caused by the pier's location over water, tidal influences and the metal content of the water.

The runway lighting system for Runway 13 at LaGuardia is not regular. The report said, "According to FAA Advisory Circular (AC) 150/5340-24, *Runway and Taxiway Edge Lighting System*, a runway-edge lighting system is a configuration of lights that defines the lateral and longitudinal limits of the useable landing area. With regard to location and spacing of runway lights, the AC states:

" 'The longitudinal spacing of the lights should not exceed [61 meters] 200 feet and be located such that a line between light units on opposite sides of the runway is perpendicular to the runway centerline. The lights should be spaced as uniformly as possible with the threshold/runway endlights used as the starting reference points.

" 'Where a runway is intersected by other runways or taxiways, a semi-flush light … should be installed to maintain the uniform spacing for the HIRLs. For MIRLs [medium-intensity runway lights] and LIRLs [low-intensity runway lights] a single elevated edge light should be installed on the runway side opposite the intersection to avoid gaps in excess of [122 meters] 400 feet where the matching of lights on opposite sides of the runway cannot be maintained … .'

"Postaccident measurement of the runway-light spacing on Runway 13 revealed that the runway lights were installed at irregular intervals, even where no other ground utilization considerations (crossing runways, taxiways, etc.) existed. The runway-light spacing distances varied, with the most common distances between lights falling between [37 meters] 120 feet and [52 meters] 170 feet. Most airports have runway edge lights generally positioned at, or near, the maximum [61-meter] intervals."

RVR is measured by visibility sensors (VSs). Runway 13 shares a common VS with Runway 22, because the two runways' touchdown points are close to each other. The common VS is about 460 meters (1,500 feet) from the approach end of Runway 13.

To get reliable RVR results, the REILs and HIRLs must be at specific settings. The report said, "The LaGuardia Tower SOP [Standard Operating Procedures] states, 'To obtain an accurate RVR reading, the Runway 4/22 edge lights must be at a step three setting or greater. If the Runway 13/31 HIRLs are [at a setting] equal [to] or greater than the Runway 4/22 HIRLs, then the Runway 13 RVR will display an accurate reading.'…

"During postaccident interviews, the LaGuardia air traffic controllers stated that they did not recall what light settings were in use at the time of the accident. However, according to [airfield] personnel, the LaGuardia HIRLs are connected to, and monitored by, a warning system. If the Runway 13 and Runway 22 HIRLs are not on the same setting, a 'fail' light and an aural warning alarm will activate. The controllers did not indicate that an alarm had activated."

LaGuardia has a phase II low-level wind-shear alert system (LLWAS) that employs six sensors, one near the center of the airport and the remaining five in locations surrounding the airport.

The report said, "Information obtained from the LLWAS northwest wind sensor (sensor 6) data and the center field average (CFA) [sensor 1] wind data for 40 seconds about the time of the accident indicated the following surface wind conditions:

		and slide inflating]
1640:20	**INT/PA**	[sound of cabin chime]
1640:22	**CAM-?**	go go.
1640:23	**CAM-3**	sit and slide [repeated several times]
1640:29	**CAM-?**	why don't you go out and meet at the front of the airplane .. meet at the front of the airplane.
1640:30	**CAM**	[sound similar to cockpit call chime]
1640:35	**INT/PA-5**	this is @ .. do you want forward?
1640:36	**INT/PA-4**	no @ I need the ba- forward.
1640:37	**CAM-1**	emergency power switch *.
1640:39	**INT/PA-5**	are we going out the back?
1640:40	**CAM**	[two sounds similar to cockpit call chimes]
1640:43	**INT/PA-4**	I'm wanting to know which way out.
1640:45	**CAM-1**	[mostly unintelligible words relating to emergency evacuation checklist]
1640:46	**INT/PA-?**	do not open the window -
1640:48	**INT/PA-2**	hello.
1640:48	**INT/PA-4**	do you want to go forward?
1640:50	**INT/PA-2**	let's come forward yes forward.
1640:56	[End of recording and transcript]	

