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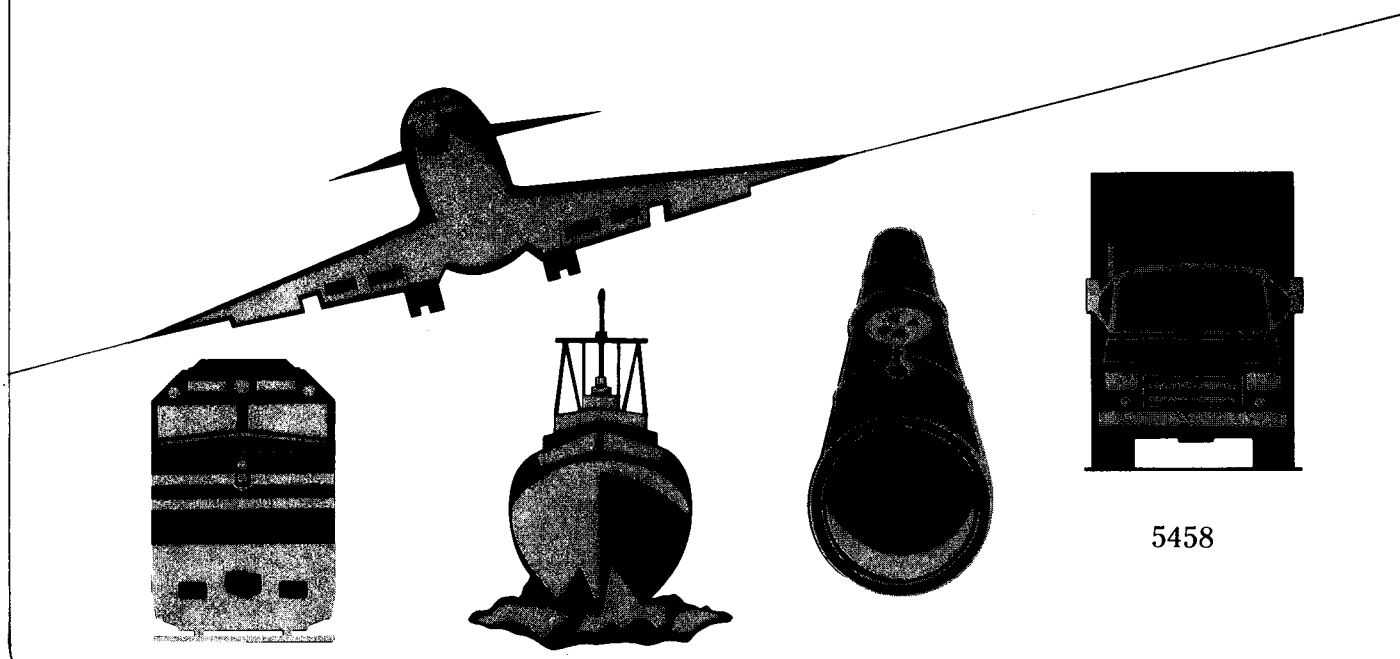
NTSB/AAR-91/03

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

RUNWAY COLLISION
OF EASTERN AIRLINES BOEING 727, FLIGHT 111
AND EPPS AIR SERVICE BEECHCRAFT KING AIR A100
ATLANTA HARTSFIELD INTERNATIONAL AIRPORT
ATLANTA, GEORGIA
JANUARY 18, 1990



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JANUARY 18, 1990

ADOPTED: May 29, 1991
NOTATION 5458

Abstract: This report explains the runway collision of an Eastern Airlines Boeing 727 with an Epps Air Service Beechcraft at the Hartsfield International Airport, Atlanta, Georgia, on January 18, 1990. The safety issues discussed in the report are air traffic controller procedures, conspicuity of airplane lighting, the "see and avoid" concept, and equipment and systems to prevent runway incursions. Safety recommendations concerning these issues were made to the Federal Aviation Administration.

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5. **APPENDIXES**

EXECUTIVE SUMMARY

On January 18, 1990, about 1904, an Eastern Airlines Boeing 727, flight 111, while landing on the runway in night visual conditions, collided with an Epps Air Service Beechcraft King Air A100, N44UE, at the William B. Hartsfield International Airport, Atlanta, Georgia. The King Air had been cleared to land on runway 26 right ahead of the Eastern flight and was in its landing roll. It was struck from behind by the B-727, which had also been cleared to land on runway 26 right. The B-727 sustained substantial damage, but none of the 149 passengers or 8 crewmembers onboard were injured. The King Air was destroyed as a result of the collision. The pilot of the King Air sustained fatal injuries, and the copilot, the only other occupant, sustained severe injuries.

The National Transportation Safety Board determines that the probable causes of this accident were (1) the failure of the Federal Aviation Administration to provide air traffic control procedures that adequately take into consideration human performance factors such as those which resulted in the failure of the north local controller to detect the developing conflict between N44UE and EA 111, and (2) the failure of the north local controller to ensure the separation of arriving aircraft which were using the same runway.

Contributing to the accident was the failure of the north local controller to follow the prescribed procedure of issuing appropriate traffic information to EA 111, and failure of the north final controller and the radar monitor controller to issue timely speed reductions to maintain adequate separation between aircraft on final approach.

The safety issues raised in this report include:

- Air traffic controller procedures and compliance with requirements for final approach separation and clearance to land.
- Conspicuity of airplane lighting.
- Limitations of the "see and avoid" principle in the night landing, final approach environment.
- Effectiveness of airport surface detection equipment (ASDE) the Airport Movement Area Safety System (AMASS) and Airport Surface Traffic Automation (ASTA) to preclude similar runway incursion accidents.

As a result of this investigation, the Safety Board made five recommendations to the FAA intended to prevent runway incursion accidents.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D. C. 20594

AIRCRAFT ACCIDENT REPORT

RUNWAY COLLISION OF EASTERN AIRLINES BOEING 727, FLIGHT 111 AND EPPS AIR SERVICE BEECHCRAFT KING AIR A100 ATLANTA HARTSFIELD INTERNATIONAL AIRPORT ATLANTA, GEORGIA JANUARY 18, 1990

1. FACTUAL INFORMATION

1.1 History of the Flights

On January 18, 1990, at 1904 eastern standard time, Eastern Airlines flight 111 (EA 111), N8867E, a Boeing 727-225A, collided with N44UE, an Epps Air Service Beechcraft King Air A100, while EA 111 was landing on runway 26 right at the William B. Hartsfield International Airport, Atlanta, Georgia, and as the King Air A100 was preparing to turn off the runway after having landed ahead of EA 111. Both airplanes were in radio communication with the Hartsfield Air Traffic Control (ATC) tower local controller at the time of the accident. As a result of the collision, the King Air A100 was destroyed and the B-727 received substantial damage. The pilot of the King Air was fatally injured, and the copilot was seriously injured, there were no passengers on board; and there were no reported injuries on the B-727.

EA 111 was operating as a regularly scheduled passenger flight from LaGuardia Airport, New York, to Hartsfield Airport, Atlanta, Georgia. The flight was conducted in accordance with Title 14 Code of Federal Regulations (CFR) Part 121. There were 149 passengers, 5 flight attendants, and 3 flight crewmembers aboard the airplane.

EA 111's Instrument Flight Rules Dispatch Release, Minimum Equipment Listing (MEL), Airplane Load Manifest, and recommended Takeoff/Landing Data were generated by Eastern's Dispatch Office and forwarded to the flightcrew at LaGuardia. All items were routine. The airplane departed LaGuardia Airport at 1659. The takeoff, climb, cruise, enroute, and descent phases of the flight were uneventful.

Upon arrival in the Atlanta area, EA 111 was vectored for a final approach and cleared for the Instrument Landing System (ILS) runway 26 right approach at Hartsfield Airport (See figure 1). The captain performed the pilot flying duties.

The Atlanta weather conditions were reported to be: five hundred scattered, three thousand five hundred scattered, estimated ceiling one zero thousand overcast, visibility 3 miles with fog.

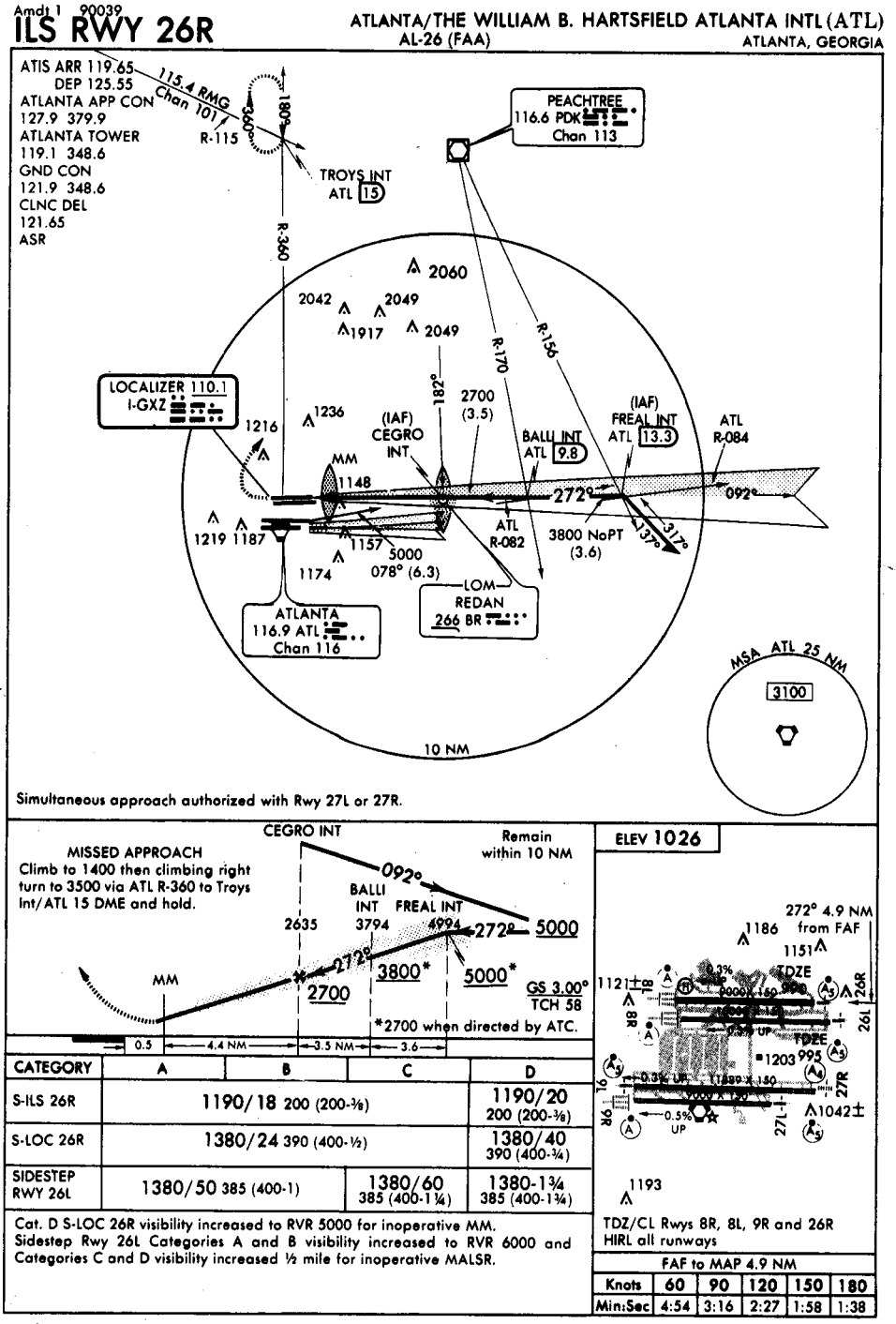

Figure 1.--Approach chart for ILS runway 26 right.

EA 111 was instructed by Atlanta approach control to maintain 180 knots until arrival over the outer marker. Flight data recorder (FDR) and ATC radar data confirm that EA 111 maintained about 180 knots until shortly before it approached the final approach fix. At that time, Atlanta approach control instructed EA 111 to decrease to final approach speed. This speed reduction instruction was the only one that EA 111 received during the approach. At the outer marker, the FDR recorded airspeed was 165 knots and at the captain's "1,000 feet" call, the airspeed was 149.5 knots. About 10 seconds later, the airspeed stabilized at 145 knots. An approach speed of 140-145 knots and a reference landing speed of 134 knots were computed by the flightcrew based on a landing gross weight of 149,000 pounds using 30^{0} of flaps. The flight was cleared to land by the local controller about 1902, and the crew indicated that they flew the glideslope and localizer to the runway landing approximately 1,200 feet down the runway. The flightcrew said that after touchdown, the spoilers were manually deployed and the nose of the airplane was lowered to the runway. As the captain reached for the thrust reversers, another airplane was seen for the first time on the right side of the runway ahead of them. The EA 111 flightcrew stated that they saw the other airplane when their landing lights illuminated it. The cockpit voice recorder (CVR) contains two exclamations about 3 seconds prior to the sound of impact.

The first officer stated that after he saw the other airplane on the runway, the captain steered the airplane to the left as an evasive maneuver. However, as the B-727 continued through the landing rollout, its right wing struck the other airplane. The captain then steered the airplane back toward the center of the runway, completing the landing rollout. He exited the runway on high-speed taxiway "B3" and stopped. (See figure 2). Some passengers on board EA 111 stated that they had seen another airplane on the runway a brief second before the collision. The collision between the two airplanes was described by some passengers as a slight jolt; however, most of the passengers interviewed said that the captain's maneuvers to avoid the other airplane were more apparent than the actual collision.

While EA 111 was parked on the taxiway, the flightcrew noticed that the reservoir of hydraulic system A was depleted. Also a passenger reported a loss of some type of fluid from the right wing. The captain shut down the No. 3 engine. Nose wheel steering was unavailable because of the loss of system A hydraulics. The captain requested that the airplane be towed to the gate. He decided that the passengers did not need to evacuate the airplane and directed that they remain seated until buses arrived for transportation to the terminal. Engines No. 1 and 2 were shut down, and the flightcrew secured the airplane. Buses arrived about 20 minutes after the collision.

The Epps Air Service Beechcraft King Air A100, N44UE, was operating in accordance with Title 14 CFR Part 91. The flight was intended to conduct on-demand air taxi operations in accordance with Title 14 CFR Part 135 at Hartsfield Airport, Atlanta, Georgia. The flight originated at DeKalb/Peachtree Airport, Georgia, and was to board passengers at Hartsfield Airport, transport them to Albany, Georgia, and return to DeKalb/Peachtree Airport. The flight departed DeKalb/Peachtree Airport about 1850 with the

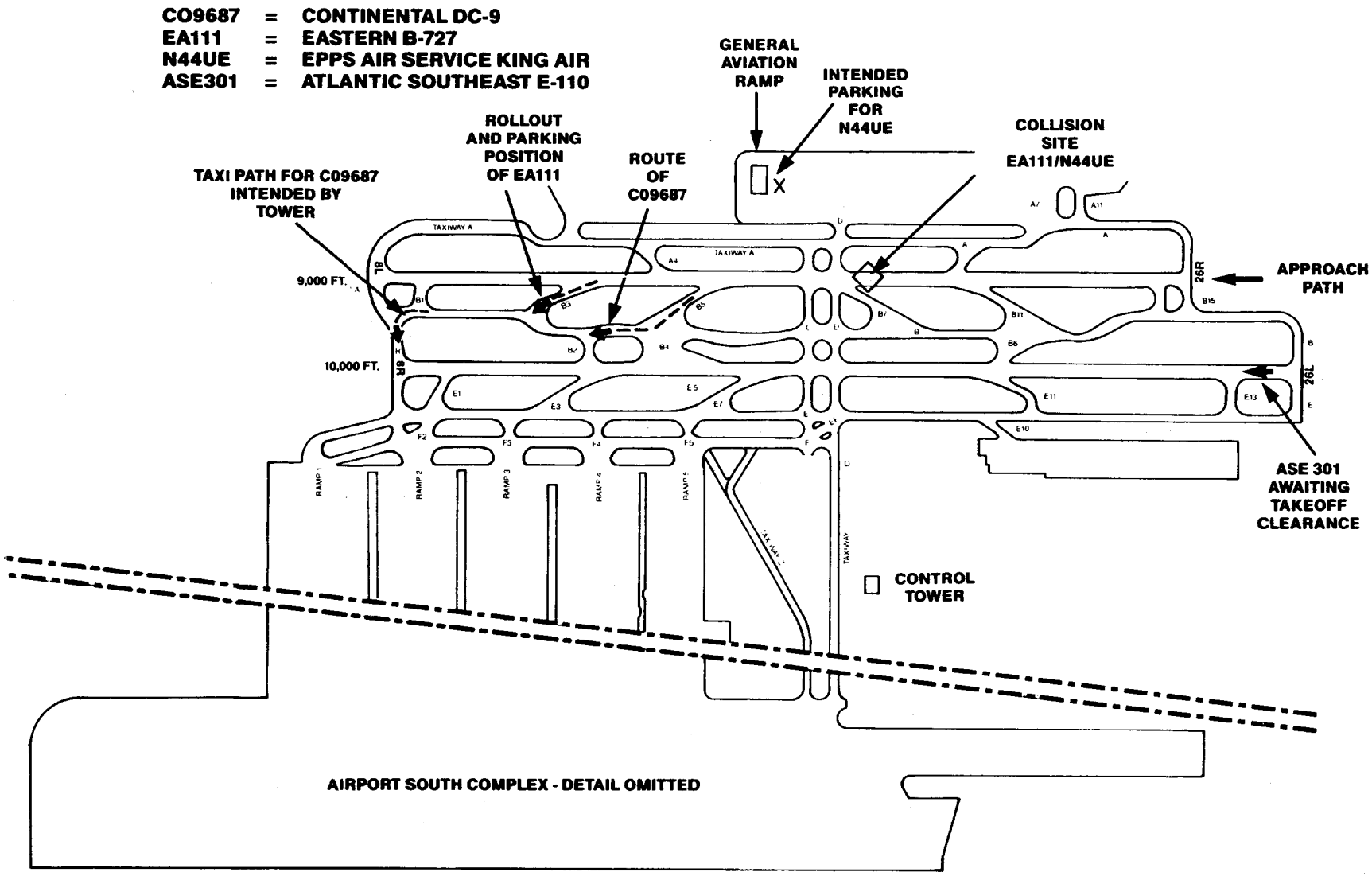

Figure 2.--Airport diagram with overlay of activity related to collision.

pilot and copilot but no passengers on board. The copilot was an Epps PA-31 (Piper Navajo) qualified pilot who was to fly in the right seat for familiarization with the King Air airplane. Instrument flight plans were filed with the Atlanta Flight Service Station for the entire route of flight (DeKalb/Peachtree-Hartsfield-Albany-DeKalb/Peachtree).

The copilot of N44UE sustained serious injuries and recalled very little about the flight. He stated the pilot was in the left seat and flew the entire route, including the approach and landing. He said that the takeoff, climb, enroute, descent, and landing phases of the flight were unremarkable.

Eight minutes after departing DeKalb/Peachtree Airport at 1858, the flight was cleared for the ILS runway 26 right approach to Hartsfield Airport. The flightcrew was instructed at this time by Atlanta approach control to maintain 180 knots until over the outer marker. It was then instructed to switch to the Atlanta tower frequency, and three speed reduction instructions were given, 160 knots, 150 knots, and 140 knots. Ground speed data derived from radar data indicate that the pilot complied with these speed reductions, slowing the airplane to approximately 140 knots approaching the final approach fix. From that position the pilot slowed the airplane on the final approach to a ground speed of approximately 100 knots. Landing data computations indicate that an approach speed of approximately 94 knots indicated airspeed (KIAS) was required for the landing at Hartsfield Airport with an estimated landing weight of 9,800 pounds.

Grounds scars from the collision indicated that the King Air had moved to the right side of runway 26 at the time of the collision and was near taxiway "D," the primary taxiway for general aviation airplanes. The turnoff for taxiway "D" was about 3,800 feet from the approach end of the runway. The right wing of the B-727 struck the tail cone and structure of the King Air, separating the horizontal and vertical stabilizers from the fuselage and shearing the top of the fuselage/cockpit from the airplane. The King Air was destroyed. It came to rest at the turnoff for taxiway "D" with the engines still running. There was no postimpact fire. Airport Rescue and Fire Fighting (ARFF) personnel shut down the engines and secured the electrical system.

ATC radar and communications data reveal that vectors were issued to three inbound airplanes to establish the landing sequence for runway 26 right immediately before the accident. (See figure 3). The three airplanes were CO 9687, a Continental Airlines DC-9; N44UE, the Beech King Air; and EA 111. A complete description of the air traffic actions is contained in paragraph 1.17.2, Air Traffic Handling.

