Crashed short, Delta Air Lines, Inc., Douglas DC-9-31, N975NE, Boston, Massachusetts, July 31, 1973

Micro-summary: This DC-9 crashed into the seawall on approach to Logan RWY 4R.

Event Date: 1973-07-31 at 1108 EDT

Investigative Body: National Transportation Safety Board (NTSB), USA

Investigative Body's Web Site: http://www.ntsb.gov/

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SA-439 FILE NO. 1-0011

AIRCRAFT ACCIDENT REPORT

DELTA AIR LINES, INC.

DOUGLAS DC-9-31, N975NE

BOSTON, MASSACHUSETTS

JULY 31, 1973

ADOPTED: MARCH 7, 1974

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D.C. 20591

REPORT NUMBER: NTSB-AAR-74-3

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SYNOPSIS

About 1108 e.d.t. on July 31, 1973, Delta Air Lines Flight 723, a DC-9-31, crashed into a seawall while executing an instrument landing system (ILS) approach to runway 4R on the Logan International Airport, Boston, Massachusetts. There were 83 passengers, 5 crewmembers, and a cockpit observer on board. All occupants, except one passenger, were killed in the crash. The lone survivor, who had been injured critically, died on December 11, 1973.

The aircraft struck the seawall about 165 feet to the right of the extended runway centerline and about 3,000 feet short of the runway displaced threshold. The aircraft was destroyed.

The accident occurred during daylight hours. The weather was characterized by lowering ceilings and visibilities; sea fog of increasing density was moving across the airport from an easterly direction.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the flightcrew to monitor altitude and to recognize passage of the aircraft through the approach decision height during an unstabilized precision approach conducted in rapidly changing meteorological conditions. The unstabilized nature of the approach was due initially to the aircraft's passing the outer marker above the glide slope at an excessive airspeed and thereafter compounded by the flightcrew's preoccupation with the questionable information presented by the flight director system. The poor positioning of the flight for the approach was in part the result of nonstandard air traffic control services.

As a result of this accident, the Safety Board has made several recommendations to the Administrator of the Federal Aviation Administration (FAA).

1. INVESTIGATION

1.1 History of the Flight

On July 31, 1973, Delta Air Lines, Inc., Flight 723, a Douglas DC-9-31 (N975NE), was a scheduled passenger flight from Burlington, Vermont, to Logan International Airport (BOS), in Boston, Massachusetts. An unscheduled stop was made at Manchester, New Hampshire, to pick up passengers who were stranded because an earlier flight had been canceled because of weather. Flight 723 was a continuation of Flight 524, which had originated at BOS earlier the same day.

The flight departed the airport gate at Manchester, New Hampshire, at 0957, 1/ with 83 passengers, 5 crewmembers, and a cockpit observer on board. After several delays, due to weather conditions at BOS, the flight was cleared to BOS on an instrument flight rules flight plan, and departed at 1050. From takeoff at Manchester until the time of the crash, the first officer in the right seat piloted the aircraft, and the captain handled air-to-ground communications.

At 1051:22, Boston Approach Control (AR-1) cleared the flight to the Lawrence, Mass., VOR 2/ advising, ". . . no delays, plan vectors ILS 3/ four right, the Boston altimeter is three zero one one. Weather is partial obscuration, estimated four hundred overcast, mile and a half and fog."

Flight 723 acknowledged the clearance from AR-1 at 1051:32, and climbed to an assigned altitude of 4,000 feet. 4/ During the climb, the cockpit observer 5/ called out the after-takeoff checklist challenges, and the captain responded.

At 1054:25, the flight advised BOS AR-1, "Delta seven two three approaching Lawrence," after which AR-1 told the flight, "Seven two three roger, fly heading now one eight zero, radar vectors ILS four right." The flight acknowledged the clearance and complied.

At 1055:57, the cockpit observer began calling out the challenges in the descent checklist.

At 1056:24, BOS AR-1 cleared the flight to descend to 3,000 feet. The flight acknowledged the request and complied.

1/ All times herein are eastern daylight, based on the 24-hour clock.
2/ VOR - Very high frequency omni-directional radio range.
3/ ILS - Instrument landing system.
4/ All altitudes herein are mean sea level unless otherwise indicated.
5/ A former Northeast Airlines, Inc., captain, in the process of requalification after he was grounded for an extensive period of time because of illness.

At 1057:36, BOS AR-1 requested, "Delta seven two three, fly heading two two zero." The flight complied.

From 1058:50 until 1100:17, the cockpit observer called out the challenges in the approach checklist; the captain responded.

From 1101:18 until 1104:07, BOS AR-1 requested four heading changes, and the flight complied.

At 1104:30, BOS AR-1 requested, ". . . Delta seven two three, fly a heading of zero eight zero now, intercept the localizer course and fly it inbound, over." This heading change was the final vector provided by BOS AR-1. At 1104:35, the flight replied, "Okay, zero eight zero for intercept."

About 45 seconds later, during intracockpit conversation, the captain stated, "Localizer is alive." The first officer then asked, "Go down to two thousand now, can't we?" The captain answered, "He didn't say to go down."

At 1105:39, the captain asked BOS AR-1, "Is seven two three cleared for ILS?" BOS AR-1 immediately replied, "Yes, seven two three is cleared for the ILS, yes."

According to flight data recorder information, the approach descent was initiated at 1105:27, following the captain's observation that the localizer was alive. The descent continued uninterrupted until the crash.

The flightpath constructed from flight recorder data indicates that the aircraft had just passed the outer marker (OM) when the first officer called, "checklist." The time was 1106:33.5. The first officer's call was followed by the cockpit observer's statement: "Three green, pressure and quantity." The only other reference to items on the before-landing checklist on the cockpit voice recorder (CVR) was recorded about 1107.8, when the observer said, "Before landing . . . before landing is complete."

Between 1106:43 and 1107:05, the following conversation took place between the captain (CAM-1) and the first officer (CAM-2):

1106:43.5

CAM-1: Get on it Joe, ah, Sid.

1106:47.5

CAM-2: Getting down, ah thousand feet a minute.

1160:50.5

CAM-1: Leave it below one* 6/

1107:05

CAM-2: This ## 7/ command bar shows*.

CAM-1: Yeah, that doesn't show much.

At 1107:14, BOS AR-1 stated, "Seven two three is cleared to land, tower one nineteen one." Three seconds later, the flight replied, "Seven two three."

Between 1107:19 and 1107:40, the following cockpit conversation took place between the captain and the first officer:

1107:19

CAM-1: Going like a ##

1107:28

CAM-1: Okay, your localizer, startin' to come back in now.

CAM-2: Okay

1107:35

CAM-2 Set my power up for me if I want it.

1107:38

CAM-1: Okay, just fly the airplane.

1107:40 (25 seconds before impact)

CAM-1: You better go to raw data, I don't trust that thing.

Twenty-two seconds before impact, the captain radioed the following: ". . . Boston, Tower, Delta seven two three, final." BOS tower controller replied, "Cleared to land four right, traffic's clearing at the end, the RVR 8/ shows more than six thousand, a fog bank is moving in, it's pretty heavy across the approach end." The flight's acknowledgement of that clearance and advice at 1107:52 was its last radio communication.

6/ * - Unintelligible word.
7/ # Nonpertinent word.
8/ RVR - Runway Visual Range.

At 1107:54, according to the CVR, the captain stated, "*'ll let's get back on course." The first officer replied, "I just gotta get this back."

At 1108:04.05, the captain stated, "*'en out," which was followed immediately by a shout, believed to be by the cockpit observer.

At 1108:05.5, the aircraft struck a seawall about 165 feet to the right of the extended runway 4R centerline and about 3,000 feet short of the runway displaced threshold. The impact and subsequent fire destroyed the aircraft.

The accident occurred during daylight hours. The weather was characterized by lowering ceilings and visibilities; sea fog of increasing density was moving across the airport from an easterly direction.

One witness, about 0.6 nautical mile from where the aircraft crashed, saw it for a few seconds fly directly overhead at an altitude which appeared lower than normal. The captain of a tug boat passing within 400 yards of the impact point heard the aircraft pass overhead but was unable to see it because of the dense fog. Several other witnesses heard the aircraft pass overhead and crash but could not see it.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other
Fatal	6*	82	0
Nonfatal	0	1 (Died 12-11-73)	0
None	0	0	

* Includes cockpit observer.

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

Part of the concrete seawall which bounded the airport was torn out. The portion which was torn out was 9 feet 1 inch wide and 1 foot 6 inches deep.

Two approach light bars, each containing five lights, were also damaged.

1.5 Crew Information

The captain and the first officer were certificated to serve as crewmembers for this flight. (See Appendix B.)

The cockpit observer was neither qualified nor certificated to serve as a crewmember for the flight.

1.6 Aircraft Information

The aircraft was certificated, equipped, and maintained according to Federal Aviation Administration (FAA) requirements. (See Appendix C.)

1.7 Meteorological Information

The official surface weather observations at BOS near the time of the accident were as follows:

1053 - Record special, partial obscuration, estimated 500 feet broken, overcast-25,000 feet, surface and tower visibility-1/2 mile, fog, temperature-68° F., dew point-64° F., wind estimated 100°, 2 knots, altimeter setting-30.12 inches, fog obscuring 3/10 of sky, sun visible.

1114 - Special, partial obscuration, overcast-estimated 400 feet, surface visibility-1 mile, tower visibility-1/2 mile, fog, wind-130°, 4 knots, altimeter setting-30.12 inches, fog obscuring 4/10 of sky, runway 4R runway visual range (RVR)-1,400 feet variable to 6,000 feet ≠. 9/

1133 - Local, observation, partial obscuration, estimated 200 overcast, surface visibility-3/4 mile, tower visibility-1/2 mile, fog, wind 130°, 3 knots, altimeter setting-30.12 inches, runway 4R RVR 2,000 feet, variable to 6,000 feet ≠, fog obscuring 5/10 of sky, aircraft mishap.

The weather around the airport was characterized by low stratus and fog. Winds near the surface were light and variable, mostly from an easterly (onshore) direction.

Pilots who were making approaches to runway 4R before and after the accident reported decreasing visibility caused by fog. Eastern Air Lines Flight 572 had completed its landing about 2 minutes before Flight 723 crashed. The first officer stated that the runway was visible from an altitude between 200 and 300 feet. Eastern Air Lines Flight 1020 which followed about 4 minutes behind Flight 723, made a missed approach. The

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9/ RVR was reported as a ten-minute mean value by the National Weather Service.

captain of Flight 1020 stated that upon reaching the decision height (216 feet), he could see "nothing" and had initiated the missed approach.

Inspection of RVR data indicated that about the time of the accident, the RVR was dropping rapidly from a value of more than 6,000 feet to about 1,600 feet. Within 1/2 minute after the accident, a BOS tower controller broadcast to all aircraft that the RVR was 2,000 feet.

1.8 Aids to Navigation

A full ILS serves runway 4R at BOS. The OM and the middle marker (MM) are located 5.3 and 0.6 nautical miles, respectively, from the displaced threshold.

The Jeppesen Approach Chart, dated February 16, 1973, indicated that the decision height (DH) for the approach of Flight 723 was 216 feet (200 feet above the terrain). (See Appendix D.)

A flight check conducted after the accident to test the pertinent en route navigational facilities, the BOS VOR, and the BOS ILS found all systems operating normally.

1.9 Communications

No communication difficulties were encountered between the crew and air traffic control facilities.

After the local controller received Flight 723's acknowledgement of the landing clearance, no further communications were received from the flight. The local controller attempted three times to reestablish communications. When he received no reply to the third call, he queried the ground controller regarding Flight 723. The ground controller believed that the local controller's query pertained to Flight 623, another Delta flight that had preceded Flight 723 on the approach to runway 4R, and was taxiing toward the terminal. After the accident, neither the local controller nor the ground controller could recall the exact words they had used during the conversation. The local controller stated that he understood from the ground controller's response that Flight 723 was going to the terminal. The local controller then had given landing clearance to the two flights that had followed Flight 723 on the approach to runway 4R.

1.10 Aerodrome and Ground Facilities

Runway 4R at BOS is 10,000 feet long. For instrument flight and nighttime conditions, a displaced threshold has been established at 2,507 feet from the approach end of the runway. The reason for this displacement is the proximity of a ship channel that crosses the approach path to runway 4R, a few hundred yards off the boundary of the airport. The

ILS glide slope touchdown point has been set 1,153 feet beyond the displaced threshold.

The elevation of runway 4R is 16 feet. The runway is equipped with high-intensity runway lights and a high-intensity approach light system (ALS) with sequence-flashing lights. The runway lights and approach light system were inspected on July 31, 1973, and on August 2, 1973. The lights, except those damaged by the accident, were operational.

Audio-visual alarms for the ALS and for the sequence flashers are displayed on the ALS monitor panel in the control tower cab. The ALS contains three regulators, each of which controls approximately 70 lights and constitutes one "loop" of the ALS. Five inoperative lights in any one of these "loops" will activate the ALS alarm. Three inoperative sequence-flashing lights will also activate the alarm system.

RVR information for runway 4R was obtained from a transmissometer located 500 feet west of the runway centerline, abreast of the ILS touchdown point. The transmissometer was established on a 250-foot baseline. Information was transmitted to a computer in which it was stored for a short time and then relayed to digital readout displays in several FAA facilities, including the tower cab. Displays in the tower cab are updated every 51.1 seconds.

The ALS and the sequence flashers on the approach end of runway 4R are monitored in the tower cab by separate systems. Each system has an associated red warning light, but one audio (buzzer) warning is associated with both systems. Illumination of either light will sound the warning.

Frequent "false alarms" of the warning light associated with the sequence flashers had been experienced for an extended period of time before the accident. According to FAA's ALS maintenance representative, these alarms were caused by moisture in the underground ducting through which the monitor cables pass. According to testimony of the BOS tower controllers, the warning lights did activate for both systems but were ignored because the activation was felt to be another "false alarm."