CAM	=	Cockpit area microphone
HOT	=	Crew member hot microphones
RDO	=	Radio transmission from accident aircraft
-1	=	Voice or position identified as captain
-2	=	Voice or position identified as first officer
-3, -4, -5	=	Voice identified as flight attendant
-?	=	Unidentifiable voice
LGA TWR	=	LaGuardia air traffic control tower
COM	=	Unknown radio information
TWA 8630	=	Trans World Airlines Flight 8630
UAL 1576	=	United Airlines Flight 1576
INT/PA	=	Flight attendant intercom and/or passenger public address system
*****	=	Unintelligible word
#	=	Expletive deleted
@	=	Nonpertinent word (or name)
( )	=	Questionable text
[ ]	=	Editorial insertion
-	=	Break in continuity

Time	Northwest Wind Sensor	CFA Wind
1638:26	080º at 14 knots	090º at 13 knots
1638:36	080º at 13 knots	090º at 14 knots
1638:46	080º at 14 knots	090º at 14 knots
1638:56	080º at 14 knots	090º at 14 knots
1639:06	080º at 15 knots	090º at 14 knots

"Examination of the LLWAS recorded data indicated that no LLWAS system alarms occurred between 1600:06 and 1649:56 [which time frame embraces the time of the accident]. Additionally, no wind gusts were recorded [during the same period].

"After the accident, FAA performed a site performance evaluation system of the LLWAS archived data. The examination revealed that three of the six sensors (sensors 3, 4 and 5) appeared to have problems. According to FAA, the sensor problems might have resulted in the system's failure to detect existing wind-shears, or the system producing false wind-shear warnings."

VASI is a light system that can be used by pilots to maintain an approximate three-degree visual glideslope to the touchdown point on the runway. The VASI system for Runway

Regulations Specify Pilot Vision Requirements and Performance

The report said, "The standards for pilot medical certification are described in [U.S. Federal Regulations (FARS)] Part 67, which was most recently updated in September 1994. According to Part 67.13, to be eligible for a first-class medical certificate, an applicant must meet the following vision requirements.

"(1) Distant visual acuity of 20/20 or better in each eye separately, without correction; or of at least 20/100 in each eye separately corrected to 20/20 or better with corrective lenses (glasses or contact lenses), in which case the applicant may be qualified only on the condition that he wear those corrective lenses while exercising the privileges of his airman's certificate. … "

In amplification of the U.S. Federal Aviation Administration (FAA) policy, the FAA Civil Aeromedical Institute (CAMI) submitted the following statement, which was quoted in the report:

"For a binocular [pilot], contact lenses that correct near visual acuity only or that are bifocal are not considered acceptable for aviation duties … . The use of a contact lens in one eye for distant visual acuity and a [contact] lens in the other eye for near visual acuity is not acceptable because this procedure makes the pilot an effective 'alternator'; i.e., a person who uses one eye at a time, suppressing the other. Stereopsis [binocular vision] is lost."

In the FAA's *Guide for Aviation Medical Examiners*, the Federal Air Surgeon determined that applicants for first- or second-class medical certificates must show at least 20/20 distant and 20/40 near visual acuity with each eye separately, with or without correction. The guide was quoted in the report. It said, "The use of a contact lens in one eye for distant visual acuity and another in the other eye for near visual acuity [MV contact lenses] is not acceptable."

The report said, "…the captain [was] not aware that the use of MV contact lenses by pilots performing flying duties was not approved by the FAA.

"The aviation medical examiner (AME) who had examined the captain [of the accident aircraft] for airman medical certification indicated that … he [the AME] was not specifically aware that MV contact lenses were not approved for use while flying. … According to several optometrists interviewed during this investigation, no published information tells optometrists that the use of MV contact lenses by pilots while flying is prohibited."

In 1968–1969, the U.S. Air Force (USAF) conducted a series of experiments to determine the degree of pilot impairment as a result of the loss of binocular vision. The report said, "[USAF] research personnel indicated that stereoscopic vision is normally most critical in determining the distance from objects close to an individual, although stereoscopic vision is generally accurate to distances up to [183 meters] 600 feet. They stated that beyond 6.1 meters to 7.6 meters, monocular cues … usually assume an increasing role in the judgment of distance.