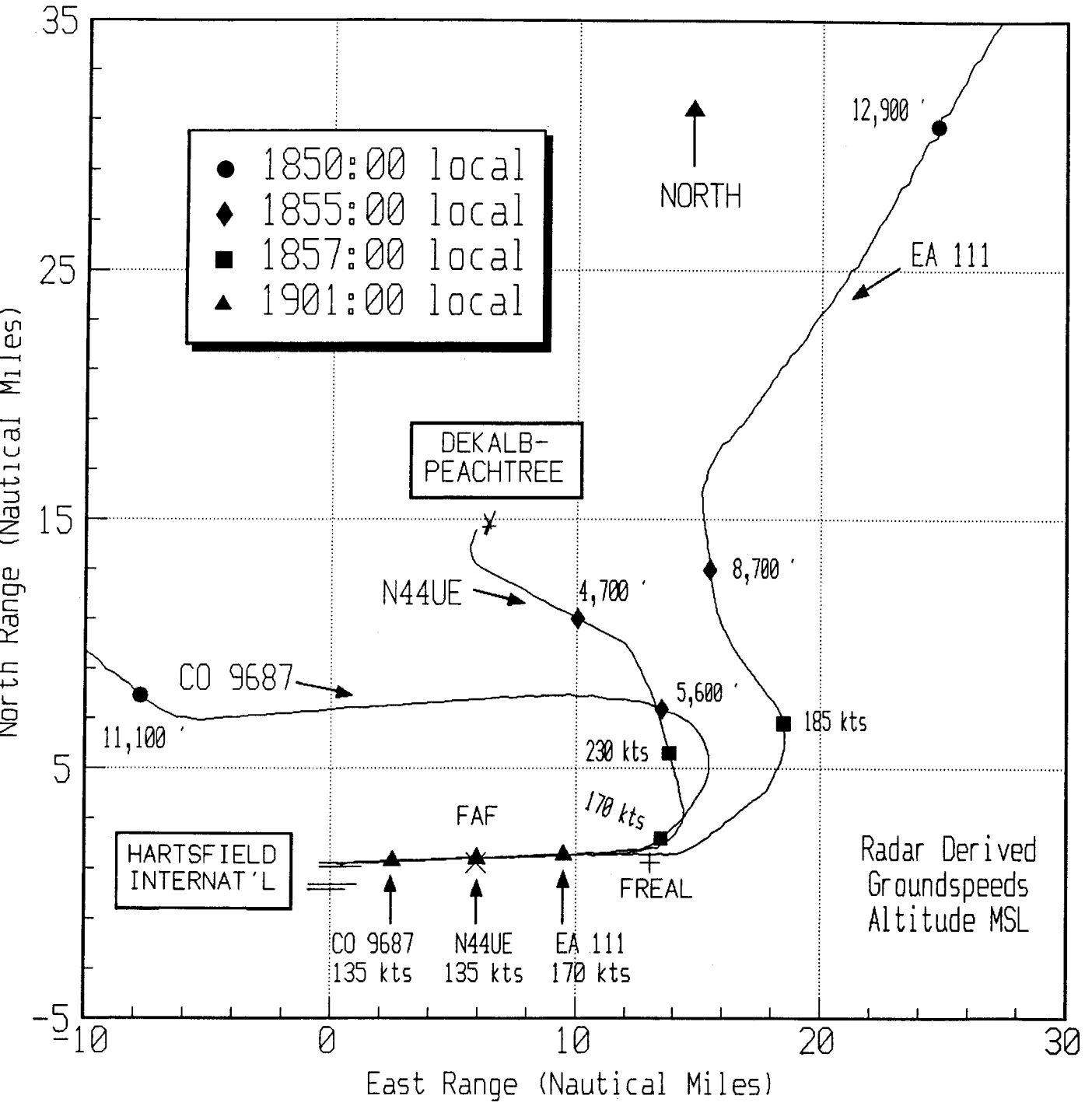

Figure 3.--Data showing landing sequence for runway 26 right.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others	Total
Fatal	1*	0	0	1
Serious	1*	0	0	1
Minor	0	0	0	0
None	8**	149	0	157
Total	10	149	0	159

* On board King Air
** On board B-727

1.3 Damage to Airplane

The King Air A100 was destroyed by impact forces of the collision. The value of the airplane was estimated at $400,000. The B-727 received substantial damage to the right wing in the area of the leading edge slats.

1.4 Other Damage

There was no other damage.

1.5 Personnel Information

1.5.1 Eastern Airlines' Crewmembers

The flightcrew and cabincrew of EA 111 were qualified in accordance with applicable Federal Aviation Administration (FAA) and company regulations and procedures. The examination of crewmember training records did not reveal anything remarkable. Further, the investigation of the background of the flightcrew did not reveal anything unusual.

The EA 111 flight was on the second day of a 3-day trip when the accident occurred. On January 17, 1990, the day before the accident, the flightcrew arrived at LaGuardia Airport at approximately 2335. They were scheduled for and received 16 hours of rest at an airport hotel and returned to LaGuardia for the outbound flight to Atlanta at 1530.

1.5.2 EPPS Air Service Crewmembers

The pilot-in-command was qualified in accordance with applicable FAA and company regulations and procedures. Investigation of his background did not reveal anything remarkable. On the evening of the flight, company personnel observed him accomplishing the flight planning and conducting preflight duties in a normal manner. The copilot, who possessed an FAA airline transport pilot rating, was assigned to the King Air flight for familiarization. His presence was not required for the flight.

1.5.3 Air Traffic Control Specialists

The air traffic controllers who provided ATC services to the accident airplanes were qualified in accordance with current regulations. Examination of their training records did not reveal anything remarkable. In addition, the investigation of these controllers' backgrounds and their activities 2 to 3 days before reporting for duty on January 18 did not reveal anything extraordinary.

The Atlanta tower north local controller was off duty the two preceding days. He indicated that most of this time was spent with day-to-day chores and family routines and patterns. He was assigned the 1600-2400 hour shift on January 18, 1990, the first day of a 5-day workweek. He stated that he was not suffering from any known chronic or acute illnesses or injuries and that there were no recent significant events that may have been a source of stress in his life. He said that he was well rested when he reported to work the day of the accident and that he had received 7 to 8 hours of sleep the preceding night. He arose on the morning of January 18 at 0630, ate breakfast, performed household chores, ate lunch, and departed for work at 1515.

The controller was relieved of duty following the accident. He was subsequently decertified from his position in the Atlanta Hartsfield Tower. He received local training and was recertified on February 22, 1990, about 1 month after the accident.

Investigators did not examine in detail the activities of the remaining ATC personnel.

1.6 Airplane Information

The B-727-225A, N8867E, was certificated for flight on November 30, 1967. Eastern Airlines operated approximately 51 B-727 airplanes. Three Pratt and Whitney JT8D-15 turbofan engines are mounted on the aft portion of the fuselage.

Discrepancies noted in the airplane maintenance logs were either repaired or deferred to MEL/Cabin Discrepancy Listing (CDL). Prior to boarding the airplane, the flightcrew of EA 111 was informed of the MEL discrepancy (anti-skid system test intermittent) via the Instrument Flight Rules Dispatch Release. The dispatch release indicated that the flight could be conducted with an inoperative anti-skid system. There were no other noteworthy MEL discrepancies found in the airplane maintenance log. There were no windshield deficiencies noted upon postaccident inspection.

The Beechcraft King Air A100, N44UE, was certificated for flight on April 23, 1971. The airplane is certificated for single pilot operations. Epps Air Service operated and maintained this airplane, a similar King Air 200, and a variety of other executive fleet aircraft. The King Air A100 is a mid-range, light-twin turboprop airplane, designed to transport a maximum of

nine passengers by commuter, executive, and air taxi operators. It is powered by two Pratt and Whitney PT6A-28 turboprop engines.

During a postaccident interview, the King Air co-pilot indicated that he participated in a preflight inspection of N44UE on the Epps Air Service ramp before departing Dekalb/Peachtree Airport. He did not recall any discrepancies. The airplane maintenance log did not reveal any discrepancies carried forward and none were added prior to the accident flight. The preflight inspection checklist and night/instrument preflight checklist in the FAA-approved flight manual require a check of all external lighting on the airplane prior to flight. The checklist was found in the airplane after the accident.

At approximately 1825, a flight line maintenance technician assisted the pilot with a ground power unit during engine start. The maintenance technician stated later that as the King Air taxied out of the ramp area, he noticed that the rear bulb in the upper flashing anticollision beacon, located at the top of the vertical stabilizer, was inoperative. He also observed on takeoff that the aft strobe light located on the tail cone was inoperative. He stated that as the airplane departed the airport, the remaining navigation position, anticollision, and strobe lights appeared to be functioning. After the accident, the Safety Board was informed that the "Beacon" switch that controls the red anticollision lighting on the vertical tail and the lower fuselage was discovered to be inoperative by a ground technician on the afternoon preceding the accident flight. Epps Air Service maintenance management personnel deferred repair until a later hangar visit. No logbook entry was made.

The refueling technician, who was to park and service the King Air on the general aviation ramp at Hartsfield Airport, observed the airplane landing and taxiing on runway 26 right. However, he did not witness the collision between the airplanes because he had turned to retrieve direction signal lights with which to park the King Air. He stated that the strobe lights and the red anticollision lights were not operating when the King Air landed and that the navigation and landing lights were the only lights he observed on the airplane. 14 CFR 91.33 and 91.73, require an approved aviation red or aviation white anticollision light system on the airplane if it is operated between sunset and sunrise or under instrument flight rules.

The latter regulation further states:

> However, the anticollision lights need not be lighted when the pilot in command determines that, because of operating conditions, it would be in the interest of safety to turn the lights off.

1.7 Meteorological Information

Hartsfield Airport arrival Automated Terminal Information Service (ATIS) during the period prior to the accident stated:

> This is the Atlanta airport arrival information Mike. All aircraft shall readback all runway holding instructions including aircraft identification. The Atlanta 2250 Zulu weather, five hundred scattered, three thousand five hundred scattered, estimated ceiling one zero thousand overcast, visibility 3 miles, fog, temperature six two, dewpoint six zero, wind two two zero at three, altimeter three zero two zero. Simultaneous ILS approaches in use runways 26R and 27L. Advise on initial contact you have information Mike.

On January 18, 1990, Atlanta official sunset was at 1755, and the end of twilight was at 1822. The National Weather Service observation at Hartsfield Airport at 1916 was reported as 400 scattered, 3,500 scattered, estimated ceiling of 10,000, visibility 5 miles, fog, temperature 61°, dew point 60°, wind 290/03 knots.

The flightcrew of EA 111 stated that the lower cloud deck was very scattered and that they could see the runway from a distance. The CVR indicated that the flightcrew saw the runway a few seconds after passing the initial approach fix, which is 12 nmi from the end of the runway. However, the flightcrew also stated in their interview that, although the runway lights were clearly visible, they did detect a hazy glow around the airport. The CVR also supports this statement. One of the crewmembers said that the lights looked fuzzy but that he did not think there was any associated fog. After the airplane passed the final approach fix, another flight crewmember commented, "well it is a little scuddy down there."

1.8 Aids to Navigation

There were no navigational equipment outages or discrepancies noted in the Atlanta facilities log that would have contributed to this accident.

1.9 Communications

The Atlanta north local controller reported communications difficulties with CO 9687, the DC-9 that immediately preceded the two accident airplanes. The DC-9 was located on taxiway B, the taxiway located between the two active north complex runways, 26 left and 26 right. Access to this taxiway is controlled by the north local controller rather than by the ground controller. Transcripts of the relevant communications from 1902:38 to 1905:05 on tower frequency 119.5 indicated several transmissions by both the north local controller and the flightcrew of CO 9687. The controller issued taxi instructions for CO 9687 to stay on Bravo taxiway and proceed to the end of (runway) 26 left. The flightcrew of CO 9687 replied, however, after two controller queries, by transmitting its position as "Bravo two, holding short." The controller then repeated "nine six eight seven continue straight ahead to the end and hold short of 26 left." A series of transmissions then took place that were unintelligible. The last of these exchanges was made by the controller at 1904:21. The EA 111 CVR placed the collision at 1904:37.

The multichannel recorders, transmitters, and receivers for frequencies 121.9 and 119.5 were certified by maintenance technicians a short time after the accident occurred. A review of the FAA "Daily Record of Facility Operation" does not indicate any equipment outages/discrepancies that would have contributed to this accident.

The airplane logbook for CO 9687 was reviewed for both preaccident and postaccident discrepancies related to communications radios. There were no entries for the time that the accident took place. The flightcrew of CO 9687 reported that they experienced no discrepancies with their radios preceding the accident.

1.10 Aerodrome Information

Hartsfield Airport is owned and operated by the City of Atlanta as a public use airport. It is approximately 8 miles south of the city. The airport elevation is 1,026 feet, and it is currently served by four parallel runways: Runway 8 left/right, 9 left/right, 26 left/right and 27 left/right. On January 18, 1990, runway 26 right was the intended landing runway for both EA 111 and King Air N44UE. It is concrete, 9,000 feet long, 150 feet wide, and has a medium-intensity approach lighting system, runway alignment indicator lights, high-intensity runway lights, centerline lights, and touchdown zone lights.

Scheduled air carrier operators normally exit runway 26 right to the left after landing. Two high speed taxiways (B3 and B5) and four other taxiways (B1, C, D, and H) are available to them for taxi to the scheduled airline terminal area. (See figure 2). Air taxi and general aviation airplanes proceeding to the fixed base operator (FBO) normally exit runway 26 right to the right after landing and use one of four taxiways available to them (D, C, A4, and A). Taxiway D is primarily used when landing to the west because it is the closest taxiway entrance to the FBO apron for passenger pickup, parking, or servicing. It is located approximately 3,800 feet down the runway and requires a 90^{0} turn off the runway.

The Atlanta ATC tower is a combined tower and Terminal Radar Control (TRACON) facility operating 24 hours a day. The tower is located in the middle of the aerodrome and is responsible for operations on Hartsfield Airport. The TRACON handles instrument flight rules (IFR) and visual flight rules (VFR) traffic within a 40-mile radius of the Atlanta metropolitan area, which has 19 satellite airports.

At the time of the accident, the facility had an on board strength of 68 full performance level controllers, and 14 developmental controllers. The facility is authorized 90 controllers.

The facility uses an ASR-7 and ASR-8 radar system augmented by Automated Radar Terminal Systems (ARTS) IIIA computer processing which provides airplane target information. An Airport Surface Detection Equipment (ASDE-1) radar monitors airplane activity on the ground during inclement

weather. On the night of the accident, the ASDE system was not in use, and there was no policy requiring its use.

The tower cab has 10 positions of operation that may be combined or separated as traffic conditions permit. On the evening of January 18, 1990, there was a cab coordinator (CC), and clearance delivery person (CD) plus a local controller[1] (LC3), and ground controller (GC2) responsible for operations on the north side of the airport. The south side of the airport was conducting separate operations utilizing an additional local controller and ground controller. In the TRACON, four controllers provided radar services to either N44UE or EA 111.

1.11 Flight Recorders

The Beechcraft King Air A100 was not equipped with a CVR or FDR nor was it required to be so equipped under current Federal Aviation Regulations. After October 11, 1991, many aircraft similar to the Beechcraft King Air A100 will be required to have operational cockpit voice recorders installed for flight when operating under Part 135 air taxi rules. New rules will not require aircraft with passenger carrying capacities of less than 10 to be equipped with flight data recorders.

The B-727 was equipped with a Fairchild A-100 CVR, S/N 655, which was removed after the accident and delivered to the National Transportation Safety Board's Engineering Services Laboratory in Washington, D.C. Its magnetic tape provided a record of air traffic control and intracockpit communications. (See appendix C).

The B-727 was also equipped with a Sunstrand FDR, S/N 6681. The unit's tape was read out at the National Transportation Safety Board's Engineering Services Laboratory in Washington, D.C. A printout of selected parameters, including the final approach heading, altitude and airspeed, are provided in appendix D.

1.12 Wreckage and Impact Information

The King Air was struck on the aft fuselage just below the horizontal stabilizer by the right wing of the B-727. The empennage and left wing of the King Air were severed and the nose gear collapsed. The cabin roof was severed from the point of impact forward to the frame of the cockpit windshield. There was no fire. Scars from propeller rotation on the surface of the runway were perpendicular to the runway centerline.

The B-727 received damage to the leading edge devices, flaps, upper surfaces, lower surfaces, and forward spar surface of the outboard portion of the right wing. The damage area included several prop slashes, surface scratches, and blue and white paint smears similar to the color scheme of N44UE. Scratches and smears were parallel to the longitudinal axis of the airplane.

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[1]The position is described in this report as the north local controller.

The surface of runway 26 left contained fresh tire tracks showing that the airplane swerved about 10^{0} left of the 260^{0} heading about 2,200 feet from the end of the landing area. The three imprints matched the dimensions of a B-727 landing gear. The tracks were about 800 feet long.

1.13 Medical and Pathological Information

The flightcrew of EA 111 submitted to toxicological tests in accordance with the FAA's drug testing regulations and company policy. No drugs were detected in any of the flightcrew's specimens.

The pilot-in-command of N44UE died of severe craniocerebral injuries. Blood, urine, and tissue specimens were sent to the Center for Human Toxicology (CHT) for toxicological analysis. The blood specimen was negative for drugs of abuse but showed a blood alcohol concentration of 0.02 percent. However, no alcohol was found in the urine. According to CHT, because of the low concentration of ethanol in the blood and the absence of it in the urine, the blood ethanol most likely resulted from microbial (postmortem) generation rather than ingestion.

The copilot of the King Air voluntarily released to the Safety Board a sample of blood that was taken upon his admittance to the hospital. Analysis at CHT indicated that no alcohol or drugs were detected in the sample.

The ATC north local controller submitted to toxicological testing immediately upon the recommendations of union representatives. Blood and urine specimens were drawn at 2230 (approximately 3.5 hours after the accident) and sent to an independent laboratory for analysis. No drugs or alcohol were found in these specimens.

According to the Department of Transportation's (DOT's) Drug Testing Guide, the controller facility Regional Division Manager had the responsibility to determine who was to be sampled for toxicological testing within 8 hours of the accident. Accordingly, the Regional Division Manager determined that the north local controller was the only individual to be subjected to postaccident toxicological testing. The controller provided a urine specimen on January 19, 1990, at 1200. At the time of the accident, federal statutes prevented the Safety Board from obtaining the results of this toxicological testing. Consequently, the results of these tests were not provided to the Safety Board. Since the accident, the Safety Board has received congressional authority to obtain drug positive results on federal employees in safety sensitive positions who are tested under DOT's postaccident testing provisions.

Other air traffic personnel were not requested by FAA management to submit to toxicological tests.

1.14 Fire

There was no fire involving either airplane.

The Atlanta Fire Bureau, Airport Fire Division, provides crash, fire, and rescue response to the Hartsfield Airport. Prior to the accident, at approximately 1855, ARFF equipment was dispatched to runway 26 left to respond to an Eastern B-727 (Eastern flight 56) with reported total hydraulic failure. The airplane had declared an in-flight emergency and was diverting to Hartsfield Airport with an expected arrival time of 1910. ARFF units were awaiting the airplane's landing when ARFF personnel near runway 26 right heard a collision at approximately 1904 and observed the wreckage of a light twin airplane on the runway. This information was immediately radioed to the Battalion Chief, and an alarm was sounded at 1905 directing ARFF units to respond to the accident site. The first ARFF unit arrived at the accident site about 1906. After ARFF personnel determined that two airplanes had collided on the runway, additional ARFF units were directed to assist the damaged B-727 that had taxied off the runway and stopped on taxiway B3. Although some ARFF personnel were within 100 yards of the accident site, none of them witnessed the actual collision.

1.15 Survival Aspects

The left pilot's seat of the King Air was crushed by impact forces that were not survivable. The area surrounding the right front seat of the airplane remained largely intact. The B-727 cockpit and cabin were not damaged, and no occupants of the airplane were injured. There was no emergency evacuation from the airplane.

1.16 Tests and Research

1.16.1 Runway 26 Right Night Visual Environment

On January 21, 1990, about 1900, Safety Board investigators, assisted by the Atlanta Airport Authority and ARFF representatives, attempted to determine night visibility conditions from the tower cab and the position of the ARFF vehicles on the night of the accident. This determination took place at approximately the same time as the accident, but the existing weather conditions were better than the prevailing conditions on the night of the accident. The 1800 local weather was reported as: two five thousand thin broken, visibility twenty five, wind two eight zero at 10 knots, and altimeter, three zero one. ARFF and security vehicles were positioned in about the same locations using the same type of emergency vehicle lights that were present on the night of the accident.