1.11 Flight Recorders

N975NE was equipped with a United Control Data Division (Sundstrand) Model FA-542 flight data recorder (FDR) serial No. 1723. After the crash, the recorder was intact with only superficial mechanical damage to its outer case. There was no evidence of fire damage; the recording foil was undamaged. All recorded parameter and binary traces were readable. Examination disclosed gaps in all parameter traces, which appeared on each parameter trace at the same point in time. Although the gaps caused difficulty with the readouts, they did not measurably affect the overall timing. (See Appendix E.)

The aircraft was also equipped with a Fairchild Model A-100 cockpit voice recorder (CVR) serial No. 263A. The outer case of the CVR was severely damaged by impact and fire. The tape, however, was undamaged and could be transcribed. (See Appendix F.)

1.12 Aircraft Wreckage

The aircraft struck a seawall on the north shore of the Boston Harbor main ship channel. The seawall forms the south boundary of the airport. The elevation of the impact point was 11.45 feet; the elevation of the intended touchdown point was 16 feet. Aluminum scuff marks were found on the rocks 6.2 feet up the seawall. Pieces of wing tip navigation lights were found at each end of the scuff marks. Portions of wing and fuselage structure were found between the edge of the water and the base of the wall. The aircraft wreckage was scattered along a magnetic heading of 017° in an area about 250 feet wide and 790 feet long. (See Appendix H.)

The largest part of the fuselage, from the aft pressure bulkhead forward to the cockpit, was found on the runway, fragmented, and almost consumed by ground fire. Control cables were still attached to the control columns. The cockpit area was flattened and damaged by fire.

The aft fuselage section, including the vertical and horizontal stabilizers, lay on the perimeter road. Ground fire damage was not evident. Most of both engine pylons were still attached to the aft fuselage section.

During the investigation, all control cables to the flight control surfaces were accounted for. Most cables and their associated bellcranks were damaged by ground fire. Discontinuity in the cables was caused by tensional overload.

The wings separated from the center wing section. Both were extensively damaged by ground fire. The fractures were typical of an overload condition.

The landing gear and flaps were fully extended.

There was no evidence of in-flight structural failure, fire, or explosion.

Both engines, including inlet cowls, upper cowl doors, thrust reverser assemblies, and portions of the pylons, separated from the fuselage. The lower thrust reverser doors separated from each engine. The lower half of the two engine inlet cowls were crushed aft. Both engine inlet cases and front compressors were crushed aft in their lower right side quadrants. The accessory gearboxes and all accessories separated from both engines. Numerous pieces associated with these areas of the engines were recovered from the initial impact area on the water side of the seawall.

First and second stage fan blade tips of both engines were bent opposite the direction of engine rotation. Chips of white paint, backed with primer, were found in the sixth stage bleed ports of the right engine.

The aircraft nose section and the cockpit area were completely fragmented. Intense ground fire obliterated most of the instrument readings and control positions. Aircraft instruments and system components were identified and documented at the site. Those components requiring further examination or test were examined at Delta's maintenance base in Atlanta, Georgia. Shop examination of the recovered components revealed no malfunctions or defects.

Because of impact and fire damage, settings and readings could not be obtained immediately from the first officer's altimeter during field examination.

The captain's altimeter was damaged, but not burned. The cover glass assembly was missing, and the barometric setting knob was sheared. The barometric setting was 30.14, and the altitude reading was 660 feet. All altimeter needles were free to rotate.

The flight director mode selector switch was found in the G/A (go-around) position. This determination was made by comparing the position of the switch shaft with that of a serviceable unit. The housing of the mode selector had been exposed to the post-crash fire; the switch shaft was not bent.

1.13 Medical and Pathological Examination

Postmortem examination of the captain and the first officer disclosed no evidence of incapacitating disease. The anterior aspects of both their shoulders showed a narrow pattern of subcutaneous hemorrhages, similar to those which result from restraint strap forces during rapid decelerations. The captain and first officer sustained downward fractures of their right clavicles.

The captain, first officer, and observer sustained multiple severe injuries

Pathological examination of the observer revealed evidence compatible with the 1967 clinical diagnosis of Parkinson's Disease.

None of the three cockpit occupants sustained thermal injuries. The surviving passenger suffered extensive third and fourth degree burns and traumatic injuries to his lower extremeties.

1.14 Fire

Three employees of a construction firm, who were working about 4,000 feet from the impact site, saw fire on runway 4R and drove to the crash site. After leaving his two companions at the crash site to search for survivors, the driver continued on to the airport fire station and alerted the fire chief that there had been an accident on runway 4R. The time was between 1114 and 1115. Airport firefighting equipment was dispatched immediately across the main ramp to runway 4R. The fire apparatus traveled an estimated 1 mile and arrived at the scene in approximately 3 minutes. Before crossing runway 4L, the crew of the leading vehicle requested permission from the tower to cross the runway; this was the tower personnel's first notification of the accident.

When firemen arrived at the scene, they found the cabin area still burning and small fires scattered along the wreckage path. The cabin fire was extinguished with foam in less than 1 minute; water was then used to cool the wreckage. The fire required approximately 15,000 gallons of water and 800 gallons of 6-percent protein foam. After assessing the crash site, the fire chief notified the tower and the Boston Fire Department Alarm Center of the accident. The Alarm Center instituted Code 612, which calls for mutual assistance from surrounding communities and the City of Boston.

At 1122, Boston City Fire Department units were notified of the accident, and nine companies were dispatched to the airport.

1.15 Survival Aspects

At 1120, Boston Police Department officers, who are assigned to the Emergency Service unit, responded and searched the wreckage for survivors. At 1121, the State police unit which is located at the airport was notified. Troopers were dispatched to the crash scene to secure the site and to control traffic and airport roads.

At 1125, the Metropolitan District Commission Police was notified, via the Intercity radio network, and responded with units to control the traffic on roads and tunnels in the vicinity of the airport and hospitals.

Between 1126 and 1129, the Boston Fire Department Alarm Center notified Boston City Hospital of the accident. At 1130, the Boston Police Department requested Massachusetts General Hospital, Boston City Hospital, and Winthrop Community Hospital to prepare for possible survivors.

At 1130, a State police unit arrived at the airport medical station to pick up medical kits and to escort four nurses to the crash scene.

At 1135, the Winthrop, Chelsea, Revere, and the Metropolitan District Commission Police Departments and the State police were requested by the Boston Police to divert all traffic away from the airport.

At 1145, after the U. S. Coast Guard was notified, the USCG Cutter Pendant was dispatched to search the water at the approach end of runway 4R. The Pendant reported on-station at 1238; later it reported finding no survivors. No occupants of the aircraft were recovered from the water.

Bodies were removed to a temporary morgue at the airport fire station, where they were examined by the Chief of the Boston City Hospital disaster staff and two physicians from the Chelsea Naval Hospital. The bodies were subsequently transferred to the Boston City Hospital Southern Mortuary.

Two passengers were found alive and were transported to Massachusetts General Hospital. One survivor died about 2 hours after the accident. The second survivor sustained third and fourth degree burns and traumatic injuries to his lower extremities. He stated that he had been seated in the last row of seats next to a window, and that when the aircraft stopped, he had been assisted in releasing his seatbelt by a passenger next to him. He said that he then had crawled through a window and away from the burning wreckage. He was found by construction workers who stayed with him until an ambulance arrived. He died on December 11, 1973.

The Suffolk County Coroner testified during the public hearing that the type and severity of injuries to the occupants would have precluded their survival, even had immediate medical assistance been available after the accident.

1.16 Test and Research

1.16.1 Altimeter System Test

Altitude readings at the time of the crash could not be determined. However, examination and tests disclosed that the captain's and first officer's altimeters had been capable of operation before damage by impact and fire. Examination revealed that the mainshaft assembly of the captain's altimeter had a broken pivot at the rear end which allowed the shaft to float free at the mesh with the synchrotel gear. In addition, both diaphragms suffered mechanical damage from impact. Both had vented to atmosphere, expanded and resulted in the rockingshafts being in a very high altitude position. Three of the four pivots supporting the dual rockingshafts were broken. Both sectors were out of mesh with the mainshaft pinion. The front end of the mainshaft assembly contains a hairspring which was unwound indicating that this shaft had rotated approximately 1-7/8 times. Although the first officer's altimeter had sustained extensive fire and impact damage, the dial showed a mark on the surface corresponding to 35 feet that may have been caused by a pointer strike.

1.16.2 Flight Track Presentation

The approximate flightpath of the aircraft was derived from the heading, airspeed, and altitude data recorded by the FDR, and reported meteorological conditions. Intracockpit and air-ground communications recorded on the CVR were correlated with the aircraft's position through use of the common time reference associated with impact. (See Appendix G.)

1.16.3 Simulator Tests

Tests were conducted in the DC-9 simulator to study the dynamics of the situation that had confronted the flightcrew of Flight 723 during the approach to runway 4R. Of primary interest was the workload placed on the crew as they intercepted the localizer at a greater angle than normal and at the high airspeed and altitude indicated in the aircraft's recorded flight data.

On each of 24 simulated approaches, the aircraft was positioned at a point in space relative to the OM, based upon the flight track described in Appendix G. Standard practices for the use of the Flight Director System were employed throughout the test sequence.

The tests revealed that the localizer intercept turn, when initiated as a result of flight director VOR/LOC mode command, would invariably result in centerline overshoot; the magnitude of the overshoot depended upon the intercept airspeed. It was also found that localizer capture occurred above the glide slope centerline. During those runs in which the flight director system was kept in the VOR/LOC mode, glide slope capture, which is required for flight director pitch command, was not effected until the aircraft was 2 or more miles past the outer marker, and at an altitude of 700 feet or less. Descent rates of about 1,300 feet per minute were consistent with a closed throttle descent and were required for these glide slope intercepts. In some approaches, the necessary descent rate was not achieved and impact occurred beyond the glide slope touchdown point. During these approaches, glide slope reference was displayed only on the pictorial deviation indicator (PDI). The PDI provides a direct display of the position of the aircraft with regard to the centerlines of the glide slope and localizer. This display is commonly referred to as "raw data".

To obtain a pitch command display on the flight director indicator before glide slope capture, it was necessary to change the flight director mode selector to the approach position; after such a selection a fly-down command appeared. Glide slope capture was difficult because of the faster-than-normal descent rate associated with interception from above and excessive airspeed. The need to decelerate to approach speed compounded the problem. Lateral guidance following localizer centerline intercept on all such approaches did not present a problem, and localizer deviations were minimal.

During at least five approaches, the flight director mode selector was switched, unbeknown to the simulator pilot, to the Go-around (G/A) mode after OM passage. When G/A mode was selected, the flight director pitch command bar came into view at the top of the instrument, and commanded a fly-up maneuver. Since this command was contrary to the raw data presented, the pilot recognized the anomaly with little delay. The anomaly was not readily apparent, however, from mere observation of the flight director roll command bar. Although localizer guidance was removed from the flight director display, the roll command bar remained centered until an inadvertent roll of little magnitude was initiated. At that time, the roll bar deflected opposite the direction of bank and commanded a return to wings-level flight in accordance with the Flight Director's G/A mode.

Subsequent attempts to follow the roll command invariably led to large deviations from the localizer centerline, which were detectable only by reference to the raw data displayed on the PDI.

During these simulations, the G/A mode could be selected inadvertently by rotating the flight director mode selection knob slightly past the approach mode detent. Even if the knob was returned to the approach mode detent, the G/A mode continued to be displayed on the flight director.

1.17 Other Information

1.17.1 The Delta Air Lines DC-9 Modification Program

Following the merger of Delta Air Lines and Northeast Airlines, a modification program changed the flight instrumentation of 14 Northeast DC-9-31 aircraft to that of the Delta DC-9-32 aircraft.

Differences between Northeast's and Delta's flight instrumentation are:

Northeast	Delta
Flight Director (Collins FD 109)	Flight Director (Sperry Z-5-534)
Dual system, dual indicators	Single system, dual indicator
Mode selector switch on each indicator	Single mode selector switch on the left side, center instrument panel.

Single command image	A pitch command bar and a roll command bar
Altimeter	Altimeter
Drum pointer	Three pointer
Compass indicator	Compass indicator
	Single ADF needle on compass indicator
Course deviation indicator	Pictorial deviation indicator
Cross pointers	Cross pointers
No radio altimeter	Radio altimeter

1.17.2 Flight Director History

Several malfunctions of the flight director had been written up in the logbook of N975NE. In addition, the CVR indicated that during the approach to BOS, the crew had been concerned about the operation of the flight director.

The records showed that the flight director computer had been replaced six times since the completion of the aircraft's modification program in April 1973. When further examined, the six computers showed no discrepancies.

The aircraft's logbook was reviewed to find writeups related to the interface between the radio and flight instruments involved in the modification program. From April 21, 1973, through July 31, 1973, the logbook listed 49 discrepancies of the radio and flight instruments, a relatively high number, compared with the number of discrepancies which occurred in a 2½-month period just before the modification program.

The records of the aircraft immediately preceding and following N975NE through the modification program, N979NE and N978NE, contained recurring discrepancies similar to those reported for N975NE.

Two flight director mode selectors, which were previously removed from N975NE, and the mode selector on the aircraft at the time of the accident were tested for evidence of intermittent operation.

The first mode selector, serial No. 6111109, was removed from the aircraft about 3 months before the accident, because the flight director pitch bar had been reported to be unreliable. The unit was tested and found to be within specifications.

The second mode selector, serial No. 7061174, was removed July 27, 1973, because "both flight director bars did not give correct pitch and bank indications to fly ILS." The unit was found to be within required specifications.

The third mode selector, serial No. 7081183, was removed from the wreckage and could not be checked electronically.

After the accident, all three mode selectors were disassembled and examined. Contact wear and small metal and plastic particles were evident inside the switch housing.

1.17.3 Operation of Sperry Flight Director

The Sperry Flight Director (Z-5-534) may be used by the crew as an aid in flying airways and in making ILS and VOR approaches.