"Because the use of MV contact lenses results in degraded depth perception and occasional blurred images, an individual wearing MV contact lenses will rely more heavily on monocular cues under all circumstances to judge distance than an individual wearing binocular vision correction."

The report said that among the conclusions of the USAF landing experiments was:

"2. Significantly steeper approaches are observed during monocular landings than those observed during approaches made with normal vision."♦

13 comprises two light boxes that are located on the left side of the runway. One box is about 200 meters (650 feet) from the approach end of the runway (the downwind box); the other box is about 475 meters (1,550 feet) from the approach end of the runway (the upwind box).

Each box contains a set of red lights and a set of white lights, with the white lights mounted over the red lights. The boxes are designed so that only one set of lights is visible at any one time. Visual glideslope guidance is provided by the color of the lights the pilot sees on his approach.

- If red lights are visible in both boxes, the aircraft is on a glideslope lower than three degrees.
- If white lights are visible in both boxes, the aircraft is on a glideslope higher than three degrees.
- If white lights are visible in the downwind box and red lights are visible in the upwind box, the aircraft is on a glideslope of about three degrees.

The report said, "According to the pilots of [the accident aircraft] … they did not observe either bar of the VASI lights during their descent to the runway.

"Postaccident interviews with the pilots of four airplanes that landed on Runway 13 just before [the accident aircraft] revealed that none of them recalled observing the VASI lights during their approach/landing. However, none of the pilots interviewed (including the flight crew of [the accident aircraft]) recalled specifically seeking VASI light guidance during their approach to land."

Table 1 shows excerpted FDR data from the final 63 seconds of the aircraft's approach to Runway 13, keyed to comments on the CVR. The FDR data ended with the first collision.

The report said, "Although the quality of the FDR data was good, the FDR experienced data loss coincident with the highest recorded vertical acceleration forces (Gs) that occurred during the airplane's impact with the approach lights and the runway pier. …

"The FDR data indicated that as the airplane descended on the ILS DME approach to Runway 13, it was established on the electronic glideslope and localizer until it reached about [140 meters] 400 feet [mean sea level]. As the airplane continued the approach from that point, it began to deviate above the glideslope and right of the localizer.

"According to FDR data and CVR information, … at 1638:26, when the first officer called a [213-meter] 700-feet per minute descent rate, the airplane's actual rate of descent … was about [366 meters] 1,200 feet per minute. At 1638:30.1, (when the captain stated, 'I'll get over there.') the FDR data indicated that the airplane was descending through about [34 meters] 110 feet AGL at a rate of descent of about [458 meters] 1,500 feet per minute. …

"By 1638:33, the FDR data indicated that the airplane was descending through about [23 meters] 75 feet AGL at [550

Table 1
FDR Data from the Final 63 Seconds of the Approach

Cockpit Voice Recorder Excerpt	Local Time	MSL Altitude (feet)	Radio Altitude (feet)	IAS (knots)	Glideslope Deviation (dots)	Localizer Deviation (dots)	EPR Eng. 1	EPR Eng. 2	Elevator Position (degrees)
A/P off	1637:33	730	895	131	0.09 fly down	0.03 fly right	1.26	1.26	6.4 TEU
200 above	1637:57	468	603	129	0.06 fly up	0.04 fly right	1.27	1.27	7.5 TEU
100 above	1638:10	377	465	131	1.18 fly down	0.26 fly left	1.30	1.28	7.0 TEU
Approach lites in sight	1638:11	376	453	131	1.30 fly down	0.32 fly left	1.33	1.32	5.2 TEU
Little bit high	1638:13	341	435	130	1.39 fly down	0.39 fly left	1.37	1.35	7.0 TEU
Minimums	1638:20	265	319	133	1.43 fly down	0.67 fly left	1.19	1.21	9.3 TEU
Speed's good	1638:25	213	259	129	2.40 fly down	0.87 fly left	1.16	1.19	4.8 TEU
Sink's 700	1638:26	202	239/189	126	2.32 fly down	0.91 fly left	1.13	1.15	9.5 TEU
I'll get over there	1638:30	151	143	127	0.89 fly down	0.84 fly left	1.09	1.09	4.3 TEU
A little bit slow …	1638:31	133	118	126	0.27 fly down	0.79 fly left	1.08	1.11	8.8 TEU
Nose up	1638:33	68	59	124	2.08 fly up	0.71 fly left	1.23	1.11	20.3 TEU
Nose up/"sink rate"	1638:34	39	30	124	3.16 fly up	0.65 fly left	1.48	1.18	24.9 TEU
GPWS "sink rate"	1638:35	23	10	126	4.03 fly up	0.55 fly left	1.65	1.43	26.0 TEU