Although there was a considerable amount of light on the ramp area north of runway 26 right, the elevation of the tower cab permitted the controllers to look down onto the airport area, a situation that allowed them to avoid having to look into a "glare" of ramp lights. The position of the ARFF vehicles was north of taxiway D. However, from the tower, a considerable number of flashing amber, red, and blue lights and blue strobe lights from security vehicles were visible. At the time of these observations, two airplanes arrived on runway 26 right and turned off the runway to the north ramp area. The first arrival was a Beechcraft Bonanza, which had a landing light, position lights and an anticollision light illuminated. The airplane was easily visible while it was airborne and

during rollout on the runway. When the airplane turned north off the runway at taxiway D (turning away from the tower cab), it was difficult to detect the airplane's low-intensity lights against the brighter lights of the ARFF vehicles. However, because taxiway D has centerline lights that extend to the edge of 26 right on the south side of the runway, the lights provided a reference point from which to initiate runway scanning.

The second arrival was a Beechcraft King Air, which had two landing lights, position lights, strobes, and anticollision lights illuminated. This airplane was also easily visible while it was airborne, during rollout, and while it was clearing runway 26 right on the north side. As the airplane entered taxiway D on the north side, the pilot turned on taxi lights that illuminated the airplane further, making it readily discernable. All air carrier airplanes that landed on runway 26 right cleared the runway on the south side and were readily visible from the tower cab because of their high-intensity anticollision strobe lights.

1.16.2 Recorded Radar Data

Recorded radar data from the Atlanta TRACON was reviewed by the Safety Board. These data were used to produce tracks that show the relative positions of CO 9687, N44UE, and EA 111 as they proceeded inbound to the airport on final approach. Radar information showed that spacing between CO 9687 and N44UE was about 3.2 miles as CO 9687 passed the FREAL intersection, the initial approach fix. Thereafter, the spacing ranged from 3.0 to 3.5 miles as the airplanes continued toward the final approach fix. Radar information indicated that EA 111 was trailing N44UE by about 4.0 miles as EA 111 passed FREAL intersection. This spacing continued to decrease to about 2.75 miles as the north local controller issued EA 111 clearance to land as follows: "EA 111 you are in sight, cleared to land 26 right." The spacing between the two airplanes decreased steadily until the last radar data about 1 mile prior to the collision point indicated 1.2 miles between the two airplanes. (See appendix E.)

1.16.3 Lighting Components, King Air N44UE

The belly anticollision light installed on N44UE was not the light model specified in the Beechcraft general assembly drawing for the King Air A100. In addition, the inside of the lens had been sprayed with red paint which muted the light intensity.

Selected lighting components were retrieved from the wreckage of N44UE and returned to the Safety Board's Materials Laboratory for investigation. Results indicated that the filaments of the bulbs removed from the navigation position and logo light systems were stretched.[2] Brittle fractures were apparent from fragments of filaments from the red anticollision light atop the vertical stabilizer.

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[2] Filament stretch is indicative of impact on an illuminated bulb. Brittle fracture of filaments is generally associated with bulbs that are not illuminated at the time of impact.

1.17 Additional Information

1.17.1 Air Traffic Control Handbook Excerpts

Controller duties and responsibilities in effect at the time of the accident are contained in the FAA Air Traffic Control Handbook, 7110.65F Chapter 3, Airport Traffic Control, Section 10, Arrival Procedures and Separation. The applicable portions of the instructions appear below:

> 3-122 Same Runway Separation
>
> a. Separate an arriving aircraft from another aircraft using the same runway by ensuring that the arriving aircraft does not cross the landing threshold until one of the following conditions exists or unless authorized in paragraph 3-131:
>
> (1) The other aircraft has landed and taxied off the runway.
>
> 3-127 Anticipating Separation
>
> Landing clearance to a succeeding aircraft in a landing sequence need not be withheld if you observe the positions of the aircraft and determine that prescribed runway separation will exist when the aircraft cross the landing threshold. Issue traffic information to the succeeding aircraft.
>
> Example.--
>
> Delta forty two cleared to land. Traffic is Eastern DC-9 over approach lights.

The Air Traffic Control Handbook, 7110.65F, states radar separation criteria that must be established between successive arrivals for landing at an airport. The basic separation criteria are set forth in Chapter 5, "Radar Separation," paragraph 5-72, "Minima," which states that basic radar separation in the terminal environment is either 3 or 5 miles between airplanes, depending on their distances from the antenna. However, this separation standard is increased to compensate for wake turbulence under certain conditions. That portion of the separation standard is as follows:

> ...separate an aircraft landing behind another aircraft on the same runway, or one making a touch-and-go, stop-and-go, or low approach by ensuring the following minima will exist at the time the preceding aircraft is over the landing threshold:

(1) Small behind large - 4 miles

(2) Small behind heavy - 6 miles

In addition, this paragraph of the handbook also contains language that is applicable to the Atlanta ATC facility. It allows for a reduction in separation to 2.5 nmi inside the final approach fix when:

(1) Facilities desiring implementation of this procedure have documented an operational need through the regional air traffic division to FAA Headquarters, ATO-300;

(2) The leading aircraft's weight class is the same or less than the trailing aircraft;

(3) Heavy aircraft and the Boeing 757 are permitted to participate in the separation reduction as the trailing aircraft only;

(4) A runway occupancy time of 50 seconds or less is documented;

(5) BRITE/TCDD[3] displays are operational and used for quick glance references;

(6) Turnoff points are visible from the control tower; and

(7) Runways are clear and dry.

Based on radar criteria, the required separation between CO 9687 and N44UE was 3 miles, increasing to 4 miles at the time CO 9687 was over the landing threshold. The required separation between EA 111 and N44UE was 3 miles until the outer marker and then the separation could be decreased to 2.5 miles inside the final approach fix. Actual separation at various intervals can be seen in the Radar Data Study, Appendix E.

1.17.2 Air Traffic Handling

The following is a chronology of communications and air traffic activity related to the three airplanes, CO 9687, N44UE and EA 111, placed in landing sequence related to the collision. At 1855:26, the flightcrew of N44UE established initial contact with the final controller. They were instructed to "fly heading one seven zero." The flightcrew acknowledged the clearance. At 1855:35, the final controller instructed the flightcrew of CO 9687 "turn right heading two one zero." At 1855:40, the final controller instructed the flightcrew of N44UE to "make that heading one six zero, fly heading one six zero." The instruction was acknowledged. At 1855:51, the final controller instructed the flightcrew of EA 111 to "turn left heading

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[3]Bright Radar Indicator Tower Equipment/Tower Cam Digital Display.

one five zero." At 1856:20, the controller directed N44UE to ..."turn right heading one seven zero."

At 1856:36, the final controller instructed the flightcrew of CO 9687, "fly heading two four zero heading to intercept the localizer maintain five thousand." At 1856:44, the final controller instructed the flightcrew of EA 111 to "turn right heading one nine zero." At 1857:12, another vector was issued to a heading of two one zero. At 1857:18, the final controller advised the flightcrew of N44UE "reduce to a hundred and eighty knots if you're above that." The flightcrew acknowledged this transmission. At 1857:29, the final controller advised the flightcrew of CO 9687 "you're passing FREAL cleared for the ILS two six right, tower one niner point five now." At 1857:36, the final controller instructed N44UE, "turn right heading two three zero." The crew responded, "four UE." At 1857:47, the final controller instructed the flightcrew of EA 111 "turn right heading two four zero." The flightcrew acknowledged this transmission.

At 1858:02, the final controller transmitted "November four Uniform Echo turn right heading two seven zero you're a mile from FREAL, maintain five or above till FREAL, a hundred eighty knots to the marker, cleared ILS two six right." At 1858:07, the flightcrew acknowledged the clearance. At 1858:17, the final controller instructed EA 111 to descend and maintain five thousand feet. At 1858:32, the final controller transmitted, "Eastern one eleven maintain five thousand you're four from FREAL, maintain five or above till FREAL, a hundred and eighty knots to the marker, cleared ILS runway two six right." The flightcrew acknowledged the approach clearance. The final controller again issued the approach clearance to the flightcrew one minute later, at 1859:32 and advised the flightcrew that they were "2 mile" from FREAL.

Simultaneous ILS approaches were underway on runways 26 right and 27 left. After receiving their approach clearances, airplanes inbound to the airport on the localizer were observed on radar by a "monitor" position in the TRACON. The Air Traffic Control Handbook outlines the function of the monitor as follows:

> to ensure separation between aircraft and to ensure aircraft do not enter the no transgression zone, (between the runways).

The monitor controller can override the tower controller and issue instructions to inbound flights.

In addition to landings on runway 26 right, takeoffs were underway on runway 26 left. Access to runway 26 left and clearance for takeoff from 26 left were controlled by the north local controller.

Tower transcriptions indicate the flightcrew of N44UE established initial contact with the local controller at 1858:23 advising, "tower King Air four uniform echo is with you inbound approach." The local controller responded, "King Air four four uniform echo Atlanta tower Roger." At 1858:29, the monitor controller, using the local controller's frequency,

asked the flightcrew of N44UE to state their airspeed. After two additional queries, at 1858:44, the flightcrew responded, "one seven five."

At 1859:13, the monitor controller instructed the flightcrew of N44UE "reduce speed to one six zero." The flightcrew acknowledged the instructions. At 1859:55, the flightcrew of EA 111 established initial contact with the local controller advising, "tower eastern one eleven is with you inbound." The local controller acknowledged their call. At 1900:16, the monitor controller instructed the flightcrew of N44UE to "reduce speed to one five zero." At 1900:50, the monitor controller advised the flightcrew of N44UE to "reduce speed to one four zero." Both of these clearances were acknowledged.

At 1901:08, the local controller cleared CO 9687 to land on runway 26 right. At 1901:15, the local controller cleared N44UE to land on runway 26 right. At 1901:50, the monitor controller instructed the flightcrew of EA 111 "reduce to your final approach speed." This transmission and a previous one were not acknowledged. Regarding departures at 1901:47, the local controller cleared Atlantic Southeast (ASE) 301 into position on runway 26 left to hold for takeoff clearance.

At 1901:57, the local controller transmitted "Eastern one eleven you are in sight from the tower cleared to land two six right." At 1902:04, the flightcrew of EA 111 acknowledged the landing clearance. The local controller stated that his transmission to EA 111 that the flight was in sight of the tower indicated that he was responsible for separation between the two airplanes. In accordance with ATC Handbook 7110.65F, paragraph 3-127, "landing clearance to a succeeding airplane in a landing sequence need not be withheld if the controller can observe the position of the airplane and determine that prescribed runway separation will exist when the airplane crosses the landing threshold." The regulation requires the controller to issue traffic information to the succeeding airplane. No traffic advisories were issued to EA 111. Radar data indicate that the distance between the airplanes decreased during their final approaches (see paragraph 1.16.2) and that 1.2 miles separated them while still airborne about 1 minute before the collision.

At 1902:38, the local controller transmitted, "Continental ninety six eighty seven, half right, stay on bravo, hold short of two six left at the end." There was no response. At 1902:49, the local controller again attempted to call the flightcrew of CO 9687 without success. At 1903:03, the flightcrew of CO 9687 transmitted, "tower Continental ninety six eighty seven bravo two holding short." The local controller responded, "ninety six eighty seven continue straight ahead to the end and hold short of two six left." This transmission was repeated at 1903:13. There were five more attempts made to establish communications with the flightcrew of CO 9687 without success. The last attempt was at 1904:22. Interspersed with these efforts, at 1904:18 the local controller cleared ASE 301 for takeoff on runway 26 left.

At 1904:48, the flightcrew of EA 111 advised the local controller "tower Eastern one eleven we just hit an aircraft on the runway." The local

controller responded, "say again." The flightcrew of EA 111 again stated, "there was an aircraft on the runway two six right." At 1905:05, the flightcrew of CO 9687 transmitted, "tower Continental ninety six eighty seven." The local controller responded, "Continental ninety eighty seven hold short of two six left, right there." At 1905:14, the flightcrew of EA 111 transmitted, "tower Eastern one eleven you better keep the traffic off six right, there's an airplane there." The local controller then advised a flight that he had previously cleared to land on runway 26 right to go around.

1.17.3 Air Traffic Interviews

1.17.3.1 North Final Controller

During a postaccident interview, the north final controller recalled the call signs of CO 9687, N44UE, and EA 111. He remembered the arrival sequence and stated that he was busy and that it was a complex working environment. He was aware that simultaneous ILS approaches were in use and that the monitor position was staffed. The final controller stated that he was directing airplanes onto the final approach course for runway 26 right, outside FREAL, at an altitude of 5,000 feet or above. The initial approach fix is approximately 12 miles east of runway 26 right, and he was "running" a 20-mile final on the night of the accident. He also stated that the ARTS position symbol for the north final position is a "V." He said that he was not aware of any airplanes that were sequenced by the south final controller to the north complex (runway 26 right) prior to the accident. As a matter of procedure, pilots would be instructed to contact the north local controller on frequency 119.5 at or prior to reaching the final approach fix for runway 26 right.

The final controller did not recall issuing any speed restrictions to the flightcrews of CO 9687 or EA 111, but he did state that he had instructed the crew of N44UE to maintain 180 knots until the outer marker. He said that the required radar separation between successive arrivals on final approach was 3 miles and that the standard would not change regardless of the types of airplanes involved. As a final controller, he stated that his responsibilities for separation would terminate after the airplane was established on the final approach course and the pilot had been advised to change to the tower frequency. He also said that after a flight was established on the final approach course, it would be advised to change to the tower frequency as early as 2, 3, or 4 miles before reaching the final approach fix and in no case later than the final approach fix. If this frequency change did not occur, the monitor or local controller would advise him to call that flight again. It was his recollection that the required separation standard between the 3 airplanes, CO 9687, N44UE, and EA 111 had been met.

The final controller could neither recall the ground speed of EA 111 nor the ground speed of N44UE, which he did not observe. However, he was aware that EA 111 was overtaking N44UE, but he did not believe that EA 111 was faster than any other jets he had observed that evening on final approach. When asked if he had issued traffic information to the flightcrew

of EA 111 to advise them of who they were following, he stated that he had not. He also said that he was issuing 180-knot approach speeds to all airplanes, action that was standard procedure and that if this speed restriction was not working, the monitor position would so advise him. When asked if he had experienced communications problems with the flightcrew of CO 9687, he stated that he had not.

1.17.3.2 Monitor Controller

The monitor controller stated that his first observation of CO 9687 was when the flight first reported on the frequency about 13 miles from the airport on final approach. He determined that the flight was on the local control frequency because he had the capability to monitor and override the local controller (frequency 119.5). He monitored the progress of all three airplanes as they proceeded inbound to the airport. He stated that his duties and responsibilities are to make sure an airplane remains on the localizer and does not enter the nontransgression area. If an airplane is observed straying from the localizer, he is authorized to take appropriate action. He can take such action by overriding the local controller and issuing appropriate vectors or clearances to the flightcrews. He stated it is also his responsibility to maintain appropriate spacing between successive arrivals through the use of speed control. He said that the separation standard is determined by the type of airplane involved. In the case of CO 9687 and N44UE, 4 miles of in-trail spacing were required; and in the case of N44UE and EA 111, 3 miles were required. The separation of 3 miles could decrease to 2 1/2 miles inside the outer marker. It was his opinion that the separation standard had been met.

The monitor controller stated that he did issue speed restrictions to N44UE. He initially asked the flightcrew what their airspeed was and learned that it was 175 knots. As a result, he issued speed reductions of 160, 150, and 140 knots to maintain proper separation between CO 9687 and N44UE. He was aware that EA 111 had made initial contact with the north local controller when the airplane was 13 miles east of the airport inbound to land on runway 26 right. He instructed the flightcrew of EA 111 to reduce to approach speed when he believed it was required. It was his belief that the final approach speed for a B-727, based on his experience, would be between 120 to 140 knots indicated. He stated that although the flightcrew did not acknowledge the transmission, he believed that EA 111 did start slowing down based on its proximity to the airport and that the airplane would have to slow down to land. In his opinion, it was not relevant that the flightcrew of EA 111 did not acknowledge the speed reduction since the local north controller assumed control of the flight about the same time.

The monitor controller stated that under normal circumstances he would discontinue monitoring the airplane when it was 1 mile from the end of the runway. He observed nothing out of the ordinary among the three airplanes on final approach. He stopped monitoring EA 111 because the local controller had advised that he had the flight in sight, meaning that the tower was providing separation by visual reference. He also stated that the speed reduction issued to EA 111 was not relevant after the local controller had advised EA 111 that the airplane was in sight and the controller had

issued a landing clearance. He said that it would be normal to give traffic information to both EA 111 and N44UE when the preceding airplane is still airborne. He considered the use of visual separation to mean that the separation standard could then be reduced further. He considered that the decision to provide visual separation was that of the local controller and that it would be the local controller's responsibility to make sure that before EA 111 crossed the runway threshold, the preceding airplane would be clear of the runway. He stated that he became aware of the accident after he heard EA 111 state that it had hit an airplane on the runway. He called the local north control position for more information. It was his opinion that the approach of EA 111 was normal, and he observed nothing unusual.

1.17.3.3 Tower Supervisor

The tower supervisor stated that up until about 4 minutes prior to the accident, he had been working the local north control position and was relieved by the controller on duty at the time of the accident. The supervisor had been working the local north control position so he could maintain currency in the tower. After being relieved, he assumed the duties of the cab coordinator to manage the overall operation of the tower cab because he had been informed that an airplane (EA 56) was inbound to the airport with an emergency. He said that he wanted to make sure that airport ARFF vehicles were in position. He also called Eastern Airlines' ramp personnel to make sure that a tug would be ready to bring the airplane to the ramp and to make preparations for the emergency. He stated that his duties and responsibilities are to observe the traffic flow and to coordinate with other positions in the tower cab or TRACON.

He recalled observing N44UE on the BRITE when the airplane was about 5 to 15 minutes away from the airport, but he could not recall the position of the airplane. He also did not recall observing either CO 9687 or EA 111. He stated that while he was at the local control position, he had received a radio call from the flightcrew of N44UE, but he could not recall any communications with the flightcrew of CO 9687. He said that when he was relieved of the north local control position, he provided a position relief briefing but could not remember the specifics. He stated that a checklist for the position relief briefing is located in the front of each operating position and that he had provided a "normal" briefing to the controller that relieved him. He said that if CO 9687 had been on the frequency, he would have briefed the relieving controller about that airplane. He also stated that at the time he was relieved it was dark outside the tower cab and that he had a full and clear view of the runway. There was no fog, obstructions to vision, or other obscuring phenomena that would have precluded observing the full length of the runway.

The supervisor stated that on the final approach the visibility would increase or decrease as "fog banks" passed east of the field. This condition determined how far out he could observe airplanes on the final approach. He did recall that airplanes were using their landing lights on final approach and that lights on the airport had been turned on. While he was at the north local control position, the facility was accommodating simultaneous ILS approaches. He stated that there had been no

precoordination with the monitor controller and that it was his understanding that the monitor position maintained control of the airplane until 1 mile from the runway. He also said that the required separation standard between CO 9687 and N44UE would be 4 miles until 1 mile from the end of the runway. He stated that to clear a succeeding airplane to land, if the preceding airplane had not crossed the landing threshold, traffic information must be issued to the succeeding airplane. He was aware that the next responsibility of the local controller is to make sure that the preceding airplane is clear of the runway before the succeeding airplane crosses the landing threshold. This determination is made visually by observing the airplane leave the runway. If visual observation cannot be made because of weather, ASDE is used. If the ASDE could not be used, the controller would revert to pilot reports of being clear of the runway.

The tower supervisor stated that prior to the accident, the traffic was of moderate intensity but that the situation was "simple." He said that he was familiar with the call sign of N44UE and that this airplane would normally park on the north side of the airport. When asked about the application of visual separation between successive arrivals, he stated that the local controller can initiate visual separation outside the 1 mile point where the monitor position has control; however, coordination, in addition to the transmission of the fact that the local controller has the airplane in sight, must take place. When asked about his interpretation of a transmission made by the local controller at 1901:57, "EA 111 I have you in sight from the tower," he stated that this transmission indicated "the local controller saw the airplane out of the window and that's all."

He stated that at the time of the accident, he had worked with and supervised the controller assigned to the north local position. He became aware of the accident when he was informed that EA 111 had reported that an airplane was on the runway. The two controllers had speculated that it had to be N44UE because they were aware that this airplane had landed before EA 111. This fact was later confirmed by the ARFF vehicles that responded. He was aware that the local controller was having difficulty communicating with the flightcrew of CO 9687. It was not discussed whether N44UE was on the local control frequency, but he had previously observed N44UE on the BRITE and knew that the airplane was inbound to the airport.

The tower supervisor said that he had reviewed the local controller's writing pad after the accident. He stated that arrivals are shown on the left side of the pad and departures on the right. When an airplane is cleared to land or has received a landing clearance, a checkmark is made by the runway number and a horizontal line is drawn through the call sign. He stated that the procedures for setting up the pad are contained in the facility operational performance standards manual. The call signs of successive arrivals are determined from information displayed on the BRITE. When asked if he had observed the call sign of N44UE on the local controller's pad, he stated that he had and that the call sign had a check mark by it with a horizontal line through it. When asked if there were any annotations for EA 111 or CO 9687, he stated that he could not recall. Immediately after learning that an accident had occurred, he directed the

north ground controller to dispatch ARFF vehicles to the airplane. He then had the north local controller relieved of his duties.