A single Sperry Flight Director with dual display is installed on Delta Air Lines DC-9 aircraft. The flight director guidance is displayed on both attitude director indicators (ADI); raw data are displayed on each pilot's PDI. A flight reference mode selector is used to select the type of flight director guidance desired.

The guidance display is composed of two command bars. A vertical bar presents roll, steering, and VOR and localizer-course tracking; a horizontal bar presents pitch guidance for glide-slope capture and tracking.

During airway operations or VOR and ILS approaches, the pilot selects the VOR/LOC mode and sets the desired radial or localizer course to be flown on the first officer's PDI. Biased out of sight in the standby (SB) mode, the vertical bar presents roll and steering commands in the VOR/LOC mode to capture and track the selected course. If heading guidance is needed before capture of the selected course, the flight instrument (FI) mode is selected. The heading information is presented to the flight director system by setting the heading bug on the captain's compass indicator. The vertical bar will show a steering command signal to fly to the selected heading. The pilot maneuvers the aircraft in a coordinated turn to center the vertical bar on the ADI. The maximum angle of bank is 25°. As the aircraft approaches the selected heading, the vertical bar will show a command to roll out of the turn. When the aircraft is established on the intercept heading, the VOR/LOC mode is selected. The heading function of the FI mode is maintained in the VOR/LOC mode until the flight director computer senses the "beam edge." Then, the flight director automatically switches to capture operation, placing the system in VOR or localizer capture mode; the vertical-bar commands direct the aircraft to roll out on the radial or localizer course.

On ILS approaches, when the aircraft is on the localizer and within one-third dot of the glide-slope indication, the VOR/LOC mode captures and tracks the glide slope. It is preferable to capture the glide slope from beneath. If localizer capture were made above the glide slope, the horizontal pitch bar would be biased out of sight, thereby presenting no glide-slope capture guidance. Under these circumstances, selection of the approach (APP) mode would provide immediate glide slope capture and tracking guidance. Regardless of the flight director mode, a raw data display of relative glide-slope and localizer positions is available to the pilot on the PDI.

If a go-around is necessary, the mode selector is rotated to the G/A position. The flight director then commands a wings-level and nose-high attitude.

In order to regain flight director guidance for an ILS approach, the selector switch should be rotated counterclockwise from the G/A position to either the FI or the SB mode and then back to the desired position.

The Blue left (BL) mode is used for backcourse ILS approaches to permit correction "toward" the vertical bar for centering. The front course, inbound heading is set on the first officer's PDI. No glide-slope signal is available in this mode.

When the selector switch is rotated to the SB position, both command bars are biased out of sight.

When a malfunction is detected in the flight director system, a caution light in the system monitoring and retraction technique (SMART) system illuminates to indicate that a warning flag is showing or that an instrument pointer bias exists.

1.17.3.1 <u>Comparison of Sperry and Collins Mode Selector Switches</u>

The single rotary-type mode selection switch of the Sperry Flight Director System is located above and to the left of the engine instrument panel. When it is rotated clockwise, the switch provides the following mode selections:

1. SB Standby
2. BL Blue left
3. FI Flight instruments
4. VOR/LOC Visual omni range/localizer glide slope
5. APP Approach
6. G/A Go-around

Dual, Collins FK 109 Flight Director Systems had been installed in the Northeast Air Lines DC-9 aircraft. With its own rotary-type mode selector switch and display, each system operated independently. The mode selector switch rotated clockwise through the following mode selections:

1. OFF

   No signals are received in this position.

2. FI

   In the flight instruments mode, the single command bar gives roll and steering commands to capture and maintain a selected heading. The selected heading is set in the course deviation indicator (CDI). An altitude-hold capability is available in this mode.

3. VOR/LOC

   This mode is used to capture either a VOR radial or the front course and glide slope of an ILS. The heading function of the FI mode is displayed in this mode, until the aircraft is about two dots from a localizer or 5° from a radial centerline. After computer-switching occurs, capture commands are displayed. Glide-slope-capture-guidance commands are received when the aircraft intercepts the glide slope. Glide-slope capture from below is preferable. Altitude-hold will disconnect automatically when glide-slope signals are received.

4. APP

   Placing the mode selector switch in the Approach mode will give immediate glide-slope-capture guidance, whenever the localizer captures from above the glide slope.

   The APP mode is the last position in the clockwise rotation of the selector switch. This position on the Collins FD 109 mode selector is identical to the position of the G/A mode in the Sperry system. Before modification of the former Northeast Air Lines DC-9 aircraft, Go-around switching was done with palm switches located on the throttles.

   The Collins system uses a single command bar for both roll and pitch commands. On each Collins system, the mode logic presented to the flight director display is read on an annunciator panel. The Sperry H-5 system has no such provision for system monitoring.

1.17.4 FAA Terminal Air Traffic Control Handbook 7110.8C

Paragraph 1352 of the FAA Terminal Air Traffic Control Handbook 7110.8C, dated January 1, 1973, requires that whenever the reported weather is below basic VFR minima, an aircraft shall be vectored to intercept the localizer course at least 2 miles from the approach gate 10/ and at an altitude not above the glide slope.

Paragraph 1351 stipulates that the maximum angle for localizer interception is 30°. In the case of Flight 723, the interception angle was 45°.

Paragraph 1360 of the handbook requires the approach controller to provide approaching aircraft with certain arrival instructions or an approach clearance before the aircraft reaches the approach gate. To be included in these instructions are:

(1) The position of the approaching aircraft relative to the final approach fix 11/;

(2) An approach clearance; and

(3) Instructions to the approaching aircraft to monitor the local frequency, to report to the tower when it is over the approach fix, or, alternatively, to contact the tower on the local control frequency.

In the case of Flight 723, the approach clearance was not issued in accordance with prescribed procedures. Public hearing testimony revealed that at the time the approach controller should have issued this clearance, he was occupied with a potential traffic conflict between two other flights. As a result, an approach clearance was not given to Flight 723, until the crew inquired about it. Shortly thereafter, the approach controller experience communication difficulties with one of the aircraft involved in the potential traffic conflict; this delayed release of Flight 723 to tower control.

1.17.5 FAA Advisory Circular 61-49

FAA Advisory Circular 61-49, "Airline Transport Pilot," (Airplane, Practical Test Guide) provides guidelines for acceptable performance of ILS and other instrument approaches; in part, it reads:

10/ Approach gate - That point on the final approach course which is 1 mile from the approach fix on the side away from the airport.

11/ Final approach fix - The fix from or over which final approach (IFR) to an airport is executed. The Milton Outer Marker is the final approach fix for ILS runway 4R at Boston.

"The ILS approach, to be considered acceptable, should be conducted so that glide slope and localizer indications do not exceed one dot deviation. Altitude should be maintained within 100 feet of prescribed altitude during initial approach, and within 0 to -50 feet of minimum descent altitude or decision height. Airspeed should be controlled within 10 knots of the recommended speed for the airplane configuration from the initial approach fix to the final fix inbound, and within 0 to +10 knots of reference airspeed, with appropriate wind/gust factor adjustment, from the final fix to minimum descent altitude or decision height."

1.17.6 Delta Airlines Operating Manual

The approach profile contained in Delta Airlines Operating Manual, Flight Training, dated August 15, 1972, describes a "stabilized" approach as an approach where:

(1) The glide slope is captured from below, before the aircraft reaches the outer marker (OM);

(2) The aircraft arrives over the OM on the glide slope, with wing flaps extended 15° to 20° and speed reduced to 160 knots, or as directed by approach control, with a minimum speed of 1.4 V_s 12/; and,

(3) After the aircraft has crossed the OM, the wing flaps are extended slowly to 50°, while the aircraft is stabilized on the glide slope, and the speed is adjusted to maintain 1.3 V_s + 5 knots for the remainder of the approach.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

The crewmembers were properly certificated, trained, and qualified for the flight. Both pilots had adequate rest periods before reporting for duty. There was no indication of any medical or physiological problem that would have affected the performance of their duties.

The aircraft was certificated, equipped, and maintained according to requirements and regulations. The gross weight and center of gravity were within prescribed limits during the takeoff at Manchester and the approach to Boston.

There was no evidence of in-flight fire, structural failure, or flight control or powerplant malfunction. There was insufficient evidence

12/ V_s - The stalling speed or the minimum steady flight speed at which the airplane is controllable.

to determine conclusively whether the flight director or navigation systems had functioned properly.

The captain's altimeter indicated an altitude of 660 feet. The altitude pointer was free to rotate because the internal driving gear mechanism had separated from the pointer. Therefore, the Board concluded that this altimeter indication was not valid.

The impact mark on the face of the first officer's altimeter, which corresponded approximately with the impact site elevation, suggests that altimetry error was not a factor in this accident. Such a conclusion is supported further by flight data recorder information related to assigned altitudes before initiation of the final approach.

Since the aircraft's impact below the glide slope cannot be attributed to altimetry problems, the remainder of this analysis deals with the operational aspects of the approach, including air traffic control and the weather information received by the crew.

As Flight 723 was proceeding inbound toward the localizer course at the assigned altitude of 3,000 feet, the BOS AR-1 controller's attention was drawn to an aircraft, transferred to him by Boston Air Route Traffic Control Center, which was in potential traffic conflict with another aircraft at the same altitude. At a time when BOS AR-1 should have been clearing Flight 723, as regulations require, he was trying to resolve the potential conflict and to avoid a possible mid-air collision. Consequently, an approach clearance was not given to Flight 723 until the flightcrew first requested it. Subsequent communications difficulties with one of the aircraft involved in the potential traffic conflict further occupied BOS AR-1 and delayed release of Flight 723 to BOS tower control. Nevertheless, proper monitoring of the flight's progress would have provided the crew with indications that should have caused them:

(1) To have been aware of their position relative to the localizer and the OM;

(2) To have anticipated localizer interception outside the OM; and

(3) To have reduced airspeed to that which would have been compatible with the aircraft's arrival over the OM in a stabilized condition which would have permitted the continuation of the approach and landing.

Actually, the aircraft's airspeed at the OM was about 206 knots. That speed was 46 knots above the maximum speed recommended by company procedures, and 63 knots above the minimum speed computed for the aircraft's gross weight, which was estimated at 87,000 pounds. During most of the approach inbound from the OM, the airspeed was maintained well over the computed 1.3 V_s +5 speed (about 123 knots).

The faster-than-normal airspeed during the approach, together with the delay in initiating the descent, resulted in two other problems for the crew. First, it increased the difficulty they had in capturing and maintaining the glide slope. The aircraft passed over the OM at an altitude more than 200 feet above the glide slope. At normal approach speed, the aircraft could easily have reached glidepath altitude by increasing slightly the rate of descent. However, at the faster-than-normal airspeeds, a rate of descent of more than 1,300 feet per minute would have been required to intercept the glidepath before reaching decision height. If the flightcrew had attempted to capture the glide slope at such a rate of descent, they would have had difficulty decreasing airspeed to an acceptable approach speed.

Second, through experience and exposure to instrument approaches during instrument meteorological conditions, pilots generally learn to pace their activities while flying such an approach. The faster-than-normal airspeed of Flight 723 during the initial and final phases of its approach required the crew to act more quickly than usual.

Another factor in an approach initiated high and fast concerns the use of the flight director system. In normal use, the VOR/LOC mode of the flight director system would be selected. Operation in the VOR/LOC mode requires following the roll command bar to maintain the heading necessary to intercept and capture the localizer. Sensing the localizer signals, the command bar will command the lateral maneuvers necessary for localizer intercept and final approach guidance. Concurrently, the system arms to capture the glide slope; after capture, pitch command information is displayed as a function of glide-slope deviation. However, the system is designed so that an aircraft operating in the VOR/LOC mode must be on or below the glide slope at the time the localizer is intercepted in order to capture the glide slope. If the aircraft is too high and the glide slope is not captured, the pilot will not have flight director pitch guidance information for the initial approach. Consequently, he cannot use the instrument to make an asymptotic interception in the VOR/LOC mode. The flight director system can accommodate an interception from above the glide slope, if the APP mode is used. Selection of the APP mode presents a fly-down command which will force capture of the glide slope.

The derived flight track and altitude profile of Flight 723 showed that the aircraft was flying well above the glide slope when it intercepted the localizer course. Thus, because of the design, if the flight director system had been in VOR/LOC, it would not have captured glide-slope signals, nor would it have displayed pitch command information. During simulation of the localizer interception, it was necessary to switch to APP mode in order to obtain pitch command information on the flight director instrument.

The Board believes that the manner in which the flight director was used during the final approach impaired the crew's awareness of their altitude.

The flightpath derived from the recorded data shows an asymptotic approach to the localizer centerline, followed by a continuous deviation of the aircraft to the left of the centerline. During the simulator tests, such an interception could not be reproduced by using the flight director steering command information. In the tests, director guidance commands invariably resulted in centerline overshoot and subsequent recovery to the localizer course before the outer marker was passed. The resulting flightpath would be similar to that derived from the flight recorder data, if a 2° + correction were applied to heading information. Such an error is compatible with the evident difference between recorded heading and vector heading throughout the interception sequence. Since such an error is within the tolerance specified for the flight data recorder, the Board believes that the flightpath traversed by Flight 723 was similar to that which was produced by the simulator: The aircraft passed the outer marker and tracked along the localizer centerline for another 30 seconds.

Thereafter, the flightpath of Flight 723 and crewmember comments recorded on the CVR indicate that the crew was experiencing problems in attempting to maintain lateral position on the localizer centerline. The first deviation from the localizer course started immediately after the captain's comment, "Get on it, Joe, ah Sid," made at 1106:43.5. At that time, according to the flight recorder data, the aircraft's altitude was 1,600 feet, still above the glide slope; the airspeed was still excessive. The Board believes that this comment was a reference to the aircraft's position above the glide slope and that it prompted a change from VOR/LOC to APP mode in order to obtain pitch guidance information. The subsequent lateral-steering problems, however, would have been understandable only if the flight director system had been inadvertently placed in the G/A mode at that time. In the G/A mode, localizer signals are removed from the flight director system, and the roll steering command functions only to keep the wings level. Conceivably, the first officer might have been confused by the pitch command displayed on the flight director instrument at that time. If he had failed immediately to analyze the situation, he would have continued to obey the roll-steering signals. Simulator tests showed that such action would produce significant deviation from the localizer centerline.