AP = Autopilot GPWS = Ground-proximity warning system MSL = Mean sea level IAS = Indicated airspeed
EPR = Engine pressure ratio FDR = Flight data recorder TEU = Trailing edge up

Source: U.S. National Transportation Safety Board

Emergency Evacuation of the Aircraft

"The [U.S. National Transportation Safety Board] considers that in general, the crew members' responses after the airplane came to a stop were commensurate with the circumstances of this accident," the official accident report said. "First, the crew members 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."

Figure 2 shows the accident McDonnell Douglas MD-88 diagram and seating chart. At the time of the accident, the flight-attendant-in-charge was seated in the aft-facing jumpseat, next to the L-1 door (left side, forward). The second flight attendant was seated in the forward-facing jumpseat on the left side of the aircraft, and the third flight attendant was seated in the forward-facing rear cabin jumpseat.

MD-88 Passenger Cabin
Delta Flight 554, Oct. 19, 1996

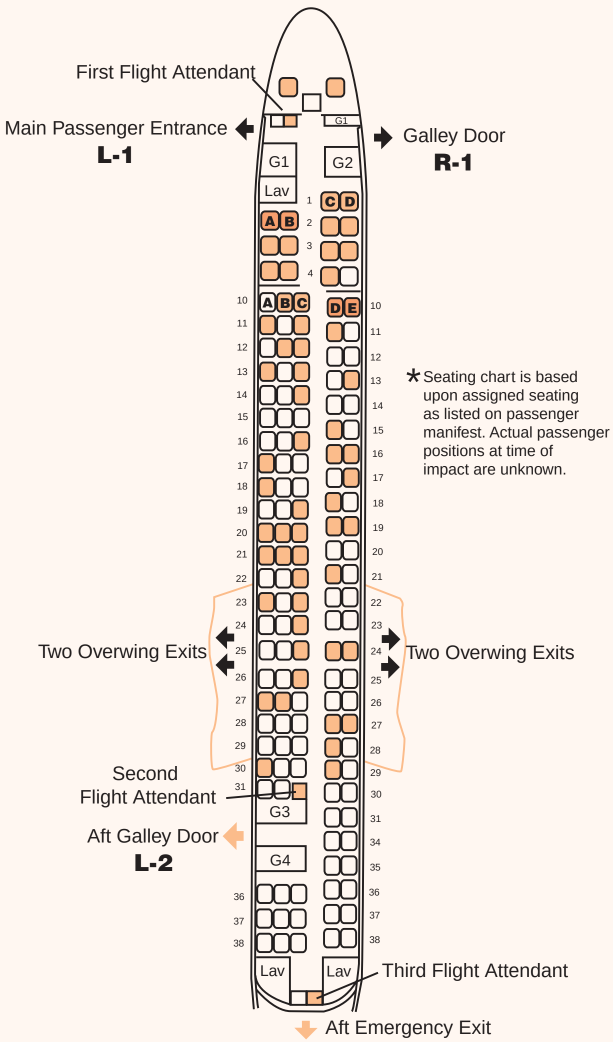


Figure 2

meters] 1,800 feet per minute. At 1638:34, the rate of descent began to decrease. At 1638:34.2 and 1638:35.7, the CVR recorded the sound of the GPWS 'sink-rate' warning, followed by … the moment of impact."

The NTSB made an effort to determine why the descent rate of the accident aircraft on final approach continued to increase until a safe landing could no longer be made. The NTSB considered several factors, including the weather at the airport, visual illusions that might have led the pilot to believe that the aircraft was higher than it actually was, the irregular runway lighting, the pilot's use of MV contact lenses, and the noninstantaneous VSI.