1.17.3.4 North Local Controller

An interview with the north local controller confirmed that he had been at his position about 4 minutes when the accident occurred. Prior to working north local control, he had been at the cab coordinator (CC) position for about 2 hours. When the north local controller was at the CC position, he was notified by the TRACON that an airplane was inbound to the airport with an emergency. He perceived the emergency as serious. He wrote down the details of the emergency and then initiated the ARFF response, relaying to personnel all the information he had been given. He then observed the ARFF vehicles responding to his call. While he was at the CC position, he notified the ground controller of what was occurring. These events occurred about 5 minutes before he was relieved of the CC position.

He then went to the north local control position to relieve the supervisor. He stated that the position relief briefing was initiated but since he was aware of everything that was going on, he was briefed only on the traffic. He described the traffic as moderate increasing to heavy and that it was the beginning of a departure and arrival "push." When asked if it was a complex working environment, he stated, "yes." He stated that all departures were taking off from runway 26 left and all arrivals were being sequenced to runway 26 right. It was dark outside, but he could visually observe the airplanes on the final approach inbound to the airport. He estimated that he could observe airplanes 4 to 5 miles on final and that the arrivals were using landing lights. He could see the airplanes from his first point of observation on the final all the way to the runway and could see both ends of the runways clearly. He could determine visually when airplanes were clear of runway 26 right.

The north local controller stated that he observed CO 9687 through the tower window, but he could not recall how far out the airplane was. He cleared the airplane to land. He then observed N44UE on the BRITE radar, behind CO 9687. He could neither recall how far out N44UE was when he first observed it, nor could he recall how far it was behind CO 9687. He did observe lights on N44UE, which were of a lower intensity than EA 111. He could not recall if the anticollision or position lights were illuminated. His first observation of EA 111 was on the BRITE, and about 3 miles behind N44UE. He could not recall how far out the airplane was on final. His first visual observation from the tower window was when the airplane was about 4 to 5 miles out on final. He observed landing lights, but he could not recall if strobes or the anticollision lights were illuminated.

He observed CO 9687 land on runway 26 right and leave the runway at taxiway B5. He then instructed the flightcrew to hold short of runway 26 left. He observed the airplane holding short of B2 on the Bravo taxiway, facing west. The airplane did not move from this position. He was unable to determine why he could not communicate with the flightcrew but initially thought the communications difficulties were occurring at his operating position. He explained that all airplanes are required to

acknowledge with their call sign all instructions to hold short of a runway. During this period, a relief controller was about to plug his headset into the position to relieve him.

The north local controller observed N44UE over the threshold for runway 26 right, in landing flare. He then advised the flightcrew of EA 111 that their airplane was in sight and cleared to land. He stated that this meant he was applying visual separation between EA 111 and N44UE. He could not recall how far out on final EA 111 was, but he did recall that N44UE was still airborne. He stated that his next responsibility was to have runway separation between the two airplanes--the first airplane must be clear of the runway before the succeeding airplane could cross the threshold.

He stated that he uses a pad when working the local control position, putting the arrivals on the left side of the pad and the departures on the right side. He explained that a checkmark indicates issuance of the landing clearance; the diagonal mark indicates that the hold short clearance has been read back; and that a horizontal line through a call sign indicates that the airplane is cleared to cross the departure runway. He also stated that he uses the horizontal line for airplanes that will exit runway 26 right to the right, only after they are clear of the runway. When shown a copy of the pad he used on the night of the accident, he stated that he had not marked the airplane call signs of CO 9687, N44UE, or EA 111 and that they were already marked on the pad when he assumed the duties of north local. He did make the checkmarks beside those particular call signs, but he did not make the horizontal lines through the call signs of N44UE or EA 111. He could not recall if he had drawn a circle around the call sign of EA 111 or made a notation "727" on the pad. He did believe that he had drawn a diagonal line through the checkmark beside the call sign of CO 9687.

He stated that he did not observe the rollout of N44UE, and he did not observe EA 111 over the threshold or on the runway prior to learning about the accident. He had heard the call sign N44UE on previous occasions and knew the airplane would be taxied to the north side of the airport. When asked why he became so involved with attempting to contact CO 9687, he stated that he wanted to get the departures off runway 26 left because he knew that an emergency was inbound to the airport. To continue to allow the departure of traffic on runway 26 left, he wanted to make sure that CO 9687 would not cross runway 26 left. He also stated that he did hear CO 9687 transmit that it was holding short at B2. However, he wanted the airplane to proceed to the west end of runway 26 left because of outbound departures.

It was his understanding that the transmission to EA 111 (in sight from the tower) automatically relieved the monitor controller from further responsibilities and fulfilled any further coordination requirements. He stated that the tower cab supervisor made the decision to switch positions. When asked whether it would have made any difference if he had received a full relief briefing, he said no. He did not consider the relieving controller's presence just before the accident to be a distraction. He stated that he was preoccupied with CO 9687 and that it distracted him from his remaining duties. He did not mention preoccupation with airplanes awaiting departure on runway 26 left.

The north local controller was asked about his understanding of anticipating separation as outlined in the Air Traffic Control Handbook, 7110.65F, paragraph 3-127. He replied that he understood this information and that, as a normal practice, he would issue traffic information. However, in this case, he could not understand why he did not. He was aware that EA 111 was closing on N44UE, and he wanted to prevent a go-around. He knew that a speed reduction instruction had been issued to EA 111, but he did not hear an acknowledgment. He stated that he would have expected the monitor controller to receive the acknowledgment, but before the clearance was repeated, he (the local controller) had assumed visual separation. He was aware that several speed reductions had been issued to N44UE.

He stated that he did not forget N44UE but that communications problems with the flightcrew of CO 9687 had distracted him from the rest of the traffic. He did not mention that ASE flight 301 was holding for takeoff on runway 26 left during this distraction. He did not observe the collision. After EA 111 advised that it had hit an airplane, he asked the supervisor to relieve him from his position. After the accident, he did not observe the airplane on the runway. He stated that he did not realize who was involved; he did not observe N44UE clear the runway, and he was not aware that the airplane was still on the runway. He said that he was looking at CO 9687 and not focusing on the arrival area of the runway when the accident occurred.

The north local controller was aware that when he initiated visual separation between EA 111 and N44UE, there was about 40 knots difference in the ground speeds. He stated that the data block for N44UE indicated 120 knots and that the data block for EA 111 indicated about 160 knots. At that time, they were about 2.5 miles apart and inside the outer marker. He did not know what the closest point was between the two airplanes during visual separation. He was aware that N44UE would have to make a 90^{o} turn to clear the runway. He stated that he knew it was his responsibility to scan the runway to make sure that it was clear. He believed that the accident occurred because he was distracted. He did not believe that the responsibility to scan the runway should have been shared with the ground controller. He stated that the BRITE radar was on a range of 18 to 20 miles. He was sitting in a chair that had a clear view of the runways. There were no other distractions, and the tower shades were not pulled down.

The north local controller stated that in retrospect, he did not believe the supervisor's decision to swap positions was necessary. It was his opinion that all the coordination relative to the inbound emergency (EA 56) had been accomplished. He also stated that it would have been difficult to "pick out" N44UE clearing the runway on the north side because of the ramp lights and the ARFF vehicles. When asked why he had placed so much emphasis on trying to establish communications with the flightcrew of CO 9687, he stated that he had issued specific instructions that had not been acknowledged, a situation that he considered was a problem. When asked why he was trying to instruct CO 9687 to proceed to the far west end of the runways, he stated that the ground controller had requested that he do so. He believed that everything was going to "work" until he became distracted by the communication difficulties with CO 9687. He stated that normally there

are "allowances given to general aviation airplanes...they are given more spacing...in order to allow the airplane to clear the runway on the north side." He stated that based on his previous experience, he assumed that N44UE was clear of the runway and was surprised to learn that it was not.

1.17.3.5 Ground Controller

The ground controller recalled being advised about EA 56, which was inbound for landing on runway 26 left with a hydraulic failure. He said that the flightcrew of CO 9687 contacted him while still north of runway 26 left. He did not observe the airplane clear runway 26 right, but he did observe the airplane between B2 and B4, facing west. The airplane was not moving. He initiated a call to the flight on ground control frequency and, on the second call, they responded. He then advised the flightcrew to return to the north local control frequency. This radio exchange occurred before he became aware of the accident.

He described his workload as moderate and the complexity as routine, consisting mostly of air carrier arrivals and departures. He said that he was seated at the position and that he had a clear view of the runways and taxiways. He did not observe N44UE land, but he first observed the airplane when it was on the BRITE radar outside the outer marker and on final for runway 26 right. He made no other observations of this airplane, and he heard no transmissions from N44UE.

The ground controller observed EA 111 on the BRITE radar, behind N44UE, outside of the outer marker and later at the outer marker. He did not observe EA 111 land or observe the accident. He heard the local north controller say that EA 111 had hit an airplane on the runway. He then directed several taxiing airplanes to stand by and stopped all traffic. He observed EA 111 after it had exited runway 26 right at taxiway B3. By using field glasses, he was able to observe an airplane on the runway, but he did not know which airplane it was. He then asked the fire chief to confirm the airplane identification. He also observed ARFF vehicles proceeding to the airplane. Because of all the lights on the ARFF vehicles, he could not determine if there were any lights illuminated on the airplane that had been hit.

He stated that EA 111 had wing tip lights and the rotating beacon illuminated. He could not recall whether he observed landing lights or any other distinguishing features. After the accident, he remained on the ground control position for about an hour. A short time later, he was involved with the arrival of EA 56, which landed uneventfully on runway 26 left and proceeded to the ramp under its own power. The flightcrew of EA 56 advised that they did not require assistance. He stated that the tower visibility was 4 to 5 miles and that there were low clouds in the area. There was some fog but no rain.

1.17.4 See and Avoid

The responsibility for pilots to maintain an adequate outside scan to assure that they are able to "see and avoid" other airplanes is mandated by Title 14 CFR 91.67, which requires:

> When weather conditions permit, regardless of whether an operation is conducted under IFR or VFR, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft, in compliance with this section.

Operation of a flight under IFR but in visual meteorological conditions does not relieve a pilot of the responsibility to see and avoid other airplanes. The receipt of a landing clearance and/or traffic advisories would not relieve pilots of their responsibilities to see and avoid other traffic.

2. ANALYSIS

2.1 General

The Eastern Airlines flightcrew was certified, trained, and qualified for their duties. No physiological factors or unusual cockpit distractions existed that would have precluded the flightcrew from seeing the King Air airplane either on the final approach or on the runway.

The Epps Air Service pilot-in-command was certified, trained, and qualified for the charter flight. The presence of a copilot-in-training (an Airline Transport Pilot-rated company employee) did not contribute to the accident.

All FAA ATC personnel were certified, trained, and qualified for their duties. There were no apparent physiological disabilities that would have detracted from their ability to perform at an acceptable level on the evening of the accident.

The air traffic volume in the Atlanta area during the timeframe of the accident was average. There were no "flow control" or "holding" procedures in effect at the Hartsfield International Airport.

Both the Eastern Airlines' flightcrew and the King Air pilot-in-command and copilot were familiar with the airport arrival procedures, runway layout, and taxi routes to their respective gates. Likewise, Atlanta ATC personnel were familiar with the Epps Air Service King Air call sign, N44UE. From previous experience, the controllers expected the airplane to exit runway 26 right at taxiway Delta and proceed onto the general aviation ramp. The Safety Board could find no evidence to suggest that the Epps Air Service flightcrew delayed their exit from the landing runway onto the general aviation ramp area.

Weather conditions were at or above the criteria for visual flight rules. However, there were scattered clouds at 500 feet and fog present

about the time of the accident. In postaccident interviews, neither the flightcrew of EA 111, the Epps Air Service copilot, nor the air traffic controllers identified environmental factors as a constraint to the normal performance of their duties.

Evidence was conclusive that the collision occurred on runway 26 right about 3,000 feet from the approach end. There were aircraft tire scuff paths with measurements corresponding to the dimensions of a B-727 landing gear. There were small parts of the King Air airplane scattered about the right side of the runway at this point. The geometry of the collision was indicative of a similar heading, and longitudinal impact was consistent with the ground tracks of both airplanes along runway 26 right.

In considering factors that interfered with visually identifying objects on the runway, the Safety Board considered the effects of lighting from a large automobile manufacturing complex to the east of the airport and the air cargo ramp adjacent to runway 26 right, as well as lights from airport emergency vehicles. Although each of these light sources made the visual acquisition of aircraft more difficult, the Safety Board did not consider the singular or cumulative effects of these sources to be a significant factor. Therefore, other reasons were considered to explain why neither the EA 111 flightcrew nor tower personnel made visual contact with the King Air airplane on runway 26 right during the critical period preceding the collision.

2.2 Airplane Airworthiness and Conspicuity

The operating condition of each of the involved airplanes was reviewed as possible contributors to the collision. The B-727 was maintained in accordance with the applicable directives, and there was no evidence that any windshield deficiency or other malfunction contributed to the collision.

The evidence indicates that the King Air was not in compliance with airworthiness requirements because of deficiencies in the anticollision lighting system. During the departure from DeKalb Peachtree Airport, an Epps Air Service flight line maintenance technician observed that the red anticollision light atop the vertical stabilizer and the white strobe light installed in the fuselage tailcone were inoperative. Further, the red anticollision light on the lower fuselage was not of an approved type and was not functional. The "Beacon" switch that controls the red anticollision lights on both the top and bottom of the airplane was reported to be inoperative by ground personnel prior to the flight. The lighting discrepancies were not entered in the aircraft log book and were not repaired before flight as required by FAA regulations. The Safety Board was not able to establish that the pilot-in-command was aware of these lighting deficiencies although lighting is a part of the preflight checklist. Therefore, the deficiencies would become apparent during a properly conducted preflight exterior inspection.

In normal operations where collision avoidance is dependent upon pilot see and avoidance, anticollision lighting plays an important part in

airplane conspicuity at night. The operation of required lighting equipment is an obligation for all pilots and operators. Consequently, any discrepancies in the aircraft navigation and anticollision lighting systems must be repaired for nighttime operations.

However, the Safety Board recognizes the prerogative available to all pilots by FAR 91.73(d) to turn off the anticollision light system in the interest of safety if it proves distracting. The regulation makes no distinction between rotating beacons and strobe lights. In the case of the King Air airplane, the wing tip strobe lights, engine nacelles and propellers are close to the pilots' position. Reflections of anticollision lighting systems on the engine nacelles and rear surface of the propellers, when operating in clouds and fog, are known to be distracting. Under such conditions pilots often turn off these lights. Therefore, the Safety Board concludes that under the conditions that existed at the time of the accident, the pilot would most likely have turned off these lights.

The Safety Board's examination of available light bulbs from N44UE confirms that some lights were not illuminated at impact. The filaments of bulbs removed from the navigation position and logo light systems were stretched, which is common to light bulb illumination at the time of impact. Brittle fractures of fragments of filaments from the red anticollision light on top of the vertical stabilizer indicate breakage while it was not illuminated. In the lighting configuration of "NAV" lights only, the aft portion of the King Air aircraft would present only a single rear white position light, with an intensity of 20 candle power, to be acquired by the following airplane. Thus, only limited conspicuity would be afforded in a field of view that included a variety of runway, taxiway, and other lights.

2.3 EA 111 Flightcrew Performance

The Safety Board examined the ATC communications and CVR records to determine the extent to which the flightcrew of EA 111 may have contributed to the reduction in the separation behind N44UE during the approach. The Board was also interested in learning the extent to which the flightcrew might have been aware of their proximity to N44UE.

While on the approach control frequency, the flightcrew of EA 111 could have heard a transmission at 1858:02 informing N44UE that it was 1 mile from FREAL maintaining 180 knots and inbound to land on runway 26 right. This radio transmission was the only one that could have provided the crew of EA 111 with an indication of their actual distance behind N44UE. EA 111 was more than 5 miles from FREAL at that time and the flightcrew did not recall being attentive to that transmission or considering it significant. At 1859:32, 1 minute and 30 seconds later, EA 111 was informed that it was 2 miles from FREAL and was directed to maintain 180 knots to the marker. The time interval between these transmissions could have led the flightcrew to believe that spacing behind preceding traffic was more than adequate at that time. Further, the flightcrew of EA 111 had no indication that N44UE was a slower airplane, which would present an overtaking situation on final approach. After switching to tower frequency, the flightcrew of EA 111 could have heard three more transmissions to N44UE: at 1900:16, a speed reduction

to 150 knots; at 1900:50, a further speed reduction to 140 knots; and, at 1901:15, a clearance to land. During this entire period, EA 111 was still cleared to maintain 180 knots approaching the outer marker. The transmissions to N44UE could have alerted the EA 111 flightcrew to an overtaking situation. However, because of the absence of specific information about the position of N44UE, as well as knowledge that the controllers were monitoring the spacing, the flightcrew recalled not being overly concerned. At 1901:44, around 1.5 nmi outside of the outer marker, the flightcrew of EA 111 was told to reduce to final approach speed. The flightcrew did not immediately acknowledge or comply with this transmission, and the instruction was repeated by the monitor controller at 1901:50. Two seconds later, the flightcrew began to reconfigure the airplane, and the beginning of a speed reduction is noted on the FDR. EA 111 passed the outer marker at 1902:15 at an airspeed of about 165 knots.

The Safety Board believes that the flightcrew of EA 111 could have taken more positive action to slow the airplane to its final approach speed when cleared to do so and that such action would have decreased the overtaking situation. However the Safety Board believes that because the transmission "reduce to final approach speed" did not provide a specific airspeed (as required in the Air Traffic Control Handbook) or any other indication that the reduction was needed for spacing behind the preceding airplane, it did not contain sufficient information to convey the need for more immediate action to slow the airplane.

The Safety Board also notes that EA 111 was given a clearance to land at 1901:57 and was advised by the tower that they were in sight at 1902:04. No indication was given that they were number two for landing behind another airplane. The Safety Board believes that flightcrews are conditioned to receive such information, as required in the Air Traffic Control Handbook procedures relating to anticipating separation. If the controller had provided traffic information to the EA 111 flightcrew, the flightcrew's sense of situational awareness and motivation to search for a preceding airplane might have been increased. Lacking such information, it appears that the crew proceeded through their normal task of completing a routine night landing on a runway to which they had been cleared, unaware that there was another airplane on the runway.

The fact that EA 111 had received a landing clearance did not relieve the flightcrew of responsibility to "see and avoid" other aircraft in their vicinity. However, in the absence of conspicuous lighting on the King Air and without prompting from ATC to direct their attention to traffic ahead, it was extremely difficult, if not impossible for the EA 111 flightcrew to detect the other aircraft on the runway. Moreover, there is a concept known as diffusion of responsibility that describes a tendency on the part of pilots in some circumstances to relax their vigilance. A National Aeronautics and Space Administration study on near midair collisions[4]

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[4]Billings, C., Greyson, R., Hecht, W., and Curry, R., "A Study of Near Midair Collisions in U.S. Terminal Airspace," NASA Technical Memorandum 81225, 1980.

indicates that an inappropriate sense of shared responsibility may occur when an airplane is under ATC radar control. In such a circumstance, a pilot may relegate a portion of his responsibility for vigilance to the controller for seeing and avoiding other aircraft. In the case of EA 111, having come from the radar environment of the approach and after having received specific landing clearance, the pilots may have experienced a natural tendency to relax in their attempts to visually search for an aircraft between their position and the intended landing runway. In any event, the Safety Board found no evidence to indicate less than expected vigilance by the EA 111 flightcrew.

The Safety Board thus concludes that the actions of the EA 111 flightcrew, while not optimal in terms of speed control and situational awareness during initial and final approaches, were not uncommon to airline operations and were not causal to the accident.

2.4 Role of Air Traffic Control

The Safety Board also evaluated the performance of the air traffic control personnel involved in this accident.

The final controller was responsible for maintaining separation of succeeding airplanes on the approach to the outer marker. The monitor controller was responsible for maintaining separation of succeeding airplanes on the approach from the outer marker to within 1 mile of the runway. It is evident, by the airspeed reductions that were issued by the monitor controller to the flightcrew of N44UE, that he was attempting to achieve additional separation between CO 9687 and N44UE prior to N44UE crossing the runway threshold of 26 right. The recorded radar data indicate that the separation between CO 9687 and N44UE never exceeded 3.5 miles. Therefore, the monitor controller's action failed to achieve the 4 mile minimum required separation standard. He also failed to compensate for the added closure rate that occurred between N44UE and the following airplane, EA 111, as a result of the airspeed reductions he issued to N44UE.

EA 111 was about 4.0 miles behind N44UE at FREAL intersection. In order to accomplish the desired sequencing of EA 111 trailing N44UE, an early speed reduction for EA 111 was required. A timely and sufficient airspeed reduction adjustment was not issued by either the final controller or the monitor controller.