Subsequent conversation by the crew indicated confusion and the realization that the flight director system was no longer providing reliable localizer or glide-slope information. Furthermore, examination of the wreckage verified that the flight director mode selector switch had been in the G/A position on impact. Since the CVR revealed no evidence that the crew had intended to execute a missed approach, it is reasonable to assume that the G/A mode was inadvertently selected earlier during the approach. In view of this possibility, the background of the crew, particularly in regard to habits previously formed, must be considered.

Before the merger of Delta Air Lines and Northeast Air Lines, these crewmembers were employed by Northeast and became accustomed to the Collins flight director instrumentation. After the merger and the modification program that replaced the Collins flight director with the Sperry system, they were trained to adapt to the different instrumentation. The APP mode in the Collins equipment is selected by full clockwise rotation of the rotary switch; whereas, the same position on the Sperry system rotary switch corresponds to the G/A mode. It is conceivable that without observing the switch, a crew might, by habit, inadvertently select the G/A mode in the Sperry system instead of the Approach mode.

During the simulator tests, investigators also found it possible unintentionally to select the G/A mode while rotating the mode selector switch to the Approach position. A very slight overshoot of the APP-position detent caused the flight director to display cues associated with the G/A mode of operation. Even if the selector switch were returned to the APP detent, the system would remain in the G/A mode because of its design. If the flightcrew believed that the selector switch was in the APP mode position, and in the absence of a mode annunciator panel to indicate otherwise, they would expect the system to react in the APP mode. Actually, however, the system would be reacting to a G/A situation and localizer guidance would no longer be presented. If the flightcrew had recognized the incorrect status of the flight director system in such a situation, they would have obtained proper indications by turning the selector switch through the "standby" position, then back to the APP mode position. In view of the position of the rotary switch at impact, this hypothesis is discounted.

Since the investigation disclosed a history of repetitive discrepancies of the flight guidance and navigation systems, a system malfunction also was considered as the cause for abnormal flight director guidance. However, examination of the recovered system components revealed no evidence of a system malfunction in the accident aircraft.

Although there is insufficient evidence to establish the underlying cause, it is apparent that the crew was aware of an abnormal display on the flight director. At 1107:05, about 21 seconds after the captain had told the first officer to "get on it," the latter commented "This # # command bar shows", and the captain responded, "Yeah, that doesn't show much." At 1107:40, the captain stated, "You better go to raw data, I don't trust that thing." At this point the aircraft was well to the left of the localizer and still high on the glide slope, and was passing through an altitude of 400 feet. Because conditions were not stable, it should have been obvious to the crew that, in order to continue the approach, radical heading and pitch corrections would be required to attain the proper aircraft-to-runway relationship. The flight recorder data showed continual heading changes from the time the captain made the above comment to impact. While passing through an altitude of less than 50 feet above decision height, the aircraft was heading 20° to the right of the published approach course. Since the crew did not consider a missed approach at this point, they might have fully expected to break out of the reported weather at an altitude that would have provided a safe maneuvering margin.

Weather information provided the flightcrew when radio contact was first established with BOS AR-1 reported: ". . . weather is partial obstruction, estimated 400 overcast, a mile and a half and fog." Twenty-two seconds before impact the captain called BOS tower. This call was not required, since the approach controller had already cleared the flight to land. In his response to the captain's call, the BOS tower controller gave the flight not only a second clearance to land, but also traffic conditions and further weather information. During this transmission, the flight had approached and passed through the decision height. The radio transmission from BOS tower contained two statements that conflicted: An RVR for runway 4 of "more than 6,000 feet," and ". . . a fog bank is moving in. It's pretty heavy across the approach end." This conflicting information, received by the captain at a very critical phase of the approach, added to the distraction already existing in the cockpit.

When the RVR value of "more than 6,000 feet" was given to the crew, the actual value was already considerably less than 6,000 feet and dropping rapidly to about 1,600 feet. Because the digital displays in the tower cab cycle each 51.1 seconds following a 48.5-second computer-integrating period, there is no reason to believe that either callout (6,000 ft. or 2,000 ft.) was incorrect in terms of what had been displayed. The controllers could read only the display they were observing; they had no way of knowing what the RVR at the transmissometer site was registering on a continuing basis.

An RVR value transmitted to a pilot is intended to represent runway visibility when his aircraft touches down near the ILS touchdown point. This value would represent the actual distance he could see down the runway, only if the atmosphere above the runway and above the transmissometer site were homogeneous. Often, however, the atmosphere is not homogeneous, particularly during fog conditions.

Another factor in the discrepancy is the location of the transmissometer equipment in relation to the runway. For runway 4 on the Logan International Airport, the location is approximately abreast of the ILS touchdown point, on a 250-foot baseline, and about 500 feet to the left of the runway. The RVR value from transmissometer equipment installed according to FAA's criteria, might still be misrepresentative, because fog covering the runway might not be covering the equipment and vice versa. The 51.1-second cycling time of the RVR digital display can further complicate the problem. With rapidly changing visual conditions over the runway, considerable disparity can exist between actual conditions and the values presented by the digital displays and reported to the flightcrews.

Further, RVR was never intended to represent the distance the pilot expects to be able to see from the outer marker, middle marker, decision height, or over the runway threshold. Before the RVR can be representative, the aircraft must be near the touchdown point on the runway. Testimony during the public hearing revealed that not all pilots may be aware of all of the limitations of the RVR reporting system.

Even if the crew was preoccupied with the attempted lateral corrections to the localizer centerline and by the air-to-ground communications, they should have followed recommended altitude-monitoring and call-out procedures. Because of the crew's operational experience with the weather in the Boston area, their primary concern during the approach should have been to monitor their altitude at all times, particularly at decision height.

The before-landing checklist requires the pilot not flying the aircraft to monitor the approach and to call out, "200' above, 100' above, and minimums," as the aircraft approaches decision height. These call-outs were never made in Flight 723, nor was any reference made to altitude after the aircraft had departed the OM.

The altitude call-outs are not required if visual conditions prevail before the call-out altitudes are reached. The weather given to the flightcrew when radio contact was first established with BOS AR-1 indicated a partial obstruction, an overcast ceiling at an estimated height of 400 feet, and a visibility of 1½ miles in fog. Actually, the ceiling and visibility, reported by witnesses who were located below the final approach path of Flight 723, were virtually zero. The two flights immediately following Flight 723 were unable to see the runway, and they conducted missed approaches. There was no evidence that the crew of Flight 723 had seen the ground or any other object outside the cockpit during the approach. It is not expected that they would have placed more reliance on the reported weather than on the conditions as they actually encountered them.

This accident demonstrated how an accumulation of discrepancies, none of them critical, can rapidly deteriorate, without positive flight management, into a high-risk situation. In this regard, the most significant factors were:

1. Vectors given by BOS AR-1 to intercept the localizer course were not according to standard operating procedures; never-

theless, the flightcrew accepted the vectors and continued the approach at an excessive airspeed.

2. Approach clearance and other required instructions first had to be requested by the flightcrew, before they were given to the flight, which delayed the flight's descent to the correct approach altitude.

3. The first officer, who was flying the aircraft, was preoccupied with the information presented by his flight director system, to the detriment of his attention to altitude, heading, and airspeed control.

4. The captain divided his attention among the problem with the flight director system, the communications with air traffic control, and the weather and visibility information given by the local controller.

The Board also considered the distraction that might have been caused by the presence of the observer in the cockpit. The CVR indicates that the observer's activities were limited to reading the challenges in each checklist and listening for the proper response and action by the flightcrew. All checklists, but one, were completed routinely. There was no record on the CVR of the prescribed challenges and responses of the before-landing checklist. The only statements related to that checklist were a response concerning the position of the landing gear and an announcement that the ". . . before landing is complete;" both were made by the cockpit observer. The Board could not determine whether the observer had accomplished the complete checklist by himself, or whether he had been assisted in any way by the flightcrew. However, if the observer had attempted to accomplish the checklist items himself, he would have interfered with the flightcrew's activity.

In a two-man crew, the pilot not flying the approach (in this case the captain) would normally be required to read the checklist challenges and call out specific altitudes during the approach. That the observer in Flight 723 was allowed to read the checklist challenges, varied from routine procedure and company instructions and might have interfered with normal crew coordination.

In summary, the Board believes that the crew's preoccupation with the flight director's presentation was the most detrimental factor during the critical phase of the approach. This preoccupation led directly to the crew's failure to monitor altitude and to recognize passage of the aircraft through decision height.

The Board could not determine why the captain had not exercised positive flight management. At several points during the approach, he had been confronted with large deviations from the approach profile, especially with regard to airspeed and localizer and glide slope alignment, that should have prompted him to abandon the procedure and initiate a missed approach. In making this observation, the Board recognizes the captain's role as the final judge in all matters pertaining to the safety of his flight. Although the distractions caused by nonstandard air traffic control services and a misleading flight director display created an error-inducing environment, the captain should not have allowed these distractions to interfere with the exercise of his command responsibility for altitude awareness and his decision to abandon the approach.

Although the misunderstanding between local and ground controllers about the location of Flight 723 had no bearing on the accident, the Board is concerned about the accident potential of such a communications breakdown in the air traffic control system. The inability to communicate with Flight 723, in conjunction with the alarms of the approach light system, should have been sufficient reasons for the controllers to issued missed approach clearances to the flights that followed Flight 723.

2.2 Conclusions

(a) Findings

1. There was no evidence that either pilot had been physically incapacitated before the accident.

2. The cockpit observer was not qualified to act as a flight crewmember, nor was he authorized to participate in the conduct of the flight.

3. There was no evidence of preimpact structural failure, fire, or flight control or powerplant malfunction.

4. The flight was vectored to the localizer course with an excessive approach course interception angle.

5. The approach controller's attention was diverted by an air traffic control problem involving two other flights, which resulted in a delay in the issuance of approach clearance and other required approach information and in a late release of the flight to the tower control.

6. Based on observations by witnesses and other flightcrews, visibility in the approach zone would have prevented the crew from sighting the airport environment, either before reaching or upon reaching decision height.

7. The RVR given to the flight was not indicative of the actual visibility on the approach to runway 4.

8. The aircraft approached and passed the OM above the glide slope at an excessive airspeed.

9. The flightcrew was preoccupied with the guidance information presented by the flight director system.

10. The mode selector switch of the flight director system was found in the G/A position.

11. The flightcrew did not make the required altitude callouts during the final approach.

12. The flightcrew made no attempt to abandon the approach.

13. The flightcrew did not monitor the altimeters during the final portion of the approach.

14. The flight that preceded Flight 723 made a successful approach and landing on runway 4R.

15. The two flights that followed Flight 723, without knowledge of the accident, abandoned their approaches at the decision height because of weather.

16. The air traffic controllers in BOS tower mistakenly assumed that Flight 723 had landed safely.

17. The ALS warning system in BOS tower was ignored by air traffic personnel because of previous false alarms and misunderstanding of the operation of the system.

(b) Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the flightcrew to monitor altitude and to recognize passage of the aircraft through the approach decision height during an unstabilized precision approach conducted in rapidly changing meteorological conditions. The unstabilized nature of the approach was due initially to the aircraft's passing the outer marker above the glide slope at an excessive airspeed and thereafter compounded by the flightcrew's preoccupation with the questionable information presented by the flight director system. The poor positioning of the flight for the approach was in part the result of nonstandard air traffic control services.

3. RECOMMENDATIONS

As a result of this accident, the Safety Board on August 29, 1973, submitted recommendations (A-73-62 through 64) to the Administrator of the FAA. Copies of the recommendation letter and the Administrator's response are included in Appendix I.

Recommendations concerning one false alarm caused by the approach light system at BOS, and the mode selector of the Sperry Flight Director System, were forwarded to the Administrator, FAA, on January 25, 1974, (A-74-1 through A-74-4). Copies of the recommendations and Administrator's response are included in Appendix I.

Testimony at the public hearing indicated that pilots do not fully understand RVR (Runway Visual Range). Opinions concerning the interpretation of the reported RVR value differed. Generally, pilots are not aware of the criteria for locating the transmissometer equipment, nor of the 51.1-second delay in updating the digital displays in the FAA facilities. The fact that RVR values may differ from actual runway visibility conditions in a nonhomogeneous atmosphere apparently is not understood.

Further investigation revealed that FAA Advisory Circular, AC-00-13A, issued on February 24, 1965, which had dealt with the subject of runway visibility measurement, had been cancelled. No advisory circular replacing AC-00-13A has been issued.

Since no description of RVR equipment, its location, operation and limitations exists, the Board recommends that the Federal Aviation Administration:

> Issue an advisory circular which describes the RVR equipment and emphasizes that the RVR value is a sampling of a small segment of the atmosphere, usually near the touchdown point. It should also be emphasized that RVR value does not necessarily represent actual runway visibility conditions near the touchdown point and includes a significant time delay before reaching the crew. This information should also be placed in the Airmen's Information Manual. (Recommendation A-74-19.)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

March 7, 1974

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Board was notified of the accident at 1140 eastern daylight time on July 31, 1973. An investigation team went immediately to the scene. Working groups were established for operations, air traffic control, witnesses, weather, human factors, structures, maintenance records, powerplants, systems, flight data recorder, and cockpit voice recorder.

Participants in the on-scene investigation included representatives of the Federal Aviation Administration, Delta Air Lines, Inc., Air Line Pilots Association, National Weather Service, Professional Air Traffic Controllers Organization, Douglas Aircraft Company, Pratt & Whitney Aircraft Division of United Aircraft Corporation, and the Massachusetts Port Authority (Massport).