The report said, "The pilots performed the instrument approach and landing in low clouds, moderate-to-heavy rain, and fog … . 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. …

"Based on the FDR data and calculated descent rate information, the airplane was established in the landing configuration (flaps and landing gear extended), on target airspeed [+/- 7.4 kph] four knots, with an average descent rate of about [263 meters] 750 feet per minute, and was established on the localizer and electronic glideslope (+/- 1/10 of a dot) from the time it descended through about [305 meters] 1,000 feet AGL (at 1637:005) until it reached an altitude of [131 meters] 431 feet AGL (approximately 1638:02)."

The descent shallowed briefly when a TWA aircraft flight crew announced that they were aborting their takeoff on Runway 13.

The report said, "Regardless of the reason for the reduction in the descent rate, by the time the airplane began to deviate more than one dot above the electronic glideslope (at 1638:10), it appears that the captain had recognized the deviation and had applied correction in an attempt to reestablish the airplane on the glideslope."

From 1638:14 until 1638:26, the approach was generally steady and on target, and the aircraft was in a position from which a successful landing could be made.

The report said, "FDR data indicated that about 10 seconds before impact, the engine power was reduced gradually [from EPRs (engine pressure ratios) of 1.2 to EPRs of 1.09] … . During this period the elevator position oscillated, averaging between two degrees nose up and about eight degrees nose up.

"The [NTSB] concludes that the captain gradually reduced the engine power because he perceived a need to slightly increase the airplane's rate of descent; however, the descent rate increased beyond what the captain likely intended to command. … By 1638:32, the captain had recognized that corrective action was required and was increasing the nose-up elevator deflection and increasing the engine power."

In interviews, the first officer said that from the time he called out "one thousand above minimums" until the captain saw the approach lights, his attention was almost exclusively on the flight instruments. He reported that he thought the approach was good, stable and not rushed — until a few seconds before impact.

The report said, "Had the first officer called out information from the airplane's radar altimeter, it would have helped one or both of the pilots to perceive the airplane's actual descent rate; however, the first officer did not (and was not required by Delta to) call out radar altimeter information (because he either did not look at it, or did not perceive the importance of that information) during the approach."

The first officer said that during the visual part of the approach, he continued to monitor the cockpit instruments, glancing outside only occasionally, while the captain flew the approach using mostly outside references. The first officer said that he never saw a rate of descent greater than 3,050 meters per minute on the VSI during the approach descent.

"According to the first officer, several seconds before impact he glanced outside and realized that the airplane was descending short of the runway, and at 1638:33.77, he stated, 'Nose up … nose up,'" said the report. The captain had already added power and the nose of the airplane pitched up; however, it was too late to avoid the accident.

The report said, "The first officer told [NTSB] investigators that he believed that Delta's manuals did not contain clearly defined guidance regarding PNF [pilot-not-flying] duties during a CAT I [Category I] ILS approach once the PF established ground contact." Minimums for a CAT I ILS approach with runway touchdown zone and centerline lighting were a decision height (DH) of 61 meters and RVR of 549 meters. Minimums for CAT II (Category II) and CAT III (Category III) approaches are less.

The first officer said that his personal practice, after the PF had established visual contact with the ground, was to monitor the cockpit instruments, provide information to the captain and be ready to take control of the airplane if necessary.

The report said, "The [NTSB] 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 (i.e., speed's good, sink's 700, a little slow, nose up), which was not specifically required by Delta's manuals … ."

As a result of this accident, program managers at Delta met on several occasions to discuss PNF duties and landing callout requirements. They examined the landing-callout requirements

The report said, " … 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.

"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. … The [NTSB] 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."

During postaccident interviews, the three flight attendants were asked to describe their actions during the evacuation.

The report said, "The FAIC … stated that when the airplane came to a stop on the runway, she picked up her interphone handset and waited for instructions. … [She stated] that when she heard the evacuation command, she opened the L-1 exit, pulled the manual slide-inflation handle and began the evacuation. … She stated that after four or five passengers 'piled up' at the bottom of the slide, she slowed the pace of the evacuation… . The FAIC indicated that when all the passengers but one had been evacuated, she exited the airplane at a firefighter's request; the flight crew remained behind to assist the remaining passenger out of the airplane.