The required separation between EA 111 following N44UE was 2 1/2 miles inside the final approach fix. It appears that the monitor controller was late in recognizing the potential conflict of decreasing separation between N44UE and EA 111. About 6 miles from the runway, he assigned an airspeed change to EA 111, "reduce to your final approach speed." This speed assignment was not in conformance with the Air Traffic Control Handbook, which states that a controller shall advise an aircraft to increase or decrease to a specified speed in knots. In addition, the monitor controller did not receive an acknowledgement from the flightcrew of EA 111 for the instruction to reduce to approach speed, and thus should not have assumed that the instruction had been received and complied with. Therefore,

the monitor controller initiated a sequence of events that caused the final approach interval spacing to quickly approach the minimum of 2 1/2 miles. Although he was relieved of direct responsibility for the ensuing loss of separation when the north local controller transmitted "EA 111, you are in sight, cleared to land 26 right," the Safety Board believes that the monitor controller's action contributed to the speed differential and to the overtake that ultimately was a factor in the accident. At the time of the north local controller's transmission, EA 111 was almost 6 miles from the runway and the King Air was about 3 miles out. However, the distance between the two aircraft was decreasing at an unacceptable rate and was less than the required 2.5 miles separation as N44UE arrived at the runway threshold.

The north local controller, in an attempt to maintain the landing sequence, initiated visual separation between N44UE and EA 111. At the time visual separation was initiated, the required minimum radar separation standard of 2 1/2 miles did exist between N44UE and EA 111. However, to make sure that an approved separation standard would exist after using visual separation, the local controller would have had to monitor both airplanes closely to assure that EA 111 did not cross the runway threshold until N44UE had been observed leaving the runway (Air Traffic Control Handbook 7110.65, paragraph 3-122, Same Runway Separation).

Unfortunately, EA 111 had about a 45 knot closure rate on N44UE, and ATC radio transcripts indicate that no action was taken to reduce the rate of closure. In addition, the radio transcripts indicate, and a personal interview confirmed, that the local controller became distracted by radio communication difficulties with the flightcrew of CO 9687. The local controller stated to investigators that he did not observe the touchdown and rollout of N44UE at the runway threshold or during landing.

The Safety Board reviewed the pertinent FAA Air Traffic Control Handbook 7110.65F requirements and concluded that the instructions contained therein clearly define the controller's responsibilities for "same runway separation" and "anticipating separation." The Safety Board concluded that the physical evidence on the runway and on both airplanes indicated that the collision occurred on a runway that was the responsibility of the north local controller.

The Safety Board attributes the north local controller's distraction and preoccupation with efforts to communicate with CO 9687 to his perceived need to clear runway 26 left for another airplane inbound with a hydraulic emergency. However, the Board believes that the local controller's concern that the flightcrew of CO 9687 was going to cross runway 26 left without a clearance was not well founded. At 1903:03 radio transmissions indicate communications difficulties between CO 9687 and the tower regarding its taxi instructions. They transmitted, "tower, Continental ninety six eighty seven bravo two [taxiway] holding short." The fact that the airplane was on the taxiway and not moving was substantiated by the ground controller in the tower cab. The CO 9687 flightcrew took positive action to avoid becoming a hazard. They stopped clear of the active runways and remained in position until their clearance was clarified.

The Safety Board concluded that there was a lack of understanding between the local controller and CO 9687, and that this communications anomaly did not result from any equipment failure. Rather it was the result of an incomplete transfer of information (taxi instructions) between the controller and the flightcrew of CO 9867. The net effect of this lack of information transfer was to create a self-imposed workload on the controller that was sufficiently high to cause him to disregard other higher priority tasks. If the local controller had been so concerned that the airplane was going to cross runway 26 left without a clearance, he had the option of discontinuing departures from that runway and directing ASE 301, that was holding in the takeoff position, to clear runway 26 left. As long as ASE 301 was holding in position on the runway, it could not be threatened by a possible runway incursion from an airplane at the opposite end of the runway. However, the local controller became distracted for a critical period by the possibility of a runway incursion involving ASE 301 and CO 9687. Eventually, at 1904:13, the local controller cleared ASE 301 for takeoff on runway 26 left. The collision of EA 111 and N44UE had taken place on runway 26 right at 1904:07.

It is recognized that concentration on one task can overload a person to the extent that other relevant cues are disregarded or otherwise not attended to, leading to a degradation of overall task performance. Because the north local controller focused his attention on the path of CO 9687 on taxiway Bravo, at the west end of runway 26 left, he was distracted at a critical time from the landing rollout of N44UE and the EA 111 airplane that was about to cross the threshold and land on the same runway.

The Safety Board concludes that this accident was a result of lapses in the performance of the Atlanta tower north local controller and, to a lesser extent, the performance of the Atlanta approach control north final controller and the radar monitor controller. Specifically, the north local controller did not ensure the separation of the aircraft approaching and landing on runway 26 right. Further, he failed to follow the prescribed procedure of issuing appropriate traffic information to the crew of EA 111. This information would have improved the flightcrew's situational awareness and their motivation to search for the preceding King Air. The Atlanta approach north final controller and the radar monitor controller had opportunities to issue timely speed reductions to ensure that adequate separation was maintained between the successive aircraft on final approach, but did not do so.

Although these lapses of controller performance are cited as causal, the Safety Board also has chosen to recognize that the controllers' performance was a direct product of FAA air traffic management institutional decisions and practices that do not allow for human performance lapses in judgement or decision making. The air traffic control procedures permitted the local controller to assume full and complete responsibility for in-trail separation of aircraft on the final approach by invoking visual separation standards. As a result, two critical problems arose: (1) the separation distance between EA 111 and N44UE was reduced from the radar requirement of 2.5 miles minimum (inside the final approach fix) to some indeterminate

distance necessary for N44UE to clear the runway prior to the arrival of EA 111 over the threshold; (2) an important redundant element, (the monitor controller) was removed from the loop. In addition, the air traffic procedures allow for the issuance of multiple landing clearances, which were issued in this case to CO 9687, N44UE and EA 111 in a period of 49 seconds while all three aircraft were still on final approach. An effect of this action was to remove another redundant element in the system: all aircraft had their landing clearances, and therefore no further communications with the local controller were necessary. When the simple but compelling distractions caused the local controller to divert his attention away from the landing aircraft, the stage was set for this accident.

It is well-documented that human performance is subject to simple lapses (errors of omission), particularly in the presence of distracting events. Thus, the designers and operators of complex systems, who implement design features and operating procedures that allow one individual to assume the full burden for safety-critical operations, like the Air Traffic Control system, must bear some of the responsibility for those accidents attributed to the occasional lapse in the performance of a single individual.

Therefore, in addition to noting individual performance in the assessment of causal and contributing factors, the Safety Board cites the broader failure of the Federal Aviation Administration to provide ATC equipment and procedures that adequately take into consideration those occasional lapses in human performance that must be expected.

In examining the specific circumstances of this accident, the Safety Board became concerned that the current provisions in ATC procedures permit the controller to issue landing clearances to several aircraft in succession without assurance that the adequate separation will be maintained among those aircraft as they approach the landing threshold.

Correlation of ATC communications and radar position data indicates that CO 9687's clearance to land was given when the airplane was about 1 mile from the threshold of runway 26 right and the landing clearances to N44UE and EA 111 were given when the former was about 1/2 mile outside the final approach fix (FAF) and when the latter was about 3/4 mile outside of the FAF, distances of about 4.5 miles and about 6 miles, respectively, from the threshold. Provision of the multiple clearances to land in relatively rapid succession may have provided the north local controller with time needed to devote attention to flights waiting for takeoff clearances from runway 26 left. However, the premature clearances also make the north local controller the only controller responsible for the spacing between successive flights by removing that responsibility from the monitor controller and it may also have reduced the vigilance of the flightcrew. As a result, appropriate spacing for completion of the landings depended entirely on the continued vigilance of the local controller and the flightcrew.

In this case, the flightcrew of EA 111 probably could not have seen N44UE because of N44UE's external lighting configuration. Also, the premature clearance for EA 111 to land removed the redundancy of flightcrew vigilance when the north local controller subsequently became distracted with

CO 9687's taxi clearance. Without the clearance to land, EA 111 would have had to remind the local controller that the clearance was needed. This reminder would probably have redirected the controller's attention to the lack of adequate spacing between N44UE and EA 111 and may have led to a correction of the problem by denying EA 111 clearance to land.

In the 1977 edition of the Air Traffic Control Handbook, 7110.65A, the issuance of multiple landing clearances was not allowed. Specifically, paragraph 1122, "Anticipating Separation," stated, "Landing clearance need not be withheld until prescribed separation exists if there is reasonable assurance it will exist when the aircraft crosses the landing threshold. However, do not clear a succeeding aircraft to land on the same runway before a preceding arriving aircraft crosses the landing threshold...." This is basically the same text that is contained in the current Handbook, 7110.65F; however, the earlier procedures went on to say, "...do not clear more than the first two aircraft to land at any one time and include traffic information with the clearance." During March 1978, this paragraph was changed to delete the numerical limits for clearing aircraft to land. The Safety Board believes that current ATC procedures, as they pertain to the anticipated separation of arriving aircraft, require nearly flawless human performance that makes no allowance for an error of omission or lapse of attention due to any type of distractive event. Therefore, the Safety Board believes that the procedures contained in the Air Traffic Control Handbook, 7110.65F, paragraph 3-127, "Anticipating Separation," should be amended to preclude the issuance of multiple landing clearances to aircraft outside of the final approach fix. Also, a numerical limit should be established so that no more than two landing clearances may be issued to successive arrivals.

The Safety Board believes that this change will increase system effectiveness, while not creating an undue burden on the controller. Nevertheless, pilots also have a responsibility for separation assurance on the runway and vigilance during landing must be a shared. The Safety Board is aware that if the local controller had provided traffic information to the crew of EA 111, the accident might have been prevented. This procedure, had it been followed, would probably have prompted the crew to query the local controller as to the position of their traffic on the runway, since it was unlikely that visual observation would have occurred. As a system redundancy, the Safety Board believes that the importance of issuing traffic information to arriving aircraft should be stressed. Therefore, the Safety Board believes that a mandatory, formal briefing should be provided to all air traffic controllers on the importance of, and the need for, giving traffic information when issuing an anticipated separation landing clearance. The briefing should be contained in an Air Traffic Bulletin.

2.5 Efforts to Reduce Runway Incursions

The Safety Board's concern about the hazard of runway incursions dates back to 1972 following an accident at the Chicago O'Hare International

Airport.[5] As a result of that accident, four Safety Recommendations were issued to the FAA addressing air traffic control procedures and pilot-controller communications.[6] The Board's concerns were further reiterated in 1979 following two more runway incursions incidents and one accident.[7] These occurrences prompted the Board to recommend that the FAA conduct a directed safety study to examine the runway incursion problem and to formulate recommended remedial action to reduce the likelihood of such hazardous conflicts. That recommendation was issued in June 1979.

In response, the FAA commissioned the Transportation Systems Center in Cambridge, Massachusetts, to conduct a study. The study was completed in April 1981 with a report entitled "An Analysis of Runway-Taxiway Transgressions at Controlled Airports." The study concluded that "there does not appear to be any pattern to the causes . . . other than human errors on the part of both air traffic controllers and pilots." The study also concluded that "more uniform communication and verification of messages between pilots and controllers could serve to reduce the chance of ambiguous or erroneous commands/actions." The report raised the question as to whether system reliability might be improved by increasing the reliability of the human element or by adding redundant elements. The study did not evaluate controller training or human performance issues. The study did suggest that incident reporting might be part of the problem since there were indications that not all incidents are reported, which caused a situation that precluded appropriate corrective measures. Furthermore, the report did not propose any specific corrective measures.

Although the FAA did conduct the study on the runway incursion problem, the study did not result in the development of remedial action to reduce or alleviate the problem.

The Safety Board's concern about the problem was heightened again after it investigated a near collision between two DC-10's at the Minneapolis-St. Paul International Airport on March 31, 1985. That occurrence prompted the Board to undertake a special investigation study of runway incursion incidents. Since that time, additional incidents and

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[5]North Central Airlines, Inc., McDonnell Douglas DC-9-31, N954N and Delta Air Lines, Inc. Convair CV-880-N8807E, O'Hare International Airport, Chicago, Illinois, December 20, 1972. NTSB/AAR-73-15.

[6]Since 1972, the Safety Board has issued 42 Safety Recommendations to the FAA addressing the problem of runway incursions. A summary of these recommendations and their current status is contained in appendix F.

[7]Midair Collision Involving a Falcon Jet, N121GW, and Cessna 150M, N6423K, Memphis, Tennessee, May 18, 1978. NTSB/AAR-78-14.

accidents have continued to occur,[8] which suggests the need for other measures to resolve this problem.

During 1985 and early 1986, the Safety Board investigated 25 more runway incursion incidents that were summarized in a special investigation report adopted on May 6, 1986.[9] The Safety Board found that the incursions were the result of both controller errors and pilot deviations.

The report indicated that controller operational errors generally resulted from a coordination breakdown between local and ground controllers or distractions that diverted a controller's attention from a developing or established conflict situation. Pilot deviations accounted for about 30 percent of the incursions investigated by Safety Board staff and involved misinterpretations of clearances and unauthorized runway crossings. Many of the incursions could have been avoided, if the pilots had looked for traffic before proceeding onto an active runway.

Fourteen recommendations were sent to the FAA addressing issues, such as procedures, training, pilot and controller communications and airport signing. The FAA took several actions in response to the Board's recommendations. These actions included establishing a runway incursion data base, distributing training material, including a video tape to bring controller and pilot attention to the problem, changes to controller and pilot phraseology, and placing more emphasis on airport taxiway guidance signs.

The MITRE Corporation also conducted an analysis of runway incursions summarized in a report in April 1989. This report[10] defined controller-related factors as follows:

- o Erroneous scanning, or failure to scan the runway or approach path (local controller [LC] and ground controller [GC]).
- o Forgetfulness about the traffic situation (LC and GC).
- o Misjudgment of traffic separation (LC).

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[8]Collision in Detroit, Michigan, December 3, 1990, between Northwest flights 299 and 1482, and Collision in Los Angeles, California, February 1, 1991, between USAir 1493 and SkyWest 5569 are under NTSB investigation.

[9]Additional information on the general subject of runway incursions can be found in the National Transportation Safety Board, Special Investigation Reports, "Runway Incursions at Controlled Airports in the United States," NTSB/SIR-86/01, May 1986, and an FAA publication "Reducing Runway Incursions: An FAA Report" dated April 1990.

[10]The MITRE Corporation, "An Analysis of ATC-Related Runway Incursions, with Some Potential Technological Solutions," MTR-89W0021, April 1989.

- o Lack of coordination or inadequate coordination with the LC on runway crossings (GC).

- o Errors in sending or receiving clearances and instructions (LC and GC).

The runway collision of EA 111 and King Air N44UE involved these same controller-related factors identified by both Safety Board and the MITRE corporation studies.

These factors are human performance-related and are being addressed in a number of different actions, including FAA and industry efforts to increase awareness of the magnitude and nature of the human performance problem, improved training and technological solutions that may reduce the workload, and a fail-safe redundancy for the human performance of air traffic controllers.

The Safety Board is aware of several advanced concepts in airport surface traffic detection and automation that, when perfected with the correct match of hardware and location specific software, could provide warnings to preclude accidents of a nature similar to the collision of EA 111 and N44UE. For example, the FAA is currently testing an Airport Movement Area Safety System (AMASS). The AMASS system will use the data available in ASDE-3 and the ARTS to identify potential incursions and will alert the controller so that timely corrective actions can be taken. The Safety Board fully supports the early development and installation of such systems at airports where the volume and complexity of traffic flow dictates its use.

On a broader scale, the Safety Board encourages the FAA to continue the research effort in Airport Surface Traffic Automation (ASTA), which is intended to develop automation tools and more complete automation for controlling the flow of aircraft on the airport surface. In addition to reducing the frequency of runway incursions, design goals of the program should include a reduction in taxiway incursions and improvements in ATC operational efficiency. This automation is intended to support interactions among the various aircraft on the airport surface and on the approach path, and their interaction with automation elements such as Departure Flow Management (DFM) and Terminal Air Traffic Control Automation (TATCA).

Although the Safety Board fully supports and encourages these efforts, it realizes that these programs are long term and are intended for a limited number of high-density air carrier airports. Therefore, the operational benefits will not be available until the late 1990's, or later. The Safety Board believes that although the efforts of the FAA are commendable, the FAA should expedite its efforts to fund, support and implement, an operational system analogous to the airborne conflict alert system to prevent runway incursion incidents at all U.S. certificated airports that are served by air carriers. The progress of preventive measures will be more fully examined and updated in future Safety Board reports.

2.6 Analysis of Toxicological Testing

The Safety Board believes that, as a minimum, FAA air traffic management personnel should have required that the local controller's supervisor, the north final controller, the ground controller and the monitor controller be subjected to the FAA's drug testing program. The local controller's supervisor was the cab coordinator and had the responsibility of observing and coordinating traffic flow. He had been working the north local control position 4 minutes before the accident. Similarly, the north final controller and the monitor controller were handling the accident airplanes and were cited in the contributing cause.

The Safety Board recognizes that all the facts and circumstances regarding an accident cannot be known immediately after an accident. Therefore, it cannot be established with certainty who should be subjected to the drug testing program. Under the circumstances, the Safety Board believes that the FAA should test all individuals who may be reasonably associated with the circumstances of an accident, such as all controllers who have had communications with an aircraft shortly before an accident and their supervisors. The specimens can be retained until the investigation has established who was reasonably associated with the accident. Then, only those specimens that are relevant to the investigation should be submitted for analysis. Those that are not submitted for analysis can be returned to the individual who submitted them.

The Safety Board was encouraged that Eastern Airlines had implemented a drug testing program that exceeded the FAA's postaccident drug testing regulation. The Eastern Airlines' program included testing for additional drugs (both licit and illicit) in urine, as well as blood sampling for alcohol analysis. The Eastern Airlines' postaccident testing program in which urine and blood are collected and screened for additional drugs, including alcohol, is consistent with Safety Board Recommendations I-89-4 through -12, which were addressed to the Secretary of Transportation on December 5, 1989. The Secretary and staff responded to these recommendations in a letter with attachments on August 3, 1990, and again on November 5, 1990. Safety Board staff has met on numerous occasions with the Secretary's Special Assistant for Drug Enforcement and Program Compliance and DOT staff to discuss DOT postaccident drug testing programs and the need to collect blood and urine, as well as to increase the number of drugs (including alcohol) in the program. The Secretary's Special Assistant indicated to the Safety Board staff that the DOT was currently evaluating the merits of establishing a separate program for drug/alcohol testing following accidents. The DOT has yet to notify the Safety Board of its planned action.

3. CONCLUSIONS

3.1 Findings

1. The Eastern Airlines and the Epps Air Service flightcrews were certified and qualified for their respective flights.

2. The air traffic control personnel were certified and qualified for their duties.

3. The air traffic control equipment was fully operational and did not contribute to the accident.

4. Weather did not contribute to the accident.

5. Both airplanes were properly certificated. Some of the King Air anticollision lights (strobes and beacons) were inoperative and thereby deprived the pilot of N44UE of the option to use the system if he had so desired. With the existing conditions, the pilot would most likely have extinguished these lights, if they had been operable, to prevent distraction during the approach and landing.

6. The absence of anticollision lights would have degraded the conspicuity of the King Air when viewed by the flightcrew of EA 111.

7. The tower local controller failed to issue the required preceding traffic information along with the landing clearance to EA 111, thereby depriving the flightcrew of a stimulus to visually search for the preceding traffic and of knowledge of the slower approach speed of N44UE.

8. The Eastern flightcrew had three opportunities to learn about preceding landing traffic by listening to the tower frequencies; however, the time between transmissions, the large number of transmissions, and the required duties in the cockpit would have limited the utility of that information.

9. Airspeed reduction transmissions to N44UE by the radar monitor controller were insufficient to achieve the required 4 miles separation from the preceding airplane, CO 9687, on the final approach and at the threshold.

10. The absence of appropriate airspeed reduction instructions to EA 111 by the Atlanta approach north final and the radar monitor controllers led to a speed differential that resulted in a loss of the separation between EA 111 and N44UE.

11. The traffic volume at the time of the accident presented an average controller workload, but the local controller was distracted with radio difficulties (misunderstood instructions) when communicating with CO 9687.

12. The local controller's distraction by communication difficulties with CO 9687 was prompted by his perceived need to clear runway 26 left for another airplane inbound with a hydraulic emergency and the possibility of a runway incursion from CO 9687 during taxiing. The controller was inattentive to the more immediate task of monitoring the separation of traffic landing on runway 26 right.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable causes of this accident were (1) the failure of the Federal Aviation Administration to provide air traffic control procedures that adequately take into consideration human performance factors such as those which resulted in the failure of the north local controller to detect the developing conflict between N44UE and EA 111, and (2) the failure of the north local controller to ensure the separation of arriving aircraft which were using the same runway.