2. Public Hearing

A public hearing started in Peabody, Massachusetts, on September 18, 1973, and terminated in Washington, D. C., on September 27, 1973. Parties represented at the hearing were: The Federal Aviation Administration, Delta Air Lines, Inc., Air Line Pilots Association, National Weather Service, Professional Air Traffic Controllers Association, and the Aviation Consumers Action Project.

APPENDIX B

CREW INFORMATION

Captain John N. Streil

Captain John N. Streil, age 49, held Airline Transport Pilot Certificate No. 256454, with airplane multiengine land rating. He held type ratings in the DC-3, 6, 7, 9; B-727; CV-240. 440, 880, 990, and the Vicker Viscount. His first-class medical certificate was dated June 15, 1973, with the limitation: "Airman must wear glasses while flying." He was qualified initially as a pilot-in-command on July 3, 1956. He received a type rating on the Douglas DC-9 aircraft on May 5, 1970. At the time of the accident, he had accumulated approximately 14,840 hours of flying time, of which 1,457 hours were in the DC-9 aircraft. The captain had completed his last proficiency check on June 18, 1973, and recurrent ground training on April 20, 1973. Captain Streil was qualified and current in both the DC-9 and the B-727 and had completed the aircraft-differences training required by the Delta training curriculum. During the last 3-year period, the captain satisfactorily completed all required training without rechecks or repeats.

The captain had a rest period of 18 hours during the 24 hours preceding the origination of Flight 524 from Boston at 0735.

First Officer Sidney W. Burrill

First Officer Sidney W. Burrill, age 31, held Commercial Airplane Certificate No. 164885, with airplane single-engine land, sea, and instrument ratings. His first-class medical certificate was dated March 13, 1973, with no limitations. He was employed by Northeast Air Lines on January 3, 1967. He was upgraded to first officer on the Boeing 737 in December 1968. On February 11, 1973, he completed initial training on the DC-9 aircraft and was assigned as a first officer on Delta's approved routes. First Officer Burrill had accumulated 6,994 flight hours, of which 217 hours were in the DC-9. He completed his last proficiency check in the B-727 on October 27, 1972, his last flight engineer line check on April 16, 1972, and recurrent ground training on October 16, 1972. Over the previous 3 years, the first officer had satisfactorily completed all required training.

The first officer had a rest period of 18 hours during the 24 hours preceding the origination of Flight 524 from Boston at 0735.

Cabin Attendants

Patricia H. Humphreys, age 29, had a seniority date of October 3, 1966. Training records showed that she had satisfactorily completed jet recurrent ditching and competency training and checks on June 7, 1973. She successfully completed the semi-annual emergency procedures quiz on April 15, 1973.

Ann L. Moore, age 33, had a seniority date of November 22, 1971. Training records showed that she had satisfactorily completed jet recurrent ditching and competency training and checks on November 10, 1972. Her semi-annual emergency procedures quiz was successfully completed on May 2, 1972.

Janice L. Wilson, age 26, had a seniority date of February 26, 1973. She successfully completed her initial training on March 23, 1973.

All the cabin attendants were qualified in the DC-9-31 and -32 model aircraft.

Cockpit Observer

Joseph E. Burrell, age 52, held Airline Transport Pilot Certificate No. 167756. His most recent first-class medical certificate was dated April 19, 1973, with no limitations. Noted on the medical application were the following: "Appendix 1949, Cryosurgery 1967, Mild Parkinsons 1967." The application showed the L-dopa was being used by the applicant.

Mr. Burrell's last ECG was on April 19, 1973.

The application contains the following comments:

"Pt was found to have Parkinson Disease approximately 6 years ago and has been under treatment for this disease with L-dopa, and is currently being treated with the same drug at the dosage of 5 grams daily. Accompanying this application is the National Transportation Safety Board Order No. EA-439, Docket No. SM-491."

The Board order stated, in part: "A first - or second class medical certificate be issued to petitioner upon his application therefor, provided he is otherwise and fully qualified therefor."

Mr. Burrell was employed by Northeast Air Lines on June 17, 1957. He was granted medical leave of absence on June 22, 1967. At that time he was qualified as second-in-command on the CV-880 and pilot-in-command on the DC-3. Mr. Burrell remained on medical leave until May 26, 1973, and returned to the payroll on May 27, 1973.

He began DC-9 initial ground school training on May 28, 1973. On June 8, 1973, he failed to complete a written examination. The records show that he again attended DC-9 initial ground training from June 11 through June 22, 1973, and satisfactorily completed it.

On June 23, 1973, Mr. Burrell received instruction in the procedure trainer at the Delta Air Lines Flight Training Center in Atlanta, Georgia. On June 24, 1973, he began DC-9 simulator training and received 24 hours of instruction and 12 hours of observing by July 24, 1973. On July 29, he was given an evaluation flight of 3 hours in a DC-9 aircraft. This evaluation flight resulted in the decision to allow Mr. Burrell to ride on DC-9 flights for the purpose of familiarization. He was authorized to occupy the jumpseat as an observer only.

APPENDIX C

AIRCRAFT INFORMATION

Aircraft N975NE, a Douglas DC-9-31, serial No. 47075, was operated by Delta Air Lines, Inc. It was manufactured September 25, 1967, and subsequently delivered to Northeast Air Lines, Inc. The aircraft was then transferred to Delta Air Lines, Inc., as a result of the merger of the two companies.

The last major inspection, a block-4 overhaul, was performed April 14, 1973, at the Delta Maintenance Facility, Hartsfield International Airport, Atlanta, Georgia.

At the time of the accident, the aircraft had accumulated 14,639.7 flight hours, of which 843 hours were flown since the last inspection.

The weight and balance manifest for this flight indicated that the aircraft had been within its weight and balance limitations both at take-off and at the time of the accident.

There were 14,950 pounds of fuel aboard the aircraft upon departure from Manchester, New Hampshire. The planned fuel burn-off for the flight to Boston was 1,900 pounds. The estimated gross weight, fuel remaining, and center of gravity at the time of the accident were 87,300 pounds, 13,050 pounds, and 15.2 percent, respectively.

According to company records, all airworthiness directives were complied with.

The aircraft was equipped with two Pratt & Whitney, JT8D-A engines. Engine serial numbers and times were as follows:

	#1 Engine S/N 657554	#2 Engine S/N 657086
Date Installed	6-23-73	7-17-73
TSO Hours	10,703.3	12,507.6
Flight Cycles	16,031	17,265
Hours since installed	324.3	111.6
Cycles since installed	405	139

Company records indicated that N975NE had been maintained in accordance with company procedures and with FAA requirements.

Illustration not Available

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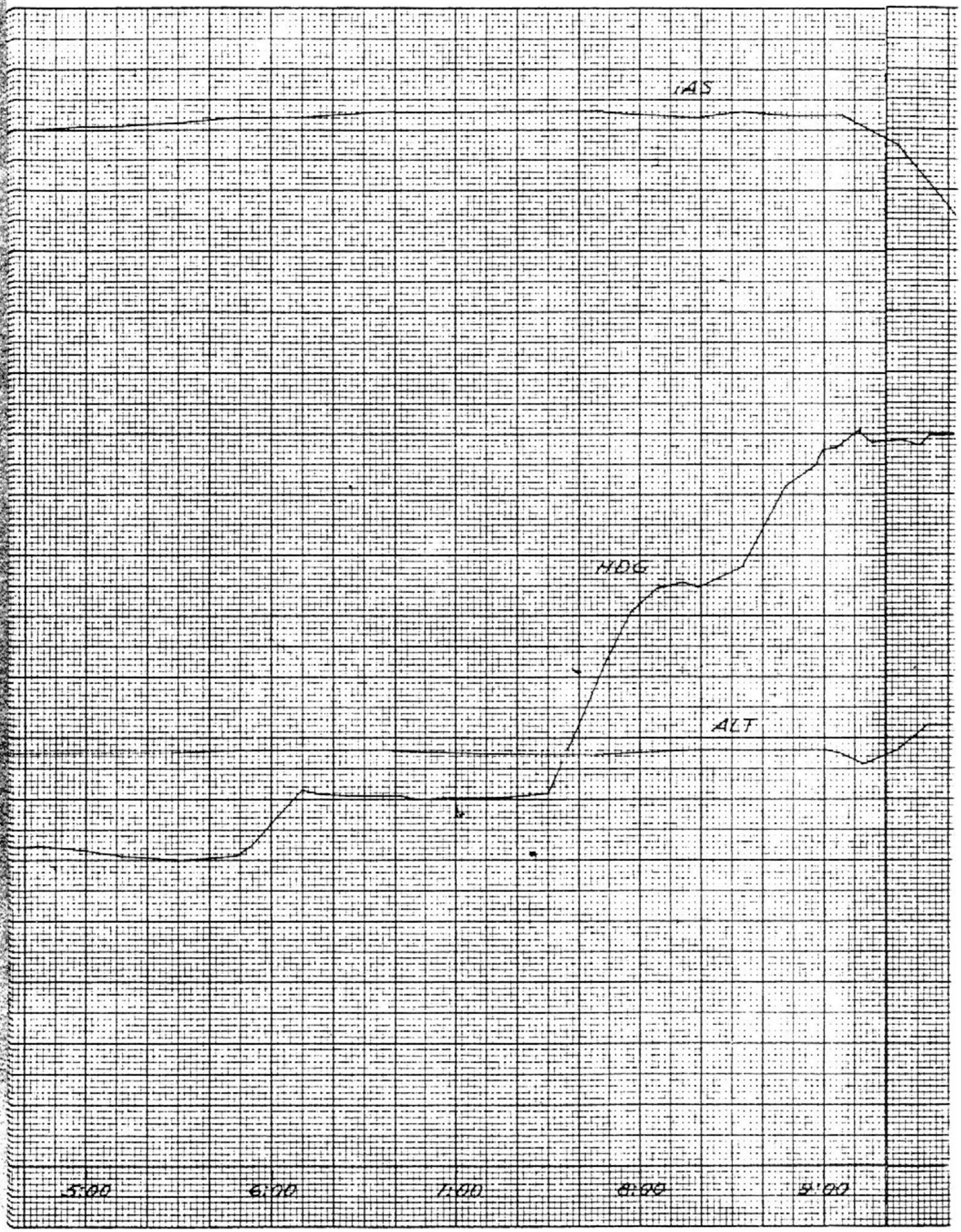
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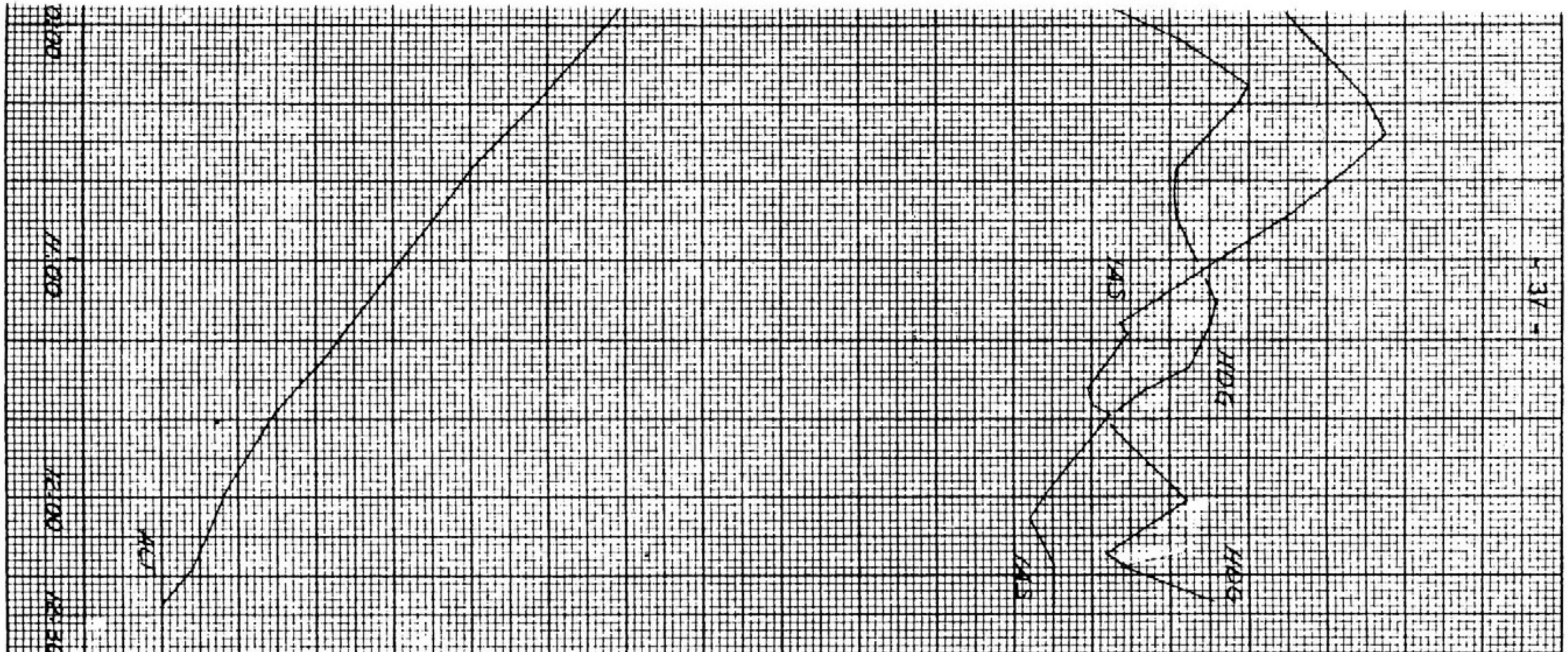
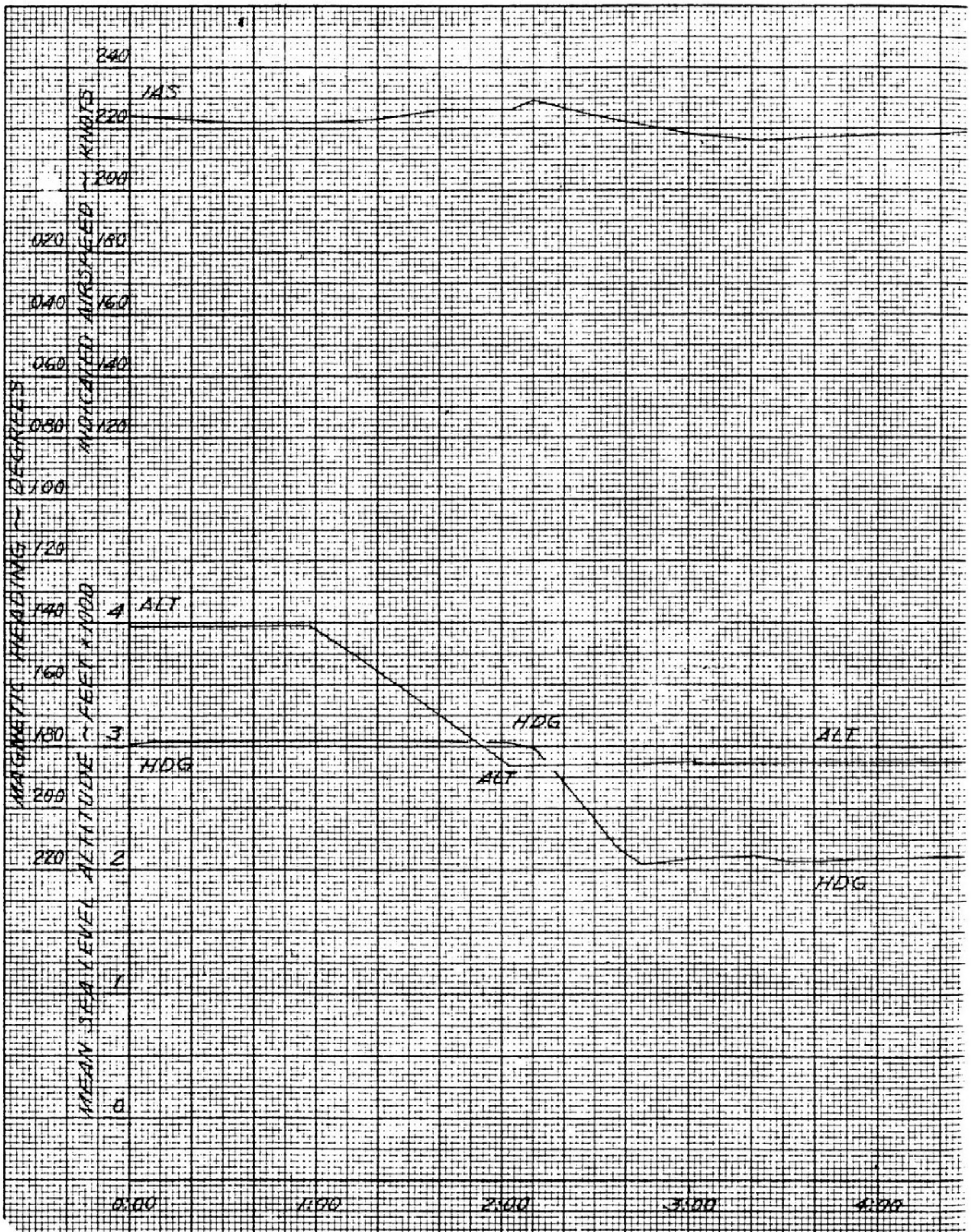