"The second flight attendant indicated that … when the airplane came to a stop, she picked up the interphone handset and waited for instructions. She stated that she heard two PA [public address] announcements from the cockpit. … [and that] sometime between the two announcements, she began to smell fumes, which she described as a combination of burned motor oil and fuel fumes.

"The second flight attendant stated that after she heard the captain's evacuation command she replaced the interphone handset, got up and began to instruct passengers to move forward to evacuate. During the evacuation process, the second flight attendant also obtained ice from the aft galley for a passenger who had bumped her head. …

"According to the third flight attendant, she believed that she was somewhat 'displaced' during the accident sequence and evacuation because she was seated in the aft cabin (tailcone) jumpseat and no passengers were seated in the rear of the cabin. … By the time she reached the middle of the coach section of the cabin, most of the passengers had moved forward into the first-class section of the airplane. …

"However, two passengers who were standing near the midsection of the airplane appeared disoriented and were not moving forward toward the exit. [She] indicated that she tried to get the two remaining passengers to move forward quickly, but the passengers did not respond. She reported that the first officer 'was telling me to hurry because there was extensive aircraft damage and potential for explosion.' When the first officer moved aft to carry one of the passengers out of the airplane, the third flight attendant exited through the L-1 door." The flight crew assisted the remaining passenger out of the airplane.♦

in effect at other air carriers, which called for frequent altitude callouts, down to altitudes as low as three meters AGL. The program managers agreed to revise the Delta flight operations manual (FOM) to explain in greater detail the duties of the PF and the PNF during instrument approaches, but not to include such callout requirements.

The report said, " … Delta's program managers concluded that … 'we wanted the PNF to be aware of the outside environment in the final phase of the approach/landing.' …

"The following procedures are expected to be included in the [FOM] revision, which is still in draft form:

"Scan policy:

- "Approach scan policy is set to ensure that someone is always focused on airspeed, altitude and profile;
- "Approach scan responsibilities for the PF and PNF are listed below;
- "**IN** means primary responsibility is inside the aircraft;
- "**OUT** means primary responsibility is outside the aircraft; [and,]
- "The item inside the parentheses ( ) means secondary responsibility.

Situation	PF	PNF
Runway environment not in sight	IN (out)	IN (out)
Runway environment in sight	OUT (in)	IN (out)

- "Except for CAT II and CAT III approaches."

With regard to the weather at the time of the accident, the report said, "Although weather conditions were sufficient for the approach to be made safely, the low overcast cloud layer and heavy rain and fog … 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."

There are several visual illusions that can give an airborne pilot the impression that the aircraft is higher than it really is. These illusions are especially critical during approach, when margin for error is diminished. Conditions which can cause a false sense of height AGL include:

- Lack of ground features, such as would be experienced when making an approach over a large body of water;
- Rain or mist on the windscreen;
- Haze or fog that limits forward visibility; and,
- Few or no lights visible on the ground.

"[NTBS] notes that all of these conditions were present when the pilots of [the accident aircraft] descended out of the overcast cloud layer and the captain transitioned to visual conditions," said the report. "Further, the Runway 13 edge lights were spaced irregularly … so the pilots were presented with a foreshortened runway. Pilots who are accustomed to operating into airports at which runway lights are spaced at consistent 61-meter intervals might perceive their distance and angle to the runway differently when presented with runway lights spaced at shorter, irregular intervals."

Although the foregoing factors presented potential challenges for any pilot landing on Runway 13 around the time of the accident, other airplanes made the ILS DME approach to Runway 13 that afternoon and landed without incident. In an effort to understand why the captain of Flight 554 was unable to land safely, the NTSB analyzed the effect of the captain's MV contact lenses on his vision.

The captain had 20/20 vision in both eyes until 1989, when the captain's near vision worsened and was corrected with glasses. Several months later, he began using MV contact lenses, alternating them with bifocal spectacles for general use. He said that he used MV contact lenses for vision correction about 75 percent of the time that he flew, and that he had never noted any problems with them.

"The [captain's] optometrist told investigators that … binocular vision correction would be preferable for pilots while performing flying duties, because there is a need for stable near and distant vision in cockpit situations," said the report. "He reported that a pilot's use of MV contact lenses could impair sink-rate perception, depth perception at some distances and scanning vision … .