Contributing to the accident was the failure of the north local controller to follow the prescribed procedure of issuing appropriate traffic information to EA 111, and failure of the north final controller and the radar monitor controller to issue timely speed reductions to maintain adequate separation between aircraft on final approach.

4. RECOMMENDATIONS

Therefore, as a result of the investigation of this accident, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Develop an Air Traffic Bulletin and provide a mandatory formal briefing to all air traffic controllers on the importance of, and the need for, giving traffic information when issuing an anticipated separation landing clearance. (Class II, Priority Action) (A-91-27)

Amend the Air Traffic Control Handbook, 7110.65F, paragraph 3-127, to preclude the issuance of multiple landing clearances to aircraft outside of the final approach fix. Also establish a numerical limit so that no more than two landing clearances may be issued to successive arrivals. (Class II, Priority Action) (A-91-28)

Expedite efforts to fund the development and implementation of an operational system analogous to the airborne conflict alert system to alert controllers to pending runway incursions at all terminal facilities that are scheduled to receive Airport Surface Detection Equipment (ASDE-3). (Class II, Priority Action) (A-91-29)

Conduct research and development efforts to provide airports that are not scheduled to receive Airport Surface Detection Equipment with an alternate, cost effective, system to bring controller and pilot attention to pending runway incursions in time to prevent ground collisions. (Class II, Priority Action) (A-91-30)

Incorporate into the training syllabus at the Federal Aviation Administration's Academy at Oklahoma City, Oklahoma, the importance of, and the need for, giving traffic information when issuing an anticipated separation landing clearance. Stress that this information will enhance pilot awareness and visual acquisition of preceding traffic, thereby providing a redundancy in separation assurance for controllers and pilots. (Class II, Priority Action) (A-91-31)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ James L. Kolstad
Chairman

/s/ Susan Coughlin
Vice Chairman

/s/ Jim Burnett
Member

/s/ John K. Lauber
Member

/s/ Christopher A. Hart
Member

James L. Kolstad, Chairman, filed the following dissenting statement:

I fully concur with the recommendations that the Board adopted on this accident and believe they represent an improvement, if implemented, in ATC procedures currently being used.

I respectfully disagree with my colleagues however, that the probable cause of this accident was "failure of the Federal Aviation Administration to provide air traffic control procedures that adequately take into consideration human performance factors such as those that resulted in the failure of the north local controller to detect the developing conflict..."

Air traffic controllers are faced everyday with challenging demands on their ability to perform their responsibilities. But like all other forms of endeavor, it constantly requires judgement calls about priorities on ones' time. It does not seem to me to be reasonable to cite the FAA as causal in

this accident for failure of the north local controller to exercise proper judgement which led to this incursion accident.

Changing procedures or overlying additional procedures in anticipation of human performance failures are of little value if they are not adhered to. As we know in this case the procedures that already exist were not adhered to. When the north local controller took the pilots of EA 111 out of the loop he removed an important redundancy. This was a serious error and the primary cause of the accident.

I believe that the probable cause as originally drafted and adopted reflected these failures and is the appropriate probable cause.

I also disagree with the notion that agencies cause accidents. Failures of people and failures of equipment cause accidents. Shifting the cause from people to agencies blurs and diffuses the individual accountability that I believe is critically important in the operation and maintenance of the transportation system.

/s/ James L. Kolstad
Chairman

Susan M. Coughlin, Vice Chairman, filed the following concurring statement:

The revised probable cause of this accident states:

The National Transportation Safety Board determines that the probable cause of this accident were (1) the failure of the Federal Aviation Administration to provide air traffic control procedures that adequately take into consideration human performance factors such as those which resulted in the failure of the north local controller to detect the developing conflict between N44UE and EA 111, and (2) the failure of the north local controller to ensure the separation of arriving aircraft which were using the same runway.

I am filing a concurring statement to clarify my vote in favor of the revised probable cause to include the broader role of the Federal Aviation Administration in this accident. In citing the FAA, it is my belief that their failure in this instance was limited to providing adequate air traffic control procedures that relate to the issuance of multiple landing clearances. I believe that other protective procedures are prescribed, such as issuing appropriate traffic information to aircraft, and, in this accident, simply, were not followed.

/s/ Susan Coughlin
Vice Chairman

May 29, 1991

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Safety Board was initially notified of this accident about 1930 on January 18, 1990, by the Federal Aviation Administration. An investigator from the NTSB Atlanta Field Office was immediately dispatched to the scene. A Washington-based team departed for the scene the following morning. The team consisted of investigative groups in the areas of Operations, Human Performance, and Air Traffic Control.

Parties to the investigation were the FAA, Eastern Airlines, Epps Air Service Inc., Beech Aircraft Company, and the National Air Traffic Controllers Association.

2. Public Hearing

A public hearing was not conducted for this accident.

APPENDIX B

PERSONNEL INFORMATION

Eastern Airlines Flightcrew

Captain Ralph A. Orlando

Captain Orlando, age 49, holds an Airline Transport Pilot Certificate No. 1673343 and is type rated in rotorcraft-helicopter (BH-204) and fixed wing (B727) aircraft. He also holds a current FAA Class I Medical Certificate issued in August 1989 with no limitations or waivers noted. He was hired in August 1967 by Eastern Airlines and has remained employed by Eastern Airlines for the past 22 years. Captain Orlando accumulated approximately 13,320 hours of total flight time, of which 7,432 hours are in the B-727 aircraft. He upgraded to Captain in the B-727 in August 1986, and logged approximately 1,839 hours of pilot-in-command time in the aircraft. His last proficiency check was accomplished in August 1989, and his last line check was accomplished in September 1989. Captain Orlando accrued approximately 50 hours of flight time in the month of January and over 215 hours in the preceding 90 days.

First Officer Michael D. Runyan

First Officer Michael D. Runyan, age 36, holds an Airline Transport Pilot Certificate No. 540687675. He also possesses a current FAA Class I Medical Certificate issued in March 1989 with no limitations or waivers. First Officer Runyan has approximately 7,388 hours of flight time, of which 92 hours are logged as First Officer in the B-727 aircraft. His initial proficiency check was accomplished in October 1989, and his initial line check was accomplished in December 1989.

Second Officer Henry K. Stanford

Second Officer Henry K. Stanford, age 49, holds an Airline Transport Pilot Certificate No. 417540468. He possesses a current FAA Class I Medical Certificate issued in April 1989 that requires him to wear corrective lenses while exercising the privileges of his certificate. He has approximately 5,430 hours of flight time, of which 128 hours are logged as second-in-command in the B-727 aircraft. Second Officer Stanford's initial proficiency check and line check were accomplished in November 1989.

EPPS Air Service Flightcrew

Pilot-in-Command Eric K. Thomas

Pilot-in-Command Eric K. Thomas, age 30, held Airline Transport Certificate No. 257132398. He possessed a current FAA Class I Medical Certificate issued in October 1989 with no limitations or waivers noted. Mr. Thomas had accumulated approximately 1,653 hours of total flight time, 230 hours of which was as pilot-in-command in the King Air.

Co-pilot Daniel J. Olthoff

Daniel J. Olthoff, age 26, was employed by Epps Air Service as a charter pilot in the PA-31 Navajo aircraft at the time of the accident. He was flying in the right seat of the King Air for aircraft familiarization. Background information is not considered relevant to this investigation.

Atlanta Air Traffic Control Tower North (Local) Controller

Marshall H. Mowery, Jr.

Marshall H. Mowery, Jr. age 31, was hired by the FAA in May 1982 as an air traffic control specialist. His first assignment was to the Indianapolis Air Traffic Control Tower (ATCT), Indiana, and in October 1988 he was transferred to the Atlanta ATCT, Georgia, where he has remained employed as a controller. He was facility rated in April 1989. In September 1989, Mr. Mowery was medically certified by a flight surgeon to perform his duties with no limitations or waivers noted.

Atlanta Approach North Final Controller

Jack D. White

Jack D. White, age 52, was hired by the FAA in July 1963. He entered duty at Atlanta in March 1968. He was facility rated in March 1971. In September 1989, Mr. White was medically certified with a waiver to connect distant vision by a flight surgeon to perform his duties.

Atlanta Approach Radar Monitor Controller

Gary Zinders

Gary Zinders, age 44, was hired by the FAA in June 1969. He entered duty at Atlanta in January 1979. He was facility rated in November 1979. Mr. Zinders was medically certified without waivers by a flight surgeon to perform his duties.

APPENDIX C

COCKPIT VOICE RECORDER TRANSCRIPT

LEGEND OF COMMUNICATION DESCRIPTIONS, ABBREVIATIONS, ACRONYMS, AND EDITORIAL SYMBOLS USED IN THE ATTACHED CVR TRANSCRIPT:

CAM	Cockpit Area Microphone Voice or Sound Source
-1	Voice of Captain
-2	Voice of First Officer
-3	Voice of Second Officer
RDO-	Accident Aircraft Radio Transmission
-1	Voice from Captain's Position (Left Seat)
-2	Voice from First Officer's Position (Right Seat)
-3	Voice from Second Officer's Position (Right Rear Seat)
INT-	Intercom Communications
-4	Voice from Flight Attendant
UNK	Unknown or Unidentified Voice or Sound Source
AR-V	Atlanta Approach Control
MON-V	Monitor V Positon
LC-3	Local Control Position 3
COA	Continental Airlines, Flight 9687
44UE	Beechcraft Kingair, N44UE
EA371	Eastern Airlines, Flight 371
EA226	Eastern Airlines, Flight 226
RMP	Eastern Airlines, Ramp Maintenance Office
ILS	Instrument Landing System ground navigation facility
(?)	Unidentified Voice

@	Nonpertinent Word
#	Expletive Deleted
-	Break In Continuity
.	Pause (..Short, ...Long)
()	Unintelligible or Questionable Text
(( ))	Editorial Insertion

TIME SOURCE	CONTENT
1857:29 AR-V	continental ninety six eighty seven your passin' the ah freal cleared for the ils two six right tower one one nine point five now
1857:34 COA	ninety five nine six eight ()
1857:36 AR-V	november four four uniform echo turn right heading two three zero
1857:40 44UE	three zero four four u e
1857:47 AR-V	eastern one eleven turn right heading two four zero
1857:50 RDO-2	eastern one eleven right two four zero
1858:02 AR-V	november four four uniform echo turn right heading two seven zero you're mile from freal maintain five above the freal a hundred and eighty knots to the marker cleared ils two six right
1858:07 44UE	four four u e

TIME SOURCE	CONTENT
1858:09 AR-V	four four uniform echo tower one one nine point five now
1858:12 44UE	(four four ())
1858:17 AR-V	eastern one eleven descend and maintain five thousand
1858:19 RDO-2	eastern one eleven out of six for five thousand
1858:32 AR-V	eastern one eleven maintain five thousand your four from the freal maintain five above freal hundred and eighty knots the marker cleared ils runway two six right
1858:40 CAM-?	()
1858:43 RDO-2	okay eastern one eleven roger cleared for the approach hundred and eighty knots to freal

TIME SOURCE	CONTENT	TIME SOURCE	CONTENT
1858:48 CAM-?	and five thousand		
1859:06 CAM-?	(localizer capture intercept the) glide slope capture		
1859:08 CAM-?	() degrees		
1859:09 CAM-?	()		
		1859:32 AR-V	eastern one eleven your two mile from freal five above the freal hundred and eighty knots marker ils two six right..tower one one niner point five now
1859:33 CAM	((sound of altitude alert))		
		1859:40 RDO-2	one eleven roger
1859:43 CAM-2	mouth full (huh or hey)		
1859:45 CAM-1	yeah I got that		

TIME SOURCE	CONTENT	TIME SOURCE	CONTENT
CAM-2	huh		
1859:47 CAM-1	((laughter))...go to the tower		
1859:50 CAM	((sound of stabilizer trim operating))		
1859:53 CAM	((sound of altitude alert))		
1859:54 CAM	((sound of click))		
		1859:55 RDO-2	tower eastern one eleven is with you
1859:55 CAM	((sound of clicking noise))		
		1859:57 LC-3	one eleven atlanta tower roger
1859:01 CAM	((sound of click followed by altitude alert))		
1900:02 CAM	moving right along here		
1900:03 CAM-1	out of five		

TIME SOURCE	CONTENT	TIME SOURCE	CONTENT
1900:04 CAM	((sound of click))		
1900:09 CAM-1	one eighty to the marker..we're on the glide slope ah () pass freal ah ((initial approach fix)) ah (balli next)		
		1900:16 MON-V	four four uniform echo reduce speed one five zero
		44UE	four four u e
1900:22 CAM	((sound of trim operating))		
1900:32 CAM	((sound of three chimes - cycling of the no smoking sign three times to alert flight attendants about 2 minutes before landing))		
1900:42 CAM-?	(runway in sight)		
1900:43 CAM-?	(yeah)		
1900:46 CAM-?	well if there's fog it might drop out when we get lower		

TIME SOURCE	CONTENT
1900:49 CAM-?	yeah I don't think there's any right down here though
1900:50 MON-V	four four uniform echo reduce speed to one four zero
1900:52 44UE	okay one four zero
1900:53 CAM-?	those lights are a little bit
1900:55 CAM-?	yeah
1900:55 CAM-?	fuzzy lookin'
1900:56 CAM-?	yeah
1901:05 CAM	((sound of click)) okay at balli
1901:08 LC-3	continental ninety six eighty seven cleared to land
1901:09 CAM-3	thirty seven nine..(six six)

TIME SOURCE	CONTENT
1901:11 COA	ninety six eighty seven continental cleared to land two six right
1901:15 LC-3	four four uniform echo cleared to land two six right
1901:26 CAM-2	I'll go over to the (ils) to the localizer
1901:29 CAM-?	yeah go ahead
1901:29 LC-3	eastern three seventy one continue to the end straight ah half right hold short of two six left at the end
1901:33 EA371	to the end half right and hold short two six left
1901:37 CAM	((electrical power interruption))
1901:44 AR-V	eastern one eleven roger reduce to your final approach speed
1901:47 CAM-?	radio altimeter alive

TIME SOURCE	CONTENT
1901:49 CAM-?	()
1901:52 CAM-1	fifteen degrees flaps
CAM-2	fifteen ((sound of two clicks))
CAM-?	(down and front mike) ()
1901:57 CAM	he said to reduce to final approach speed
1901:59 CAM-?	okay
1902:00 CAM	((unidentified sound)) followed by sound of trim operating
1902:02 CAM	(he's talkin' at us)

TIME SOURCE	CONTENT
1901:50 MON-V	eastern one eleven monitor reduce your final approach speed
1901:57 LC-3	eastern one eleven you are in sight (from the tower) cleared to land two six right

TIME SOURCE	CONTENT	TIME SOURCE	CONTENT
		1902:04 RDO-2	eastern one eleven cleared to land two six right
1902:06 CAM	((sound of trim operating))		
1902:14 CAM-1	coming up on the marker....gear down final check please		
		1902:15 RDO	((sound of outer marker beacon))
1902:17 CAM-2	gear down		
1902:21 CAM	((sound of landing gear lever movement and increase in background noise follows immediately))		
1902:22 CAM-?	(let's take her out twenty six fifty)		
1902:26 CAM	((sound of trim operating))		
1902:31 CAM	((unidentified sound))		
1902:32 CAM-3	before landing final checklist..no smoking		

TIME SOURCE	CONTENT	TIME SOURCE	CONTENT
1902:36 CAM-2	it's on		
1902:37 CAM-3	gear down		
		1902:38 LC-3	continental ninety six eight seven half right stay on bravo go to two six left at the end
1902:39 CAM-1	I see three green lights..three green		
1902:41 CAM-2	got three green pressure and quantity check		
1902:44 CAM-3	anti-skid...inop		
1902:46 CAM-1	inop	1902:46 LC-3	over
1902:48 CAM-3	fuel panels set		
1902:49 CAM-2	wing flaps		

TIME SOURCE	CONTENT
1902:49 CAM-1	twenty five
1903:05 CAM	flaps thirty please
1903:07 CAM-2	flaps thirty
1903:07 CAM	((sound of two clicks))
1903:08 CAM-2	well it is a little bit scuddy down there
1903:11 CAM	((sound of trim))

TIME SOURCE	CONTENT
1902:49 LC-3	continental ninety six eighty seven tower
1903:03 COA	tower continental ninety six eighty seven bravo two holding short
1903:06 LC-3	ninety six eighty seven continue straight ahead to the end and hold short of two six left

TIME SOURCE	CONTENT
1903:13 CAM-1	thousand feet
1903:14 CAM-2	wing flaps
1903:16 CAM-1	I see thirty thirty green lights
1903:18 CAM-?	thirty thirty l e green
1903:20 CAM-2	thirty thirty l e green (call as required)
1903:23 CAM-?	before landing final checklist complete
1903:24 CAM	((sound of ringing alert))

TIME SOURCE	CONTENT
1903:12 COA	(yeah rog')
1903:13 LC-3	ninety six eighty seven hold short of two six left at the departure end
1903:21 LC-3	continental ninety six eighty seven how do you hear

TIME SOURCE	CONTENT
1903:25 COA	and ah continental ninety six...eighty seven say again
1903:28 LC-3	taxi to the end of the runway and hold short continental ninety six eighty seven
1903:47 LC-3	continental ninety six eighty seven tower
1903:49 COA	eighty seven
1903:50 LC-3	continental ninety six eighty seven taxi straight ahead and hold short of two six left at the end over
1904:04 LC-3	continental ninety six eighty seven
1904:10 CAM	((sound of click))
1904:16 CAM-?	(gear's down)

TIME SOURCE	CONTENT
1904:21 LC-3	continental ninety six eighty seven tower
1904:27 CAM	((sound of clicks - followed by the sound of something falling))
1904:29 CAM-2	three lights
1904:34 CAM-2	oh #
1904:34 CAM-2	oooooh
1904:37 CAM	((sound of impact))
CAM-2	god bless
1904:38 CAM-1	christ
1904:39 CAM-1	what the hell was that
1904:41 CAM-2	that was ah ah some kind of ah two oh two

TIME SOURCE	CONTENT	TIME SOURCE	CONTENT
1904:42 CAM-1	son of #		
1904:43 CAM-1	son of #		
1904:46 CAM-1	##...tell 'em we had an accident		
		1904:48 RDO-2	tower ah eastern one eleven ah we just hit an aircraft on the runway
		1904:51 LC-3	say again
		1904:52 RDO-2	there was an aircraft on the runway two six right
1904:57 CAM-1	##		
1905:05 CAM-?	oh that's awful ()	1905:05 COA	tower continental ninety six eighty seven
1905:09 CAM-1	tell we had somebody on the runway		

TIME SOURCE	CONTENT
CAM-2	I just did
1905:12 CAM-1	tell 'em again
1905:13 CAM-?	##
1905:19 CAM	((sound of interphone chime))
1905:22 CAM-1	oh my god

TIME SOURCE	CONTENT
1905:11 LC-3	ah ninety six eighty seven hold short of two six left right there
1905:14 RDO-2	tower eastern one eleven ah you better kept the traffic off of two six right there's an airplane there
1905:20 LC-3	eastern two twenty six go around fly runway heading
1905:23 EA226	okay runway heading go around eastern two twenty six

TIME SOURCE	CONTENT
1905:34 CAM-1	I think we just lost an engine..did we lose an engine or a pump
1905:39 CAM-?	((exhalation)) ## oh my god
1905:47 CAM-2	we were cleared to land
1905:48 CAM-1	I know
1905:49 CAM-2	just inside
CAM-?	yeap
1905:50 CAM-2	we were cleared to land
1905:52 CAM-?	((sound of exhalation))

TIME SOURCE	CONTENT
1905:25 LC-3	one eleven thank you
1905:30 RDO-2	okay tower eastern one eleven we just hit an airplane look like ah four oh two or somethin'
1905:32 LC-3	one eleven roger

TIME SOURCE	CONTENT	TIME SOURCE	CONTENT
1905:54 CAM-1	((on PA)) folks this is captain orlando I'm sorry to say there was an airplane on the runway..a little aiirplane...and our right wing did catch that airplane so ah we're holding here for ah further instructions and ah passenger assistance		
1906:07 CAM-1	tell 'em we'd like..let's see what's goin' on why don't we have A system		
1906:11 CAM-3	I'm sorry		
1906:12 CAM-1	why don't we have A system		
1906:17 CAM-3	I don't know		
1906:18 CAM-1	call the company....## we don't have any steering tell 'em we need a tug		
1906:23 CAM-3	okay		
		1906:25 RDO-3	atlanta ramp ah eastern one eleven