NATIONAL TRANSPORTATION SAFETY BOARD
BUREAU OF AVIATION SAFETY
WASHINGTON, D. C.
DELTA AIR LINES, DOUGLAS MODEL DC-9, N975NE
FLT 723, BOSTON, MASS., JULY 31, 1973
LANDING APPROACH ACCIDENT
FLIGHT DATA RECORDER GRAPH
UCDD (SUNDSTRAND) MODEL FA 542, S/N 1723

DCA 74-A-Z004 RPT NO 74-5 AUGUST 3, 1973



MAGNETIC HEADING ~ DEGREES
INDICATED AIRSPEED ~ KNOTS
MEAN SEA LEVEL ALTITUDE ~ FEET x 1000
240
220
200
020 180
040 160
060 140
080 120
100
120
140 4
160
180 3
200
220 2
1
0
IAS
ALT
HDG
0:00
1:00
2:00
3:00
4:00

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APPENDIX F

TRANSCRIPTION OF COCKPIT VOICE RECORDER DATA, FAIRCHILD A-100, S/N 2634, DELTA AIR LINES DOUGLAS MODEL DC-9-31, N975NE, FLIGHT 723, LOGAN INTERNATIONAL AIRPORT, BOSTON, MASSACHUSETTS JULY 31, 1973

LEGEND

CAM	Cockpit area microphone
RDO	Radio transmission from DAL Flight 723
INTP	Interphone transmissions on DAL Flight 723
-1	Voice identified as Captain
-2	Voice identified as First Officer
-3	Voice identified as Second Officer
-?	Voice unidentified
STEW	Unidentified stewardess voice
BAPPR	Boston Approach AR-1 (Frequency 126.5
BTWR	Boston Tower (Frequency 119.1)
*	Unintelligible word
#	Nonpertinent word
%	Breaks in continuity
( )	Questionable text
(( ))	Editorial insertion
----	Pause

Note: Times expressed in Greenwich Mean Time (GMT)

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INTRA-COCKPIT TIME & SOURCE	CONTENT	AIR-GROUND COMMUNICATIONS TIME & SOURCE	CONTENT
1450:17.5 CAM-1	Bring her up		
CAM	Sound of click		
1450:23.5 CAM-2	Gear up		
CAM	Sound of click ((similar to sound of gear handle operated to the up position))		
CAM-1	What I can do is this Joe, is pull the gear up *		
CAM-2	Is that a right or a left turn * he wanted?		
CAM-1	Left turn		
CAM-3	Left turn		
1450:41.0 CAM	Sound of stabilizer-in-motion warning horn		
		1450:41.5 RDO-1	An' we'll see you later, sir
		1450:43.0 MTWR	Roger, good day
CAM-2			
		1451:16.0 RDO-1	An' Boston Approach, ah, Delta seven two three, just off Manchester climbing out of two thousand to Lawrence

INTRA-COCKPIT TIME & SOURCE	CONTENT	AIR-GROUND COMMUNICATIONS TIME & SOURCE	CONTENT
CAM	Sound of click		
CAM	Sound of stabilizer-in-motion warning horn ((twice))	14:51.22.0 BAPPR	Seven two three roger, cleared to Lawrence, no delay, plan vectors ILS four right, the Boston altimeter is three zero one one. Weather is partial obscuration, estimated four hundred overcast, mile an' a half and fog
		1451:32.0 RDO-1	Very good sir, we'll, uh, check with ya four thousand
1451:36.0 CAM	Sound of stabilizer-in-motion warning horn		
CAM	Sound of click		
CAM-2	Did 'ja get the checklist done?		
CAM-1	We'll let Joe do it himself		
CAM-?	*		
CAM-?	* * ((masked up by Tower transmission))		
CAM-1	(Okay) if ya do the things and then - then we'll complete that checklist		
1451:48.5 CAM	Sound of stabilizer-in-motion warning horn ((appears simultaneously with the word complete))		
CAM	Sound of click		

INTRA-COCKPIT TIME & SOURCE	CONTENT	AIR-GROUND COMMUNICATIONS TIME & SOURCE	CONTENT
CAM-1	You gotta ask him		
CAM-?	* * *		
CAM-1	Huh?		
CAM-3	Gear uplatch check		
1451:58.0 CAM	Sound of altitude warning horn		
CAM-1	Uplatch checked		
1452:02.0 CAM-3	Flaps and slats		
CAM-3	Hydraulic pumps		
CAM-1	Like hydraulic pumps, I leave it to him to do steps on the calls		
CAM-3	Air-conditioning shutoff?		
CAM-1	I got the shutoff right after takeoff		
		1452:15.5 BAPPR	Delta seven two three, squawk ident please
CAM-1	Go ahead, ident		
		1452:21.0 RDO-1	Seven two three
		1452:22.5 BAPPR	Okay, thank you very much
1452:24.0 CAM	Sound of stabilizer-in-motion warning horn		
CAM-1	Sound of person imitating a bugle		

INTRA-COCKPIT

TIME & SOURCE	CONTENT
CAM	Sound of click
CAM-1	Okay the gear was up, we got the gear up, right?
CAM-2	Yeah
1452:45.0 CAM-1	Five hundred feet, we go to five degree flaps. I'm afraid you got a little hot with the engines, just pull back a hair and crack them a little bit down here. It would be better to leave climb power on till fifteen hundred feet * * if they're bordering on the high, come back to maybe one point nine
0453:10.0 CAM-2	What's our limit, Danvers or, ah, Lawrence?
CAM-3	Lawrence VOR direct
CAM-1	Crossbearing or something on it, he didn't give us huh? ((Crossbearing or something on it, begins after the word VOR))
CAM-3	Lawrence * VOR direct
CAM-1	We go the Boston VOR direct?
CAM-2	From Lawrence?
1453:21.0 CAM-3	Lawrence, we're only cleared to Lawrence

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT

INTRA-COCKPIT TIME & SOURCE	CONTENT	AIR-GROUND COMMUNICATIONS TIME & SOURCE	CONTENT
CAM-1	Only to Lawrence		
CAM-3	Lawrence, direct		
CAM-1	I'll get ya somethin for comin up on Lawrence		
CAM-2	Go ahead		
1453:32.0 CAM-1	I'll give you, ah, Boston		
CAM-2	Okay, give me Boston		
CAM-?	* * *		
CAM-2	Let me have our clearance *		
CAM-1	Ah thousand feet to go		
CAM-2	Right		
1454:11.0 CAM-2	What's our clearance limit again?		
CAM-?	*		
CAM-2	Right		
CAM-?	* * *		
		1454:25.5 RDO-1	Ah, Delta seven two three approaching Lawrence
		1454:29.0 BAPPR	Seven two three roger, fly heading now one eight zero, radar vectors ILS four right

INTRA-COCKPIT		AIR-GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
CAM	Sound of heavy click		
		1454:33.0 RDO-1	One eight zero
		1454:36.0 BAPPR	You level at four thousand now?
CAM-2	Yep		
		1454:39.0 RDO-1	That's affirm, four thousand
CAM-1	They're gettin down --- sound of two clicks --- ((clicks occur in rapid succession, similar to the sound of turning on fuel pump switches))		
1454:59.0 CAM-1	I'll leave this on to help the girls		
CAM-2	Did you identify Milton?		
CAM-1	* identified Boston		
CAM-1	Oh yeah, yeah		
1455:10.0 CAM	Sound of loud clunk		
CAM-1	Boston outer marker		
1455:20.0 CAM	Dah, dit ((sound of code phonetically))	RDO-1 ((ADF))	Dah, dit dit, dit, --- dah, dah, dah ((Sound of code appears on radio channel simultaneously with CAM channel and are the letters B and O which identify Milton. Coded signal occurs numerous times thereafter))

INTRA-COCKPIT TIME SOURCE	CONTENT	AIR-GROUND COMMUNICATIONS TIME & SOURCE	CONTENT
1455:30.0 CAM-1	It's identified		
CAM-2	Thank you		
CAM-?	* * * *		
CAM-?	* * * *		
1455:57.0 CAM-1	Pressurization is set, right?		
CAM-3	Flight instruments, altitude -- test set and crosschecked?		
CAM-1	Test set and crosschecked		
1456:02.0 CAM-3	Landing data, you gotta flip this thing around		
CAM-1	Ah, I had already put it back two thousand and put it back		
1456:13.0 CAM-1	Set one twenty on the bug		
CAM-3	* descent check (complete)		
		1456:24.0 BAPPR	Delta seven two three, descend to three thousand, over
		1456:27.5 RDO-1	Okay sir, leaving four for three, seven two three

INTRA-COCKPIT TIME & SOURCE	CONTENT	AIR-GROUND COMMUNICATIONS TIME & SOURCE	CONTENT
1457:02.0 CAM-1	We'll let you do the rest if you'd like to do it		
CAM-3	Seatbelt is on your *		
1457:09.0 CAM	Sound of altitude alert warning horn		
CAM-1	Right, seatbelt is on		
		1457:36.0 BAPPR	Delta seven two three, fly heading two two zero
1457:40.0 CAM	Sound of altitude alert warning horn	1457:40.0 RDO-1	Two two zero, seven two three
CAM-3	* *		
CAM-1	Yeah		
1457:50.0 CAM	Sound of altitude alert warning horn		
CAM	((Sound of severe tape flutter))		
1458:00.0 CAM-3	What do you want to tell the girl?		