"Individuals with normal binocular vision use both binocular and monocular cues for depth perception. Although binocular vision is generally accurate to distances up to [183 meters] 600 feet, binocular cues are most critical in determining distance from objects close to an individual, while monocular cues assume an increased role in the perception of distances from objects farther away … .

"However, because of the degraded conditions encountered by [Flight 554], the captain was not presented with adequate monocular cues to enable him to accurately perceive the airplane's altitude and distance from the runway during the visual portion of the approach and landing. This resulted in the captain's failure (during the last 10 seconds of the approach) to either properly adjust the airplane's glidepath or to determine that the approach was unstable and execute a missed approach."

The unnecessary increase in the descent rate that occurred 10 seconds before impact supports the thesis that the captain's binocular vision was degraded, because the descent rate suggests that he believed the aircraft to be higher than it really was. A pilot with normal binocular vision might not have had that misperception; he or she might have sensed the aircraft's excessive sink rate earlier, and either slowed the descent to allow for a normal landing or elected to go around.

"… The captain did not have normal depth perception and did not recognize that anything was wrong with the approach until about four seconds before the accident, when the 'aim point shifted down into the lights,'" said the report.

In discussing the VSI, the report said, "… During the final 12 seconds before impact, the airplane's rate of descent … began to increase. At 1638:26, as the first officer called out a sink rate of [214 meters] per minute (based on VSI information), the airplane was actually descending at about [366 meters] per minute.

"Had the first officer seen a descent rate of 366 meters 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.

"The first officer told the [NTSB] 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 requires landing over water, a [76-meter] 250-foot DH and an offset localizer — as being worthy of special-pilot-qualification requirements."

The designation of special airports is an ongoing issue, and the NTSB is concerned that current U.S. regulations do not provide operators with detailed information as to the justification for special airport designation and do not describe specific approaches, runway, hazards or obstacles. (See "Special Pilot Qualifications and Airports Defined.")

The report said, "The [NTSB] 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 NTSB's findings as a result of their investigation of this accident included:

- "The pilots held appropriate flight and medical certificates; they were trained and qualified for the flight, and were in compliance with the federal regulations on flight time and duty time. However, the captain was using monovision contact lenses, which were not approved by the FAA for use by pilots while flying;
- "The flight attendants had completed Delta's [FAA]-approved flight attendant training program;
- "The airplane was properly certificated, and there was no evidence that airplane maintenance was a factor in the accident;
- "No air traffic control factors contributed to the cause of the accident.
- "Although the pilots did not receive several pieces of weather information, Delta Air Lines provided the pilots with sufficient preflight, en route and arrival weather information to allow them to conduct the flight safely;

Special Pilot Qualifications and Airports Defined

The criteria for special pilot qualifications and the definition of special airports are contained in U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 121.445-1D.[1]

Specific airports are determined to be unique because of surrounding terrain, obstructions or complex arrival and departure procedures. Special qualifications are required of pilots-in-command to land at or take off from these airports.

The AC said, "The pilot-in-command or second-in-command [can] meet the airport qualifications specified by making a qualifying entry to that airport (including a takeoff and landing) while serving as a pilot flight crew member. The pilot-in-command may also meet the airport qualification by using pictorial means that are acceptable to the [FAA] administrator. These qualifications are to be met within the preceding 12 months [of landing at or taking off from that airport] … ."

A complete list of airports requiring special pilot qualifications and the general reason for their designation as special airports is contained in the appendix to the AC.

The AC said, "Air carriers are encouraged to recommend additions or deletions to these listings. Recommendations, along with an explanation of the need for the addition or deletion, should be submitted to the assigned principal operations inspector. The principal operations inspector will forward the recommendation with his/her comments to [the] regional Flight Standards Division. The regional Flight Standards Division will provide updated information on these listings, as changes occur, to the Air Transportation Division, AFS-200, who will make appropriate changes periodically.♦

however, because of rapidly changing surface conditions, the conditions they encountered differed from what was forecast;