TIME SOURCE	CONTENT
1906:34 CAM-1	god almighty.....he had no lights
1906:36 CAM-2	he had no lights
1906:39 CAM-1	I didn't see him till he was right there
1906:40 CAM-2	he was yeah..there were no lights

TIME SOURCE	CONTENT
1906:29 RMP	one eleven
1906:31 RDO-3	ah one eleven ah there's been an accident ah we hit an aircraft on the runway and we don't have any steering we need a tug we're off to the side of runway two six right
1906:41 RMP	copy that off of two six right
1906:44 RDO-3	yeah we're off to the left side of two six right
1906:47 RMP	off to the left of two six right and you need a tug ah have hit another aircraft

TIME SOURCE	CONTENT
1906:50 RDO-1	tower eastern one eleven
1906:52 RDO-3	ah that's correct
1906:53 LC-3	one eleven tower
1906:54 RDO-1	yeah we don't have any hydraulics and we're calling for a tug and ah ah also there's an emergency vehicle right ahead of us here I'm not sure what he's doing
1907:03 LC-3	eastern one eleven just ah hold in position then
1907:12 CAM-1	unbelievable
1907:15 CAM-1	we were on tower and we were cleared to land is that correct
1907:18 CAM-2	that's correct
1907:19 CAM-3	that's correct

APPENDIX D

FLIGHT DATA RECORDER

EXTRACT OF FACTUAL REPORT

ENGINEERING UNITS DUMP
DUMP VARIABLE DICTIONARY

MNEMONIC	PARAMETER NAME	ENGINEERING UNITS
ALT	PRESSURE ALTITUDE	FEET
IAS	COMPUTED AIR SPEED	KNOTS
HEAD	MAGNETIC HEADING	DEG
VERG1H	VERTICAL ACCELERATION	G'S
VERG2H	VERTICAL ACCELERATION	G'S
MIC KEY	VHF MICROPHONE KEYING	N/A

END OF PARAMETER LIST THIS PASS

BEGINNING DUMP OF PASS PARAMETERS

NTSB DATA DUMP PROGRAM
22-JAN-90 EAL,FLT.111,AT ATL,1-18-90,B-727-200

TRIP DATE

S	FRAME	LAPSE	UCT	ALT	IAS	HEAD	VERG1H	VERG1H	VERG1H	VERG1H	VERG2H	VERG2H	VERG2H	VERG2H	
	646.	00:43	01:01	5701.	170.02	242.11	0.9671	0.9671	0.9671	0.9380	1.0108	0.9671	1.0253	0.9816	
				5701.	169.75	241.76	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	
				5675.	170.02	241.76	0.9671	0.9671	0.9671	0.9525	0.9671	0.9671	0.9671	0.9671	
				5675.	170.02	241.76	0.9671	0.9525	0.9671	0.9671	1.0399	0.9671	1.0399	0.9671	
	647.	00:43	01:01	5675.	170.02	241.41	0.9671	1.0108	0.9525	0.9671	0.9816	0.9816	0.9671	0.9671	
				5648.	170.02	241.41	1.0108	0.9816	0.9671	0.9671	0.9671	0.9671	1.0108	0.9671	
				5635.	170.02	241.41	0.9671	0.9671	0.9671	0.9525	0.9525	0.9380	0.9380	0.9380	
				5635.	170.55	241.41	0.9234	0.8943	0.9234	0.9234	0.9380	0.9380	0.9234	0.9088	
	648.	00:43	01:01	5609.	170.55	241.41	0.9234	0.9380	0.9380	0.9380	0.9380	0.9234	0.9380	0.9380	
				5596.	170.81	241.76	0.9525	0.9234	0.9380	0.9380	0.9380	0.9380	0.9380	0.9380	MIC KEY
				5596.	171.33	241.76	0.9525	0.9525	0.9525	0.9525	0.9525	0.9671	1.0108	0.9671	MIC KEY
				5596.	171.59	241.76	0.9671	0.9816	0.9671	0.9671	1.0108	0.9525	0.9671	0.9816	MIC KEY
	649.	00:43	01:01	5570.	172.11	241.76	0.9671	0.9525	1.0108	0.9671	0.9671	0.9671	0.9671	0.9380	
				5557.	172.11	241.76	0.9525	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	
				5530.	172.38	241.76	0.9671	0.9525	0.9816	0.9671	0.9525	0.9671	1.0108	0.9525	
				5517.	172.38	241.76	0.9671	0.9671	1.0108	0.9671	1.0253	0.9671	0.9816	0.9671	
	650.	00:43	01:01	5518.	173.67	242.11	0.9671	1.0108	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671	
				5518.	174.44	242.11	0.9671	0.9816	0.9671	1.0108	0.9816	0.9671	0.9671	0.9671	
				5478.	174.95	242.11	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	0.9816	1.0108	
				5478.	174.95	241.76	1.0108	0.9816	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	
	651.	00:43	01:01	5452.	174.95	242.11	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	
				5439.	175.21	241.76	0.9671	0.9671	0.9671	0.9816	0.9671	0.9816	0.9671	0.9671	
				5439.	175.72	241.76	0.9671	0.9816	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	
				5439.	175.21	241.76	0.9671	0.9671	0.9671	0.9671	1.0108	0.9525	0.9671	0.9962	
	652.	00:43	01:01	5400.	175.72	241.76	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	
				5400.	175.98	241.41	0.9671	0.9671	0.9671	0.9671	0.9816	1.0108	0.9671	0.9816	
				5374.	175.98	241.41	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	
				5361.	176.48	241.41	0.9671	0.9671	0.9671	0.9671	0.9816	0.9816	1.0108	0.9671	
	653.	00:43	01:01	5361.	176.48	241.41	1.0108	0.9671	0.9671	0.9671	0.9671	0.9671	1.0108	0.9816	
				5361.	176.48	241.41	0.9671	0.9816	0.9962	0.9671	0.9671	0.9671	0.9671	0.9671	
				5335.	176.74	241.07	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671	
				5322.	176.74	241.07	0.9525	0.9671	0.9816	0.9671	0.9525	0.9525	0.9525	0.9671	
	654.	00:43	01:01	5322.	176.74	241.07	0.9671	0.9671	0.9671	0.9671	0.9671	0.9525	0.9671	0.9671	
				5296.	177.24	240.73	0.9380	0.9525	0.9380	0.9088	0.9088	0.9380	0.9088	0.9088	
				5296.	177.24	240.39	0.9380	0.9234	0.9088	0.8943	0.9234	0.9088	0.9234	0.9380	
				5283.	177.49	240.73	0.9088	0.8943	0.8943	0.8797	0.8797	0.9088	0.9088	0.8943	
	655.	00:43	01:01	5283.	178.00	241.07	0.9234	0.9525	0.9525	0.9380	0.9380	0.9671	1.0253	1.0253	
				5283.	178.25	242.11	0.9671	0.9671	0.9671	0.9380	1.0108	0.9525	0.9525	1.0253	
				5244.	178.75	243.52	0.9671	0.9380	0.9671	0.9671	0.9671	0.9671	0.9671	0.9816	
				5218.	179.50	244.61	0.9816	0.9671	0.9671	0.9525	0.9671	0.9816	0.9671	0.9671	
	656.	00:43	01:01	5218.	179.00	245.72	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	
				5192.	179.50	246.84	0.9671	0.9525	0.9671	0.9525	0.9525	0.9525	0.9671	0.9380	
				5192.	180.25	247.99	0.9671	0.9525	0.9671	0.9671	0.9525	0.9525	0.9525	0.9525	
				5154.	180.99	249.15	0.9380	0.9380	0.9380	0.9088	0.9380	0.9380	0.9380	0.9380	
	657.	00:43	01:01	5141.	181.73	250.33	0.9380	0.9234	0.9380	0.9671	0.9671	0.9380	0.9525	0.9671	
				5115.	181.73	251.13	0.9525	0.9671	0.9816	0.9525	0.9671	0.9671	0.9525	0.9671	
				5115.	182.95	251.94	0.9380	0.9671	0.9525	0.9088	0.8943	0.9234	1.0836	1.0836	
				5115.	182.46	252.75	1.0981	1.0836	0.8797	1.0981	0.9088	1.0836	0.9088	1.0690	
	658.	00:43	01:01	5102.	182.95	253.57	0.9234	0.9234	0.9088	0.9234	0.9088	0.8943	0.9088	0.9234	
				5102.	182.95	253.98	0.9088	0.9380	0.9380	0.9234	0.9234	0.9525	0.9671	0.9525	
				5076.	182.46	254.81	0.9671	0.9671	0.9671	0.9671	1.0253	0.9525	0.9671	1.0108	
				5076.	181.73	255.65	0.9380	0.9380	0.9671	0.9671	0.9671	0.9671	0.9816	0.9525	
	659.	00:43	01:01	5076.	181.73	256.49	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671	0.9380	
				5063.	181.73	257.77	0.9525	0.9380	0.9380	0.9380	0.9234	0.9380	0.9380	0.9380	
				5063.	181.23	258.63	0.9380	0.9671	1.0108	0.9816	0.9671	0.9671	0.9671	0.9816	
				5063.	180.99	259.49	0.9671	0.9671	1.0108	0.9671	0.9671	0.9671	0.9671	0.9671	
	660.	00:43	01:01	5038.	180.99	260.79	1.0108	0.9525	0.9380	0.9525	0.9671	0.9671	0.9671	0.9525	
				5038.	181.23	262.11	1.0108	0.9671	0.9525	0.9671	0.9525	0.9671	0.9380	0.9525	
				5038.	180.99	263.87	0.9380	0.9671	0.9671	0.9380	0.9671	0.9671	0.9671	0.9671	
				5038.	180.99	264.76	0.9525	1.0253	0.9671	1.0108	0.9671	1.0108	0.9671	0.9525	

NTSB DATA DUMP PROGRAM
22-JAN-90 EAL,FLT.111,AT ATL,1-18-90,B-727-200

S	FRAME	TRIP LAPSE	DATE UCT	ALT	IAS	HEAD	VERG1H	VERG1H	VERG1H	VERG1H	VERG2H	VERG2H	VERG2H	VERG2H	
	661.	00:44	01:01	5025.	180.49	266.09	0.9525	0.9525	0.9380	0.9380	0.9671	0.9525	0.9816	0.9671	
				4999.	180.99	267.43	0.9816	0.9525	0.9671	0.9671	0.9816	1.0253	0.9816	1.0108	
				4999.	181.23	268.77	0.9671	0.9816	0.9671	0.9816	0.9671	0.9816	0.9671	0.9671	
				4986.	181.23	270.00	0.9671	0.9671	0.9816	0.9525	1.0108	0.9671	0.9671	0.9671	
	662.	00:44	01:01	4986.	181.23	270.90	0.9525	0.9816	0.9525	0.9525	0.9671	0.9816	0.9525	0.9671	
				4961.	180.99	271.79	1.0108	0.9380	1.0108	0.9671	0.9525	0.9525	0.9671	0.9380	
				4961.	180.49	273.13	0.9380	0.9525	0.9380	0.9380	0.9380	0.9525	1.0253	0.9380	
				4961.	181.23	274.02	0.9525	0.9671	0.9671	0.9671	0.9816	0.9525	0.9671	0.9671	MIC KEY
	663.	00:44	01:01	4922.	182.22	274.91	0.9671	1.0108	1.0108	0.9671	0.9816	1.0108	0.9816	1.0108	
				4910.	182.95	275.80	0.9671	1.0108	1.0108	0.9671	0.9671	0.9671	0.9816	0.9671	
				4910.	182.95	276.24	0.9671	0.9671	0.9671	0.9816	0.9671	0.9816	0.9671	0.9525	
				4884.	182.95	276.68	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9525	1.0108	
	664.	00:44	01:01	4884.	182.95	277.57	0.9671	0.9525	0.9671	0.9380	0.9671	0.9962	1.0108	0.9671	
				4871.	183.20	278.00	1.0108	0.9671	0.9525	0.9671	1.0253	0.9671	0.9525	1.0108	
				4846.	183.68	278.44	1.0253	0.9525	0.9671	0.9671	1.0108	0.9525	0.9671	0.9525	
				4833.	184.65	278.44	0.9671	0.9671	0.9816	0.9671	0.9671	1.0253	0.9525	0.9525	
	665.	00:44	01:01	4808.	184.65	278.88	0.9671	1.0108	0.9380	0.9816	0.9671	0.9525	0.9671	0.9671	
				4808.	185.86	278.88	0.9816	0.9525	0.9525	1.0108	0.9525	0.9671	1.0108	1.0108	
				4769.	186.10	278.88	0.9671	0.9671	0.9525	0.9671	0.9380	0.9525	0.9671	1.0108	
				4744.	187.30	279.32	0.9380	0.9525	0.9671	0.9525	0.9380	0.9671	0.9671	0.9671	
	666.	00:44	01:01	4731.	188.01	279.32	0.9525	0.9671	0.9671	0.9671	0.9816	0.9380	0.9671	0.9816	
				4731.	188.01	279.75	0.9671	1.0253	0.9671	0.9671	1.0108	1.0108	0.9671	1.0108	
				4693.	188.72	279.32	0.9671	0.9671	0.9671	0.9671	1.0108	0.9671	0.9816	1.0108	MIC KEY
				4668.	188.72	279.32	0.9671	0.9671	1.0108	0.9671	1.0108	0.9380	0.9525	1.0253	MIC KEY
	667.	00:44	01:01	4655.	188.72	279.32	0.9671	0.9671	0.9671	0.9671	0.9525	0.9671	0.9671	0.9525	
				4630.	189.43	279.32	0.9671	1.0108	1.0108	1.0108	0.9671	1.0108	0.9671	0.9816	
				4592.	188.96	279.75	0.9671	0.9671	0.9671	0.9671	1.0253	0.9525	0.9671	0.9671	
				4592.	188.96	279.32	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	1.0108	
	668.	00:44	01:01	4579.	188.72	279.32	1.0108	0.9671	0.9671	0.9525	0.9525	0.9671	0.9816	0.9525	
				4506.	188.72	279.75	1.0108	0.9816	0.9671	0.9671	0.9671	0.9816	0.9525	0.9671	
				4480.	188.72	280.19	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9525	
				4467.	187.53	280.19	0.9525	0.9671	0.9671	0.9671	0.9525	0.9671	0.9525	0.9671	
	669.	00:44	01:01	4467.	187.30	280.19	0.9671	0.9816	0.9671	0.9816	0.9816	0.9671	0.9671	0.9525	
				4427.	186.58	280.19	0.9671	0.9671	0.9816	0.9671	0.9816	1.0399	0.9671	0.9816	
				4401.	186.10	280.62	1.0108	1.0253	0.9671	0.9671	0.9816	0.9816	0.9525	0.9671	
				4388.	185.86	280.19	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9816	0.9816	
	670.	00:44	01:01	4388.	185.38	280.19	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9816	
				4335.	184.65	280.62	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	
				4322.	184.65	280.62	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	
				4296.	184.41	280.62	0.9525	1.0108	0.9525	0.9671	0.9671	0.9671	0.9671	0.9671	
	671.	00:44	01:01	4296.	183.68	280.62	0.9671	0.9671	0.9525	0.9816	0.9671	0.9671	0.9671	0.9671	
				4256.	183.20	280.19	0.9671	0.9525	0.9380	0.9671	0.9671	0.9671	0.9671	0.9671	
				4243.	182.95	280.19	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	
				4243.	182.95	280.19	0.9671	0.9671	0.9671	0.9671	0.9671	1.0108	0.9525	0.9671	
	672.	00:44	01:01	4217.	182.46	279.75	0.9671	0.9671	0.9671	0.9525	0.9671	0.9671	0.9671	0.9671	
				4204.	181.73	279.75	0.9671	0.9671	0.9671	0.9671	1.0108	0.9671	0.9671	0.9671	
				4178.	181.73	279.32	0.9671	0.9671	0.9671	0.9671	0.9816	1.0108	0.9671	0.9671	
				4165.	181.23	279.32	0.9671	0.9671	0.9671	1.0108	0.9816	0.9671	0.9671	0.9671	
	673.	00:44	01:01	4139.	180.99	278.88	0.9816	0.9671	0.9816	0.9671	0.9525	0.9671	0.9671	0.9671	
				4139.	180.99	278.88	0.9671	0.9525	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671	
				4100.	180.49	278.88	0.9671	1.0108	0.9671	0.9525	0.9671	0.9671	0.9671	1.0108	
				4100.	179.75	278.88	0.9671	0.9671	0.9671	0.9671	0.9525	1.0108	1.0253	0.9671	
	674.	00:44	01:01	4087.	180.25	278.88	0.9671	0.9671	0.9671	0.9671	0.9671	1.0253	0.9816	0.9671	
				4061.	179.75	278.88	0.9671	0.9671	0.9380	0.9671	1.0253	0.9525	0.9671	0.9671	
				4061.	178.75	278.88	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	
				4048.	178.75	278.44	1.0108	0.9671	0.9671	0.9671	1.0108	1.0108	0.9671	0.9671	
	675.	00:44	01:01	4009.	177.24	278.44	0.9816	0.9671	1.0108	0.9671	0.9816	0.9671	0.9671	0.9671	
				4009.	177.49	278.44	0.9671	0.9671	0.9525	0.9671	0.9671	0.9671	0.9816	0.9671	
				3983.	176.74	278.00	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	0.9816	1.0108	
*	SYNC LOSS			3983.	~~0.00~~	278.00	0.9671	~~1.0253~~	~~1.5955~~	~~8.4072~~	~~8.4072~~	~~8.4072~~	~~4.3741~~	~~0.9671~~	