INTRA-COCKPIT		AIR-GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
CAM-1	You want to answer the girl?		
1458:04.0 CAM-2	Right, seatbelt's on		
CAM-1	You want to answer the girl? She just rang		
CAM-3	Right, I got the phone. I got it		
1458:13.0 CAM	Sound of heavy click ((sound similar to the interphone hand set being removed from cradle))		
CAM-1	Just press the thing in and talk to her	INTPH-3	Yes?
		STEW	Uh, are we going to be able to go right in, or are we going to be doing some circling around and all?
		INTPH-3	We've got a radar vector to the final approach course now
		STEW	To the where?
		INTPH-3	Final approach course, we're on a radar vector to the final --
		STEW	Okay, good, thank you, bye
		INTPH-3	Okay
1458:37.0 CAM	Sound of heavy click ((sound similar to replacing the interphone hand set in its cradle))		

INTRA-COCKPIT		AIR-GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1458:50.0 CAM-3	Fuel tanks on one, the mains on, both pumps on the mains		
CAM-1	Yeah, I'm just going to let it bleed a little bit more out of the center for now		
1459:00.0 CAM-3	Check the radio altimeter, needs a DH (abbreviation for Decision Height)) ---- you know it's Four Right		
CAM-1	It's, ah ----		
CAM-3	Two hundred?		
CAM-1	Yeah		
CAM-1	All right, let's get the approach outta the way		
1459:13.0 CAM-3	This category two?		
CAM-1	No * * ((sound similar to sneeze)) ((radio transmission masks CAM))		
CAM-3	* * *		
CAM-1	When you're on this speed, you know you're not pressed for much, even though it's a short ride, Manchester to Boston, we're only doin' two twenty, so no hurry		

INTRA-COCKPIT

TIME & SOURCE	CONTENT
1459:32.0 CAM-3	It hasn't changed much
CAM-1	Right
CAM-?	Ohh * ((comment in response to female voice on a radio transmission))
CAM-2	There's an awful lot of women flying today --- pilots
1459:47.0 CAM	Sound of click
CAM-1	We're looking in for a high temperature up here. The DC-nine's temp control is wild
CAM-2	Yeah
CAM-3	I love the airplane
1459:59.0 CAM-2	* relax --- love the DC-nine
CAM-?	* * *
CAM	Sound of metal turning against metal ((sound similar to the opening of the fresh air vent control knob))
1500:10.0 CAM-1	I makes a lot of noise when you open it. We've both got the same thing
CAM-1	Ah, you got one over your head too, eh

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT

INTRA-COCKPIT TIME & SOURCE	INTRA-COCKPIT CONTENT	AIR-GROUND COMMUNICATIONS TIME & SOURCE	AIR-GROUND COMMUNICATIONS CONTENT
CAM-3	Right ((word appears between "eh" in the previous statement and "it" in the following statement))		
1500:17.0 CAM-1	It's okay, it doesn't cost anything. They make a lot of noise but if you want extra air sometimes * *		
CAM-1	* * * right behind ya		
CAM-?	* *		
CAM-1	It's supposed to go down again tonight here ---- it's supposed to get good today and then go down again tonight again * *		
		1501:18.0 BAPPR	Seven two three, fly heading now two zero zero
		1501:21.0 RDO-1	Two zero zero, seven two three
CAM-1	It might be # tomorrow morning when we come up from Washington for awhile it may be fog *		
CAM-2	Radar approach was blocked out ((the word "radar" in the above statement and the first word "lost" in the following statement occur simultaneously))		
1501:31.0 CAM-1	Lost, ah, lost the whole day before I go back to work ---- by tomorrow		
CAM-?	Yeah		

INTRA-COCKPIT

TIME & SOURCE	CONTENT
1501:59.0 CAM	Sound of heavy click
CAM-1	Sound of person imitating a bugle
CAM	Sound of stabilizer-in-motion warning horn

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
1502:58.0 BAPPR	Delta seven two three, fly a heading of one five zero
1503:01.0 RDO-1	One five zero, seven two three
1503:20.0 BAPPR	Delta seven two three, fly a heading of, ah, one three zero
1503:23.5 RDO-1	One three zero, seven two three
1504:02.5 BAPPR	Seven two three, fly a heading of zero niner zero
1504:05.0 RDO-1	Zero nine zero, seven two three
1504:07.0 BAPPR	That's correct
1504:30.0 BAPPR	And Delta seven two three, fly a heading of zero eight zero now, intercept the localizer course and fly it inbound, over
1504:35.0 RDO-1	Okay, zero eight zero for intercept

INTRA-COCKPIT TIME & SOURCE	CONTENT	AIR-GROUND COMMUNICATIONS TIME & SOURCE	CONTENT
1504:49.0 CAM-3	Fuel pumps		
1505:23.0 CAM-1	Localizer's alive		
1505:31.5 CAM-2	Go down to two thousand now, can't we?		
1505:33.5 CAM-1	He didn't say --- He didn't say to go on down		
		1505:39.0 RDO-1	Is seven twenty-three cleared for ILS?
		1505:41.5 BAPPR	Yes, seven two three is cleared for the ILS, yes
		1505:43.5 RDO-1	All righty
1505:49.0 CAM-3	(Plate) just like this		
1505:59.0 CAM	Sound of altitude alert		
1506:04.0 CAM-1	Gear down?		
CAM-2	Yeah		

INTRA-COCKPIT		AIR-GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1506:07.0 CAM	Clunk ((similar to gear handle operation)).		
CAM	Sound of ambient cockpit noise increases ((consistent with landing gear extension))		
1506:14.0 CAM	Sound of landing gear warning horn		
1506:17.0 CAM	Heavy click ((similar to sound of arming spoiler handle))		
CAM	Sound of chime ((chime sounds automatically when no smoking sign switch is turned to on position))		
1506:19.5 CAM	Sound of click ((similar to sound of flap handle moved into detent))		
1506:22.5 CAM	Sound of click ((similar to sound of flap handle moved into detent))		
1506:33.5 CAM-2	Checklist		
1506:43.5 CAM-3	Three green, pressure and quantity		
CAM-1	Get on it Joe, ah, Sid		
1506:47.5 CAM-2	Gettin down (ah) thousand feet a minute		

INTRA-COCKPIT TIME & SOURCE	INTRA-COCKPIT CONTENT	AIR-GROUND COMMUNICATIONS TIME & SOURCE	AIR-GROUND COMMUNICATIONS CONTENT
1506:50.5 CAM-1	Leave it below one *		
1506:58.5 CAM-1	Sound of stabilizer-in-motion warning horn		
1507:05.0 CAM-2	This # # command bar shows *		
CAM-3	Before landing ---- before landing is complete		
CAM-1	Yeah that doesn't show much ((the three above statements occurred almost simultaneously in the following order --- before landing starts after word "this." The statement beginning with "Yeah" starts between words "bar" and "shows"))		
		1507:14.0 BAPPR	Seven two three is cleared to land, Tower one nineteen one
1507:14.5 CAM	Sound of stabilizer-in-motion warning horn		
		1507:17.0 RDO-1	Seven two three
1507:19.0 CAM-1	Going like a # # # #		
1507:21.5 CAM-3	Oh my God		
1507:24.0 CAM	Sound of heavy click		

INTRA-COCKPIT TIME & SOURCE	CONTENT	AIR-GROUND COMMUNICATIONS TIME & SOURCE	CONTENT
1507:28.0 CAM-1	Okay, your localizer ((sound of stabilizer-in-motion warning horn)) startin' to come back in now		
		RDO-?	All right
CAM-2	Okay		
1507:35.0 CAM-2	Set my power up for me if I want it		
1507:37.0 CAM	Sound of heavy click		
1507:38.0 CAM-1	Okay, just fly the airplane		
1507:40.0 CAM-1	You better go to raw data, I don't ((sound of stabilizer warning horn)) thrust that thing		
		1507:43.0 RDO-1	And Boston Tower, Delta seven two three final
		1507:45.5 BTWR	Cleared to land four right, traffic's clearin' at the end, the RVR shows more than six thousand, a fog bank is movin in, it's pretty heavy across the approach end
		1507:52.0 RDO-1	Seven two three
1507:54.0 CAM-1	*'ll let's get back on course if ya can		

INTRA-COCKPIT TIME & SOURCE	CONTENT	AIR-GROUND COMMUNICATIONS TIME & SOURCE	CONTENT
1507:55.0 CAM-2	I just gotta get this back		
1508:04.5 CAM-1	* 'en out		
1508:05.0 CAM-3	Shout		
1508:05.5 CAM	Sound of impact ((End of Recording))		

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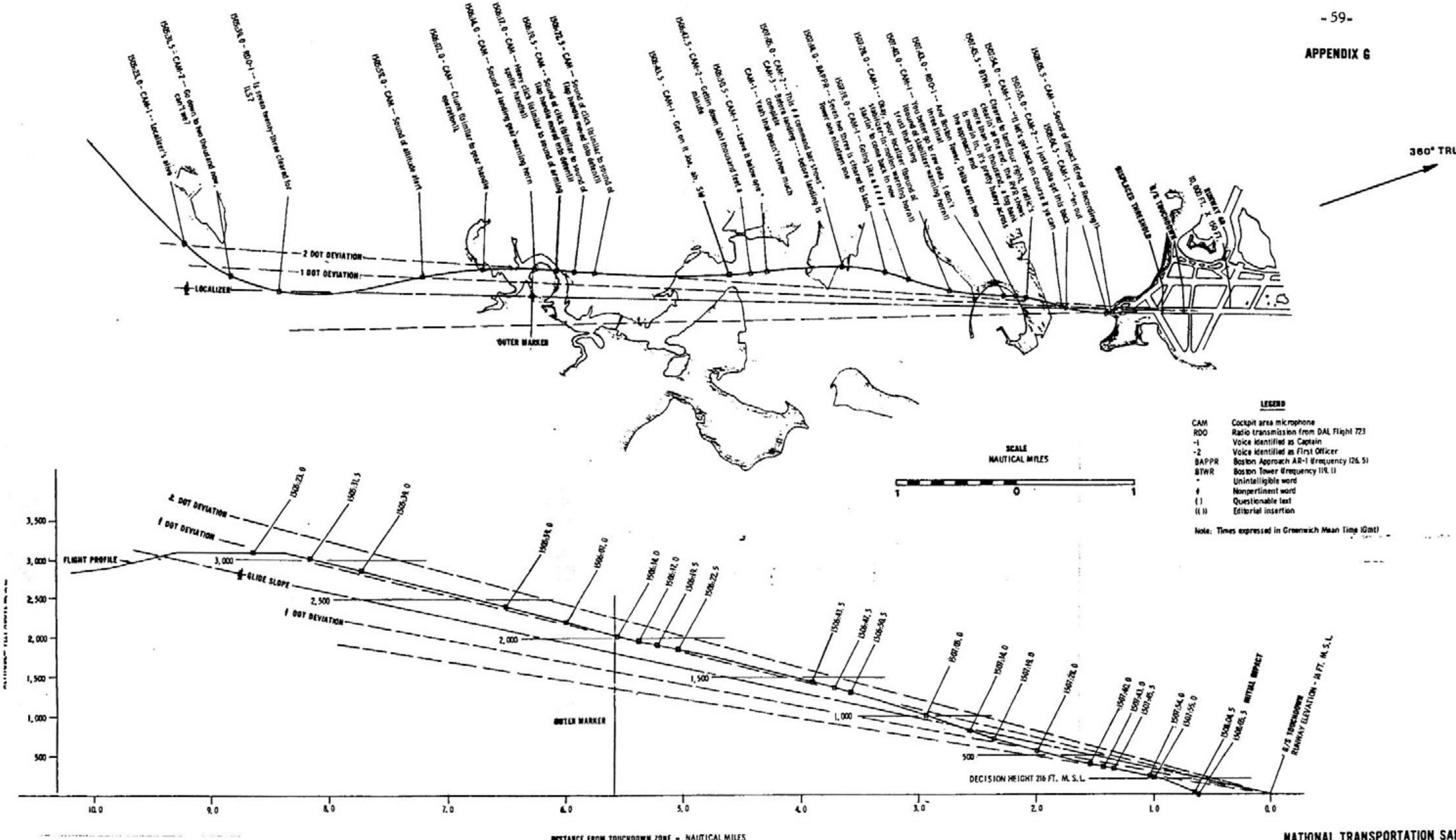
APPENDIX G



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NOTE: This flight track was derived using data obtained from the aircraft flight data recorder and reported meteorological conditions. The accuracy of the track is dependent upon the accuracy of these data.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

FLIGHT TRACK PRESENTATION

DELTA AIR LINES, INC.

DC 9, N975NE

FLIGHT NO. 723

LOGAN INTERNATIONAL AIRPORT BOSTON, MASSACHUSETTS

JULY 31, 1973

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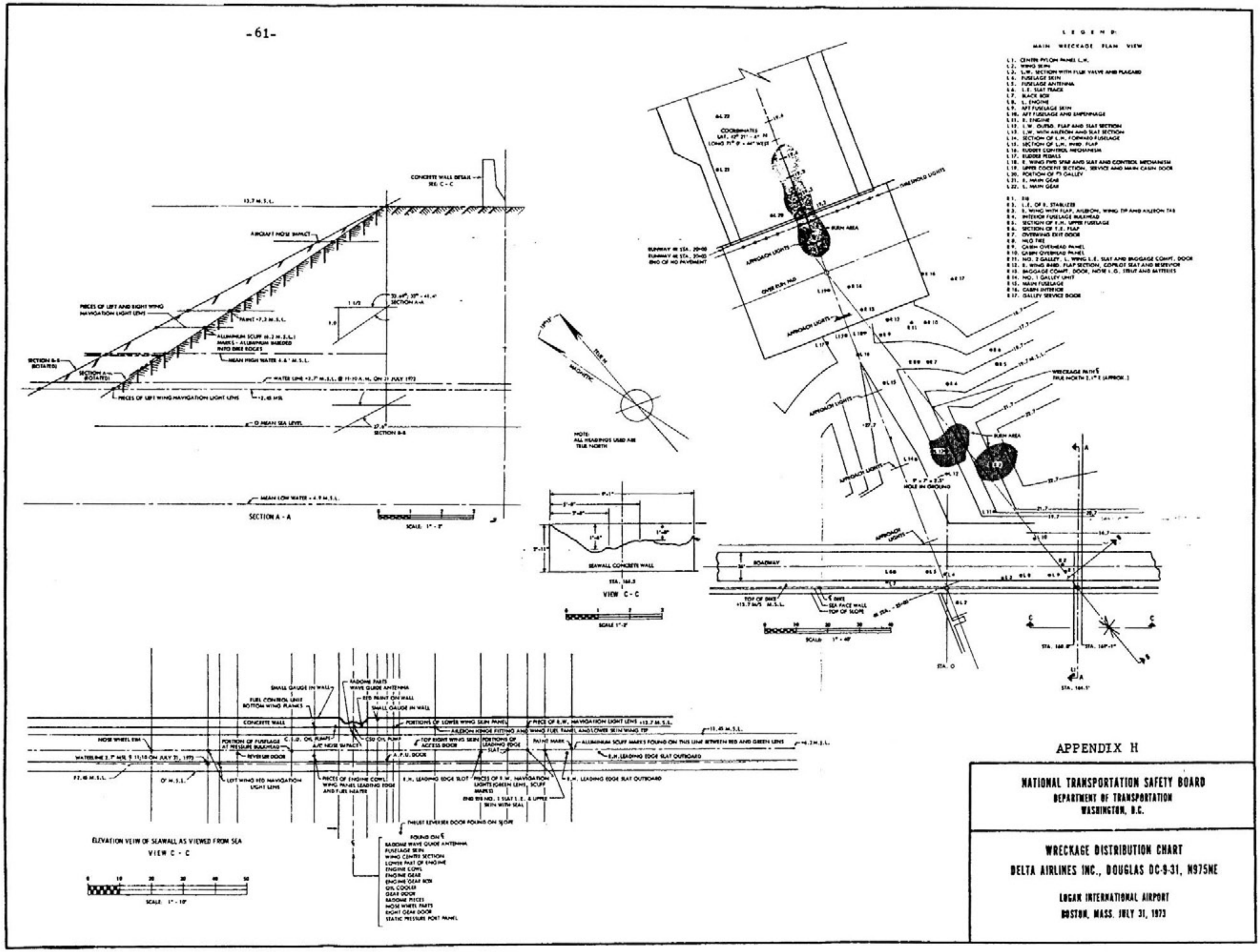

APPENDIX H

NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
WASHINGTON, D.C.