- "Although the weather conditions encountered by the pilots during the approach differed from the forecast conditions, these conditions should not have affected the pilots' ability to conduct a safe approach and landing;
- "[Flight 554] did not encounter wind shear during its approach to Runway 13 at LaGuardia;
- "Because the airplane was in stable flight and the captain had taken actions to correct for a glideslope deviation, the captain's continuation of the approach after he established visual contact with the approach lights was not inappropriate;
- "The captain gradually reduced the engine power because he perceived a need to slightly increase the airplane's rate of descent; however, the descent rate increased beyond what the captain likely intended to command;
- "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;
- "The captain's use of monovision contact lenses resulting in his (unrecognized) degraded depth perception, and thus increased his dependence on monocular cues (instead of normal three-dimensional vision) to perceive distance;
- "Because of the captain's use of monovision contact lenses, he was unable to overcome the visual illusions resulting from the approach over water in limited light conditions (absence of visible ground features), the irregular spacing of the runway-edge lights at shorter-than-usual intervals, the rain and the fog, and that these illusions led the captain to perceive that the airplane was higher than it was during the visual portion of the approach, and thus, to his unnecessarily steepening the approach during the final 10 seconds before impact;
- "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;
- "The Delta manuals were not sufficiently specific regarding [PNF] duties during Category I [ILS] approaches after the [PF] establishes ground contact;
- "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;
- " … AMEs [aviation medical examiners] 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;
- "Information concerning the possible hazards of monovision contact lens use is not well disseminated among optometrists and the pilot population;
- "The lag time in the display of vertical speed information in the vertical speed indicator installed in [Flight 554] 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;
- "Pilots need to be aware of the type of vertical speed information provided by the vertical speed indicator installed in their airplane, and to understand the possible ramifications of that information;
- "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 current requirements for special-airport pilot qualifications might not be sufficient to ensure that pilots who are so qualified have been exposed to runways and/or approaches at those airports that make the airport 'special';
- "The flight crew coordination appeared adequate, and the decision to evacuate the airplane was appropriate and timely;
- "The flight attendant in charge, who began shouting evacuation commands within two seconds of the evacuation order, reacted to the evacuation command promptly and assertively, in accordance with Delta's flight attendant manuals and training;
- "The two aft flight attendants did not react promptly or demonstrate assertive leadership, as specified in Delta's flight attendant manuals and training;
- "The quality of the crew resource management was not a factor in this accident;
- "The atypical installation and use of runway visual range transmissometer equipment at LaGuardia did not

adversely affect the validity of the runway visual range values reported at the time of the accident; [and,]

- "The low level wind-shear alert system equipment anomalies were not a factor in the accident."

The NTSB addressed the following recommendations to the FAA:

- "Identify [FARs] 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 … Part 121 and 135 operators to review and revise their company operations manuals to more clearly delineate flight crew members [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.' (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 [FAA] Civil Aeromedical Institute to 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. (A-97-87);
- "Require all … 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 flight crew 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 [MV] contact lens use by pilots while flying. (A-97-89);
- "Require all … 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/noninstantaneous) 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 … Part 121 and 135 operators to convert, where practical, the noninstantaneous vertical speed instrumentation on airplanes that have inertial reference units installed to provide flight crews with instantaneous vertical speed information. (A-97-1);
- "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 [those] criteria and update special airport publications accordingly. (A-97-94); [and,]
- "Require all … 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)."

The NTSB addressed the following recommendation to optometric associations:

- "Issue a briefing bulletin to member optometrists, informing them of the potential hazards of and prohibition against [MV] contact lens use by pilots while performing flying duties, and urging them to advise pilot-rated patients of those potential hazards (MV contact lens' effect on distance judgments/perceptions). (A-97-96)."♦

Editorial note: This report was adapted from *Descent Below Visual Glidepath and Collision with Terrain, Delta Air Lines Flight 554, McDonnell Douglas MD-88, N914DL, LaGuardia Airport, New York, October 19, 1996.* Report no. NTSB/AAR-97/03, August 1997. The 170-page report contains figures and appendices.

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1. U.S. Federal Aviation Administration Advisory Circular 121.445-1D, *Pilot-in-Command Qualifications for Special Area/Routes and Airports, Federal Aviation Regulations Section 121.445.* June 20, 1990.

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