WRECKAGE DISTRIBUTION CHART
DELTA AIRLINES INC., DOUGLAS DC-9-31, N975NE

LOGAN INTERNATIONAL AIRPORT
BOSTON, MASS. JULY 31, 1973

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UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C.

ISSUED: August 29, 1973

Adopted by the NATIONAL TRANSPORTATION SAFETY BOARD
at its office in Washington, D. C.
on the 16th day of August 1973

FORWARDED TO:
Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATIONS A-73-62 thru 64

The National Transportation Safety Board is now investigating the Delta Air Lines DC-9 accident which occurred during an ILS approach to the Logan International Airport in Boston, Massachusetts, on July 31, 1973.

During our review of the flight logs and maintenance records of the aircraft involved, N975NE, a problem was found which, we believe, merits your immediate attention.

These records show that numerous complaints about radio and flight instruments were recorded in the flight logs of N975NE after the aircraft was modified from the Northeast Airlines to the Delta Air Lines DC-9 avionics configuration in April 1973. Many of these complaints were of a recurring or chronic nature, as evidenced by the seven writeups between July 25 and 29, 1973, dealing with the functioning of the flight director, the DME, and one of the navigational receivers.

A total of 14 NEA DC-9 aircraft were affected by this modification plan. The records of the aircraft which immediately preceded and followed N975NE through the modification program also were examined. The records of both these aircraft, N979NE and N978NE, contained recurring radio and flight instrument complaints similar to those reported on N975NE.

Although our investigation has not progressed far enough to assess the role of avionics and instrumentation in this accident, we are concerned about possible operational implications of these chronic discrepancies and the apparent difficulty that Delta Air Lines has experienced in correcting them.

Honorable Alexander P. Butterfield (2)

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

(1) Investigate the adequacy of the modification program, its implementation, and the quality control aspects monitored by the appropriate FAA office.

(2) Review the adequacy of the Delta Air Lines' quality control procedures in detecting and correcting the reported discrepancies.

(3) Consider the necessity of imposing appropriate operational restrictions on the modified DC-9 aircraft until the underlying reasons for the avionics discrepancies have been identified and corrected.

The Safety Board will appreciate an expeditious report of the findings resulting from the above actions.

Reed, Chairman, McAdams, Thayer, Burgess, and Haley, Members, concurred in the above recommendations.

William R. Haley acting for

By: John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

August 29, 1973

Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D.C. 20591

Dear John:

I have launched an indepth evaluation of Safety Recommendations A-73-62 thru 64, which you intend issuing on August 29 concerning the July 31 Delta Air Lines DC-9 accident at Logan International Airport.

Our findings to date on each of your recommendations are as follows:

1. A special inspection team has conducted a comprehensive audit of all technical aspects of the Delta Air Lines modification program. They have concluded that there is nothing in the modification program that could have contributed to the introduction of spurious signals or system failures in the flight director system.

2. Prior to receipt of your letter, our Southern Region had already initiated an indepth inspection of Delta Air Lines entire system - operations and maintenance. A final determination on this matter has not yet been made as the investigation is still in progress.

3. Based on the results of our investigation, we do not believe that there is any basis for placing an operational restriction on these aircraft. In every case, there is adequate back up or other navigational intelligence to apprise the flight crew of any misinformation.

I will send you the final report of the indepth inspection findings upon conclusion of our comprehensive team evaluation.

Sincerely,

Alexander P. Butterfield
Administrator

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DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

FEDERAL AVIATION ADMINISTRATION

OFFICE OF THE ADMINISTRATOR

FEB 20 1974

Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Dear Mr. Chairman:

This supplements our August 29, 1973, response to Safety Recommendations A-73-62 thru 64. As a result of our indepth study, the following comments are provided.

Recommendation No. A-73-62. Investigate the adequacy of the modification program, its implementation, and the quality control aspects monitored by the appropriate FAA office.

Comment. Quality control in the DC-9-31 modification is considered to have been satisfactory.

Recommendation No. A-73-63. Review the adequacy of the Delta Air Lines' quality control procedures in detecting and correcting the reported discrepancies.

Comment. Our study revealed a need for improvement in procedures and standards in the aircraft and engine reliability programs. Documentation, alert values and follow-up systems are the specific areas concerned. The computerized reports used by the systems maintenance coordinator and the aircraft maintenance analyst did not provide the input necessary for adequate and timely analysis and correction of repetitive items.

Delta Air Lines is in the final evaluation of some major management changes. A change being contemplated is to combine Maintenance Coordination, Technical Analysis and Aircraft Maintenance and Central Planning into a single department. The company has revised its computerized "exception report" to identify two repeat write-ups in four days with a second identification at five repeat write-ups in 31 days.

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We believe the above changes will provide an acceptable level of control of repetitive writeups. We are performing continuous surveillance to determine if the program is completely satisfactory.

Recommendation No. A-73-64. Consider the necessity of imposing appropriate operational restrictions on the modified DC-9 aircraft until the underlying reasons for the avionics discrepancies have been identified and corrected.

Comment. Based on the results of our study, we do not believe there is any basis for placing an operational restriction on the modified aircraft.

Sincerely,

Alexander P. Butterfield
Administrator

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: January 25, 1974

Forwarded to:

Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-74-1 & 2

About 1108 e.d.t. on July 31, 1973, Delta Air Lines Flight 723, a DC-9-31, crashed into a seawall while executing an ILS flight director approach to runway 4R on the Logan International Airport in Boston, Massachusetts. The aircraft struck the seawall 165 feet to the right of the approach light system centerline and about 3,000 feet short of the displaced runway threshold. The impact point was below and to the right of the 200-foot decision height area on the ILS glide slope.

On October 23-25, 1973, the National Transportation Safety Board conducted a test in a DC-9 simulator at the Delta Air Lines Training Department in Atlanta, Georgia. The test revealed that if the mode selection switch is moved slightly past the Approach mode detent toward the Go-Around (G/A) mode, the G/A mode indication will be displayed on the Sperry Flight Director model No. Z-5-534. Even if the selector is returned to the Approach mode, the G/A mode will continue to be displayed. This condition was found to exist in line aircraft also. Since there is no annunciator panel in a DC-9, some time can elapse before the G/A mode indication is recognized. It is conceivable that such an inadvertent selection might have been made in Flight 723.

In the G/A mode, the ILS signals are eliminated from the flight director system and may be regained only by switching to the Standby (SB) or Flight Instrument (FI) modes, and then back to the VOR/LOC or Approach modes.

Honorable Alexander P. Butterfield 2

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

1. Require that the Sperry Flight Director mode selection switch be modified to prevent inadvertent selection of the G/A mode.

2. Require an annunciator panel whenever any flight director system is installed. The panel would indicate electronically the mode in which the flight director is operating, regardless of the position of the mode selector switch.

REED, Chairman, McADAMS, BURGESS, and HALEY, Members, concurred in the above recommendations. THAYER, Member, was absent, not voting.

By John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

JAN 29 1974

Honorable John H. Reed, Chairman
National Transportation Safety Board
Department of Transportation
Washington, D.C. 20591

Dear Mr. Chairman:

This replies to your Safety Recommendations A-74-1 and 2 issued January 25 concerning modifications to preclude the recurrence of an accident such as the one involving Delta Air Lines DC-9-31 which crashed on Logan International Airport in Boston on July 31 of last year.

We are studying your recommendations now, and as soon as our evaluation is completed, we will inform you of the actions we will be taking.

Sincerely,

Alexander P. Butterfield
Administrator

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: January 25, 1974

Forwarded to:

Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-74-3 and 4

On July 31, 1973, Delta Air Lines Flight 723, a DC-9-31, was involved in an accident at Logan International Airport in Boston, Massachusetts. The National Transportation Safety Board's investigation of the accident disclosed two problems which impaired the safety of airport operations immediately after the accident.

First, a problem was detected with the approach light system (ALS) monitor panel which is located in the tower cab. The monitor panel contains two sets of red alarm lights which are associated with the sequence flashers and the ALS. The alarm lights associated with the sequence flashers often illuminated because of water which was frequently present in the power line. When water was present in the power line, maintenance personnel determined the status of the sequence flashers by visually observing the installations. If the sequence flashers were found to be operating normally, signs which advised tower controllers to disregard the alarm were usually placed on the control consoles. Maintenance personnel cleared the line after several hours of manual pumping. No effort had been made to install automatic pumping devices, nor to prevent the water from getting into the lines. We have been advised recently that this problem was eliminated by the installation of waterproof lines.

Light bars Nos. 25 and 26 of the ALS and their associated sequence flashers were destroyed by Flight 723 when the airplane crashed. Destruction of the lights caused an alarm to sound and both sets of red lights to illuminate. When the alarm was detected, controller personnel silenced the signal and ignored the red lights.

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Honorable Alexander P. Butterfield 2

An inoperative ALS requires increased landing minimums for arriving flights. Tower controllers are directed to advise inbound flightcrews of an indicated malfunction in the ALS, pending visual verification of the system's status. Because the crash of Flight 723 was not detected for several minutes, two other flights were cleared to land without the benefit of such an advisory. Since the major portion of the wreckage of Flight 723 remained on the landing runway short of the displaced threshold, additional accidents may have been averted when the pilots of these flights initiated missed approaches.

Controllers do not receive formal training in the use of the ALS monitor panel. In addition, controllers at Logan International Airport minimize the significance of the ALS alarms because of the frequency of false alarm signals caused by water in the line.

The Board's investigation disclosed also that heavy fog which existed over portions of the airport at the time of the accident restricted visibility and precluded visual observation of the accident from the tower cab. Also, controllers could not determine visually the status of the ALS.

The second problem resulted from a lack of communication between the tower ground controller and the local controller concerning the sequence of incoming flights.

Delta Air Lines Flight 623, a preceding arrival, was ~~taxiing~~ toward the passenger debarkation area when Flight 723 crashed. The similarity between flight numbers caused confusion because controllers believed that the flight which was taxiing toward the passenger debarkation area was Flight 723. Accordingly, airport operations continued without interruption. The actual location and status of Flight 723, however, was not known for several minutes, when emergency crews were alerted by an engineering aide.

Since the tower ground controller was not provided control information pertaining to the arrival sequence, he was not aware that two arriving flights had similar flight numbers. Such information could have eliminated the confusion regarding identification of the accident aircraft.

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

1. Require that controllers receive formal training in procedures for using the approach light system monitor panel.

2. Revise air traffic control operational procedures to assure that the ground controller is provided, concurrently, with the same arrival sequence information that is provided the associated local controller.

Members of our Bureau of Aviation Safety will be available for consultation in the above matter if desired.

REED, Chairman, McADAMS, BURGESS, and HALEY, Members, concurred in the above recommendations. THAYER, Member, was absent, not voting.

By: John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

JAN 30 1974

Honorable John H. Reed
Chairman, National Transportation
Safety Board
Washington, D. C. 20591

Dear Mr. Chairman:

This is in response to Safety Recommendations A-74-3 and A-74-4 issued on January 25.

Recommendation No. 3. Require that controllers receive formal training in procedures for using the approach light monitor panel.

Comment. In the past, controllers were briefed on the ALS system and applicable monitor procedures as part of their local control on-the-job training. While not formal per se, the training was considered adequate. The line problem has been corrected at Boston by the installation of waterproof lines. The Boston Control Tower has developed and implemented a controller training program on both the ALS systems installed at Logan Airport. This training package is all inclusive and covers system components and functions, alarm system operation and controller's responsibilities. Each individual will be given training using this briefing material. In this connection, we are also looking at the ALS monitor procedures at other towers to determine if the problem is national.

Recommendation No. 4. Revise air traffic control operational procedures to assure that the ground controller is provided concurrently with the same arrival sequence information that is provided the associated local controller.

Comment. The Boston Tower issued an internal order on August 7, 1973, requiring the flight progress strips on arrival aircraft be passed to the ground controller. Nationally, we are supplementing our Terminal Air Traffic Procedures Handbook 7110.8C to require pertinent information be forwarded to the ground controller on arrival aircraft when the active runway cannot be observed visually from the tower cab.

Sincerely,

Alexander P. Butterfield
Alexander P. Butterfield
Administrator

U.S. GOVERNMENT PRINTING OFFICE: 1974—731-658/20