NTSB DATA DUMP PROGRAM
22-JAN-90 EAL,FLT.111,AT ATL,1-18-90,B-727-200

TRIP DATE

S	FRAME	LAPSE	UCT	ALT	IAS	HEAD	VERG1H	VERG1H	VERG1H	VERG1H	VERG2H	VERG2H	VERG2H	VERG2H
*		SYNC LOSS	:	10707.	0.00	0.00	8.4364	8.4364	8.4364	8.4364	8.4364	8.4364	8.4364	8.4364
*		SYNC LOSS		10707.	0.00	0.00	8.4364	8.4364	8.4364	8.4364	8.4364	8.4364	8.4364	8.4364
*		SYNC LOSS		10707.	0.00	0.00	8.4364	8.4364	8.4364	8.4364	8.4364	8.4364	8.4364	8.4364
				3905.	175.72	277.13	1.0253	0.9671	0.9380	0.9671	0.9671	0.9525	0.9525	0.9380
	677.	00:45	01:01	3905.	175.21	277.13	0.9525	0.9234	0.9671	0.9671	0.9525	0.9671	0.9671	0.9671
				3879.	175.21	276.68	0.9671	0.9671	0.9671	0.9525	0.9671	0.9816	0.9525	0.9671
				3866.	174.95	276.24	0.9671	0.9671	0.9816	0.9816	0.9525	0.9671	0.9671	0.9816
				3841.	174.44	276.24	0.9671	0.9671	1.0108	0.9380	0.9671	0.9671	1.0253	0.9671
	678.	00:45	01:01	3828.	174.18	276.24	0.9816	0.9816	0.9671	0.9671	0.9816	1.0108	0.9671	0.9816
				3828.	173.67	276.24	1.0399	0.9671	0.9671	1.0399	0.9816	1.0108	0.9525	0.9671
				3802.	174.18	276.24	0.9671	1.0108	1.0108	0.9671	0.9816	0.9671	0.9671	0.9816
				3789.	173.67	276.24	1.0108	0.9671	0.9816	0.9816	0.9671	0.9671	0.9671	0.9816
	679.	00:45	01:01	3763.	173.67	276.24	0.9671	1.0108	0.9671	0.9671	0.9816	0.9816	0.9671	0.9816
				3751.	174.18	276.24	1.0253	0.9671	0.9671	0.9671	0.9671	0.9671	1.0253	0.9671
				3751.	173.67	276.24	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671
				3725.	174.18	276.24	0.9671	0.9671	0.9525	0.9525	0.9671	0.9671	0.9671	0.9671
	680.	00:45	01:01	3712.	173.15	276.24	0.9525	0.9671	0.9816	1.0108	0.9671	0.9671	0.9671	0.9816
				3686.	173.67	276.24	0.9816	0.9816	0.9816	0.9816	0.9671	0.9671	0.9671	0.9671
				3674.	173.67	276.24	0.9816	0.9380	0.9671	0.9525	1.0253	0.9671	0.9671	1.0108
				3674.	173.15	276.24	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671
	681.	00:45	01:01	3635.	173.67	275.80	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	1.0253
				3635.	173.67	275.80	0.9671	0.9816	0.9671	0.9671	0.9671	0.9816	0.9671	0.9816
				3610.	174.44	275.36	0.9671	0.9671	0.9671	0.9671	1.0253	0.9671	0.9816	0.9671
				3597.	174.44	275.36	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9816	0.9671
	682.	00:45	01:01	3597.	174.18	275.36	0.9671	0.9671	0.9671	0.9671	0.9671	1.0108	0.9671	0.9816
				3571.	174.44	274.91	0.9671	0.9525	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671
				3558.	174.18	274.91	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671
				3533.	173.67	274.47	0.9816	0.9671	0.9671	1.0108	0.9671	0.9816	0.9671	0.9525
	683.	00:45	01:01	3520.	173.15	274.47	0.9671	0.9671	0.9816	0.9816	0.9816	0.9816	0.9671	0.9671
				3520.	173.15	274.47	0.9671	0.9816	0.9525	0.9962	0.9816	0.9671	0.9525	0.9671
				3495.	172.89	274.02	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671	0.9525
				3469.	172.38	274.02	1.0108	1.0108	0.9671	1.0108	0.9671	0.9671	1.0108	0.9671
	684.	00:45	01:01	3457.	172.38	274.02	1.0108	1.0108	0.9671	0.9671	0.9671	1.0108	0.9671	0.9671
				3431.	172.11	274.47	0.9816	1.0253	1.0108	0.9671	0.9816	0.9671	0.9671	0.9671
				3431.	171.59	274.47	0.9816	0.9671	0.9525	0.9816	0.9671	0.9671	0.9671	1.0108
				3418.	171.59	274.91	0.9671	0.9671	0.9671	0.9671	0.9525	0.9671	0.9816	0.9671
	685.	00:45	01:01	3380.	171.59	274.91	0.9671	0.9671	1.0108	0.9671	0.9525	0.9816	1.0399	1.0108
				3380.	171.59	275.36	1.0399	0.9671	0.9816	0.9525	0.9671	0.9671	0.9671	0.9671
				3355.	171.59	275.36	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	1.0108	0.9671
				3355.	172.11	275.36	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9816	0.9816
	686.	00:45	01:01	3342.	172.11	275.80	0.9671	1.0108	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671
				3317.	172.11	275.80	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	1.0108	0.9671
				3304.	172.38	275.80	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9525
				3279.	172.38	275.80	0.9671	1.0108	0.9671	0.9671	0.9671	0.9816	1.0108	0.9525
	687.	00:45	01:01	3279.	172.38	276.24	0.9816	0.9671	0.9816	0.9671	0.9816	0.9671	0.9816	0.9671
				3267.	172.89	276.24	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671
				3241.	173.15	276.24	1.0108	0.9671	0.9671	0.9816	0.9671	0.9671	0.9816	1.0108
				3229.	172.89	276.24	0.9671	0.9671	0.9671	0.9671	1.0108	0.9671	0.9816	0.9671
	688.	00:45	01:01	3229.	172.89	276.24	1.0108	0.9671	0.9671	1.0108	0.9962	0.9671	0.9671	0.9671
				3204.	172.38	275.80	0.9671	0.9671	0.9816	0.9671	0.9671	0.9816	0.9671	0.9816
				3204.	172.89	275.80	0.9525	0.9525	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671
				3204.	173.67	275.80	0.9671	0.9671	0.9671	0.9816	1.0108	0.9671	0.9671	0.9671
	689.	00:45	01:01	3191.	174.18	275.80	1.0108	0.9671	0.9671	0.9816	0.9671	0.9671	0.9816	0.9671
				3166.	173.67	275.80	0.9671	1.0108	0.9671	0.9816	1.0108	0.9671	0.9671	0.9380
				3153.	173.67	275.80	0.9525	0.9525	0.9671	1.0253	0.9671	0.9671	0.9380	0.9380
				3153.	173.67	275.80	0.9380	0.9671	0.9671	0.9525	1.0399	0.9671	0.9816	0.9525
	690.	00:45	01:01	3128.	173.67	275.80	0.9525	0.9671	0.9525	0.9380	0.9380	0.9671	0.9671	0.9525
				3128.	173.67	276.24	0.9525	0.9671	1.0108	0.9671	1.0108	0.9671	0.9671	1.0108
				3128.	174.18	276.24	0.9671	0.9671	1.0253	0.9671	1.0108	0.9671	0.9525	1.0108	0.9380
				3090.	173.67	276.24	0.9671	1.0108	0.9380	0.9525	1.0108	0.9671	0.9525	0.9380

NTSB DATA DUMP PROGRAM
22-JAN-90 EAL,FLT.111,AT ATL,1-18-90,B-727-200

TRIP DATE

S	FRAME	LAPSE	UCT	ALT	IAS	HEAD	VERG1H	VERG1H	VERG1H	VERG1H	VERG2H	VERG2H	VERG2H	VERG2H	
	691.	00:46	01:01	3090.	173.67	276.68	0.9380	0.9671	0.9525	1.0108	0.9671	0.9671	0.9816	1.0108	
				3065.	173.67	277.13	0.9671	0.9671	0.9671	1.0108	1.0108	0.9525	0.9816	1.0108	
				3053.	174.44	277.13	0.9671	0.9525	0.9816	1.0108	0.9380	0.9525	0.9671	0.9671	
				3053.	174.44	277.57	0.9671	0.9671	0.9671	0.9816	1.0253	0.9816	1.0108	0.9671	
	692.	00:46	01:01	3028.	174.18	277.57	0.9671	1.0108	0.9671	1.0108	0.9816	0.9671	0.9671	0.9671	
				3015.	174.95	278.00	0.9671	0.9671	1.0399	0.9671	0.9816	0.9671	0.9816	0.9671	
				2990.	174.95	278.44	0.9671	0.9671	0.9671	0.9671	1.0108	0.9671	0.9816	1.0108	
				2978.	174.44	278.44	0.9525	0.9380	1.0399	0.9380	0.9380	0.9671	0.9671	1.0253	
	693.	00:46	01:01	2978.	174.95	278.44	0.9525	0.9671	0.9671	0.9816	1.0108	0.9525	0.9816	1.0108	
				2953.	175.21	278.44	0.9380	0.9671	0.9380	1.0108	0.9671	1.0108	0.9671	0.9671	
				2940.	175.72	278.88	0.9380	0.9380	0.9816	1.0253	0.9671	1.0108	0.9671	0.9816	
				2915.	175.72	278.88	0.9816	0.9525	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	
	694.	00:46	01:01	2903.	175.72	278.44	0.9671	0.9816	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671	
				2903.	175.98	278.44	0.9671	0.9816	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	
				2878.	175.98	278.44	0.9671	0.9671	1.0108	0.9671	0.9671	0.9816	0.9671	0.9671	
				2866.	176.48	278.44	0.9816	0.9671	0.9671	1.0108	0.9671	0.9671	0.9671	0.9671	
	695.	00:46	01:01	2841.	175.98	278.44	0.9671	0.9671	0.9671	1.0253	0.9671	1.0253	1.0253	0.9525	
				2828.	176.48	278.44	0.9671	0.9816	0.9671	1.0253	0.9671	0.9671	0.9671	0.9671	
				2828.	176.74	278.44	0.9671	0.9671	1.0108	0.9671	0.9962	0.9671	0.9671	1.0108	
				2791.	176.74	278.44	0.9671	0.9671	1.0108	0.9816	0.9671	0.9671	1.0108	0.9671	
	696.	00:46	01:01	2766.	176.74	278.44	0.9671	0.9671	0.9671	0.9671	0.9816	0.9816	0.9525	0.9671	
				2754.	176.74	278.44	0.9671	0.9671	0.9816	0.9671	0.9525	0.9671	0.9816	0.9671	
				2754.	176.74	278.00	0.9671	0.9671	0.9671	0.9525	0.9525	0.9671	0.9525	0.9525	
				2729.	176.48	277.57	0.9380	0.9525	0.9525	0.9671	0.9380	0.9234	1.0690	0.9380	
	697.	00:46	01:01	2717.	175.98	277.57	0.9380	0.9088	0.9088	0.9671	0.8943	0.9380	0.9380	0.9380	
				2692.	175.72	277.13	0.9380	0.9671	0.9671	0.9671	0.9671	0.9525	0.9671	0.9671	
				2692.	175.21	277.13	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9816	0.9671	
				2667.	174.44	276.68	0.9671	0.9671	0.9671	0.9525	0.9671	0.9671	0.9816	1.0108	
	698.	00:46	01:01	2668.	174.18	276.24	0.9525	1.0108	1.0108	0.9380	0.9671	1.0253	0.9671	0.9525	
				2655.	173.15	276.24	0.9671	0.9380	0.9380	0.9671	0.9671	0.9816	0.9816	0.9816	
				2631.	172.89	276.24	0.9671	0.9671	0.9671	0.9816	0.9816	0.9380	0.9525	0.9671	
				2618.	172.38	275.80	0.9816	0.9671	0.9671	0.9671	0.9380	0.9671	0.9671	1.0399	MIC KEY
	699.	00:46	01:01	2594.	172.11	275.80	0.9671	0.9525	1.0253	1.0253	1.0108	0.9671	0.9671	0.9671	MIC KEY
				2594.	171.33	276.24	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	
				2594.	170.55	276.24	0.9671	0.9525	0.9525	0.9671	0.9671	0.9671	0.9671	0.9671	
				2594.	170.02	276.24	0.9671	1.0108	1.0108	0.9671	0.9671	0.9671	0.9816	0.9816	
	700.	00:46	01:01	2581.	169.23	276.24	0.9671	0.9816	0.9671	0.9671	0.9816	0.9671	0.9671	1.0108	
				2557.	168.96	276.68	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	
				2544.	168.43	277.13	0.9671	0.9380	0.9671	0.9671	0.9525	0.9671	0.9671	0.9671	
				2520.	167.63	277.57	0.9671	0.9380	0.9671	0.9525	0.9525	0.9671	0.9671	0.9671	
	701.	00:46	01:01	2519.	167.36	278.00	0.9671	0.9816	0.9671	0.9671	0.9671	0.9816	0.9816	0.9816	
				2519.	166.55	278.00	0.9671	0.9671	0.9671	0.9671	1.0253	0.9525	0.9671	0.9525	
				2519.	165.74	278.00	0.9380	0.9380	0.9380	0.9380	0.9671	0.9671	1.0108	0.9525	
				2483.	164.66	278.00	0.9671	0.9671	1.0108	0.9525	0.9671	0.9671	0.9525	0.9380	
	702.	00:46	01:01	2471.	164.38	277.57	0.9380	0.9525	0.9380	0.9525	1.0108	0.9671	0.9525	0.9671	
				2471.	163.83	277.57	0.9671	0.9525	0.9380	1.0108	0.9525	0.9671	0.9671	0.9816	
				2446.	163.83	277.57	0.9671	0.9525	0.9671	0.9671	0.9671	0.9671	1.0108	1.1272	
				2446.	163.01	277.57	1.0544	0.9816	0.9816	0.9671	0.9816	0.9671	0.9525	0.9671	
	703.	00:46	01:01	2446.	163.56	277.57	0.9671	0.9962	0.9671	0.9671	0.9671	0.9525	0.9380	0.9671	
				2434.	162.73	277.57	1.0399	0.9816	0.9671	0.9671	0.9380	1.0399	0.9234	0.9671	
				2397.	161.90	277.57	0.9525	1.0399	0.9816	0.9671	0.9816	1.0108	1.0544	0.9671	
				2373.	161.07	277.57	1.0108	0.9671	0.9671	0.9671	0.9671	1.0399	0.9525	0.9671	
	704.	00:46	01:01	2373.	161.90	277.13	0.9671	1.0253	0.9671	0.9380	0.9525	0.9525	0.9525	0.9671	
				2361.	162.73	277.13	0.9671	0.9671	0.9671	0.9380	0.9671	0.9671	0.9380	0.9525	
				2336.	160.23	277.13	0.9671	0.9671	0.9671	0.9671	0.9816	0.9816	0.9671	1.0108	
				2324.	158.54	277.13	0.9380	0.9816	1.0108	1.0108	1.0108	0.9671	0.9671	1.0108	
	705.	00:46	01:01	2300.	157.97	277.13	0.9380	0.9671	1.0108	0.9234	0.9525	0.9380	0.9088	0.9380	
				2300.	158.54	277.13	0.9671	0.9380	1.0544	0.9380	0.9380	0.9525	0.9234	0.9380	
				2300.	158.82	276.24	0.9380	0.9380	0.9525	0.9671	0.9671	1.0399	0.9671	0.9671	
				2287.	158.82	275.80	1.0253	0.9671	0.9525	1.0108	0.9671	0.9671	1.0108	0.9671	

NTSB DATA DUMP PROGRAM
22-JAN-90 EAL,FLT.111,AT ATL,1-18-90,B-727-200

TRIP DATE

S	FRAME	LAPSE	UCT	ALT	IAS	HEAD	VERG1H	VERG1H	VERG1H	VERG1H	VERG2H	VERG2H	VERG2H	VERG2H
	706.	00:47	01:01	2263.	158.82	274.91	0.9962	0.9671	0.9525	1.0108	0.9671	0.9671	0.9671	0.9671
				2239.	158.54	274.47	1.0108	0.9671	0.9816	0.9671	0.9671	1.0108	1.0253	0.9671
				2227.	158.54	274.47	1.0108	0.9671	0.9671	1.0108	0.9671	0.9525	0.9671	0.9380
				2227.	157.68	274.47	0.9380	0.9671	1.0108	0.9380	0.9671	1.0108	0.9671	1.0108
	707.	00:47	01:01	2190.	157.68	274.47	0.9671	0.9816	1.0108	0.9671	0.9671	0.9671	0.9671	0.9816
				2166.	157.11	274.91	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671
				2166.	157.11	275.80	0.9525	0.9671	0.9380	0.9671	0.9671	0.9671	0.9380	0.9380
				2154.	157.11	275.80	0.9525	0.9671	0.9671	0.9671	0.9671	0.9671	0.9380	1.0108
	708.	00:47	01:01	2130.	156.82	276.24	0.9816	0.9525	0.9671	1.0108	0.9671	0.9671	0.9816	0.9671
				2118.	157.11	276.24	0.9816	1.0108	0.9525	0.9671	0.9671	0.9525	0.9671	0.9816
				2093.	156.82	276.68	0.9671	0.9671	0.9671	0.9671	1.0108	0.9816	0.9816	0.9816
				2057.	156.82	276.68	0.9671	0.9671	0.9671	0.9816	0.9671	0.9816	0.9671	1.0253
	709.	00:47	01:01	2021.	156.82	277.13	0.9525	0.9671	0.9671	0.9380	0.9525	0.9671	0.9671	1.0399
				2021.	156.82	277.13	0.9525	0.9671	0.9671	1.0399	0.9671	0.9816	0.9671	1.0108
				2021.	157.11	276.68	0.9671	0.9671	0.9816	0.9671	1.0108	0.9671	0.9816	0.9525
				2009.	157.11	276.68	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671
	710.	00:47	01:01	2009.	157.68	276.24	0.9671	0.9671	0.9671	0.9816	1.0108	0.9671	0.9671	0.9671
				2009.	158.54	276.68	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671
				1973.	158.82	276.68	0.9671	0.9525	0.9671	0.9671	0.9671	0.9525	0.9671	0.9234
				1949.	158.82	276.68	0.9671	0.9525	0.9380	0.9525	0.9525	0.9380	0.9380	0.9380
	711.	00:47	01:01	1937.	158.54	276.68	0.9380	0.9380	0.9380	0.9380	0.9525	0.9671	0.9671	0.9525
				1937.	157.68	276.68	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671
				1937.	157.11	276.68	0.9671	0.9671	0.9671	0.9525	0.9671	0.9671	0.9671	0.9525
				1913.	156.82	276.68	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	0.9525	0.9671
	712.	00:47	01:01	1853.	156.25	276.68	0.9525	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671
				1877.	155.38	276.68	0.9671	0.9816	0.9671	0.9816	0.9525	0.9816	0.9671	0.9671
				1877.	154.80	276.68	0.9671	1.0108	0.9671	0.9671	0.9816	1.0108	0.9816	0.9671
				1877.	153.93	276.68	0.9671	0.9816	0.9671	0.9671	0.9816	0.9816	0.9671	0.9671
	713.	00:47	01:01	1853.	153.63	276.68	0.9816	0.9816	0.9380	0.9525	0.9525	0.9380	0.9380	1.0399
				1853.	152.75	276.68	0.9525	0.9380	0.9088	0.9380	0.9525	0.9234	0.9234	0.9671
				1841.	152.16	276.24	0.9525	0.9088	0.9234	0.9525	0.9525	0.9525	1.0253	0.9380
				1805.	153.04	276.24	0.9671	0.9671	0.9671	0.9525	0.9671	0.9671	0.9816	0.9671
	714.	00:47	01:01	1805.	152.75	276.68	0.9671	0.9671	0.9671	1.0108	0.9671	0.9525	0.9816	0.9671
				1781.	151.86	276.68	0.9671	0.9525	0.9671	0.9380	0.9671	0.9671	0.9525	0.9671
				1781.	151.86	276.68	0.9525	0.9671	0.9671	0.9816	1.0108	0.9671	0.9671	0.9671
				1781.	151.86	276.68	0.9671	0.9671	0.9525	0.9525	0.9525	0.9234	0.9671	0.9525
	715.	00:47	01:01	1769.	151.86	277.13	0.9525	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671
				1745.	151.27	277.13	0.9816	0.9380	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671
				1733.	150.37	277.13	0.9671	0.9816	0.9671	0.9671	0.9671	0.9525	0.9671	0.9671
				1709.	150.07	277.13	0.9671	0.9671	0.9525	0.9671	0.9525	0.9816	0.9671	0.9671
	716.	00:47	01:01	1709.	149.47	277.13	0.9671	0.9816	0.9816	0.9671	0.9671	0.9671	0.9671	0.9525
				1709.	148.56	277.13	0.9671	0.9671	0.9816	1.0399	0.9671	0.9816	0.9525	0.9671
				1697.	148.25	277.57	0.9671	0.9671	1.0108	0.9525	0.9671	0.9671	0.9816	0.9671
				1673.	148.25	277.13	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9816	0.9671
	717.	00:47	01:01	1661.	147.64	277.13	0.9525	0.9671	0.9671	0.9816	0.9671	0.9671	0.9525	0.9525
				1638.	147.34	277.13	0.9816	0.9671	0.9671	0.9816	0.9671	0.9525	0.9816	0.9671
				1638.	146.72	277.13	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9525
				1638.	146.42	277.13	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	1.0253
	718.	00:47	01:01	1626.	146.42	276.68	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671
				1590.	146.42	276.68	0.9671	1.0108	0.9671	0.9525	0.9671	0.9671	0.9671	0.9671
				1590.	146.42	275.80	0.9816	0.9816	0.9671	0.9671	0.9816	0.9671	0.9816	0.9525
				1590.	145.80	275.36	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9525
	719.	00:47	01:01	1566.	145.18	274.47	0.9816	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671	0.9816
				1555.	144.87	274.02	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	1.0253
				1531.	144.87	274.02	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9816
				1519.	144.87	273.58	0.9816	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671	0.9525
	720.	00:47	01:01	1495.	144.87	273.58	0.9671	0.9816	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671
				1495.	144.87	273.58	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	1.0108	0.9816
				1495.	144.24	273.58	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671
				1460.	144.24	274.02	0.9816	0.9525	0.9671	0.9671	1.0108	0.9816	0.9671	0.9671

NTSB DATA DUMP PROGRAM
22-JAN-90 EAL,FLT.111,AT ATL,1-18-90,B-727-200

TRIP DATE

S FRAME	LAPSE	UCT	ALT	IAS	HEAD	VERG1H	VERG1H	VERG1H	VERG1H	VERG2H	VERG2H	VERG2H	VERG2H
721.	00:48	01:01	1436.	144.24	274.47	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671
			1424.	144.24	274.91	0.9525	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9816
			1424.	144.24	274.47	1.0253	0.9671	0.9816	1.0108	0.9671	0.9671	0.9671	0.9671
			1424.	144.24	274.91	0.9816	0.9816	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671
722.	00:48	01:01	1389.	144.24	274.91	0.9816	0.9816	0.9671	0.9525	0.9671	0.9816	0.9671	0.9671
			1365.	144.87	274.91	0.9671	0.9816	0.9671	0.9816	0.9816	0.9671	0.9671	0.9671
			1365.	144.87	274.91	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9525
			1354.	145.18	274.91	0.9525	0.9671	0.9671	1.0108	1.0108	0.9671	0.9816	0.9816
723.	00:48	01:01	1354.	145.18	274.91	0.9525	0.9671	0.9671	0.9671	0.9525	0.9671	0.9671	0.9380
			1318.	145.18	274.91	0.9525	0.9671	0.9671	0.9671	0.9525	0.9671	0.9671	0.9671
			1295.	145.18	274.91	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671
			1295.	145.18	274.91	0.9671	0.9671	0.9671	0.9671	1.0253	0.9525	0.9816	0.9671
724.	00:48	01:01	1283.	144.87	274.91	0.9380	0.9671	0.9671	0.9671	1.0253	0.9671	0.9816	0.9671
			1283.	144.87	274.47	0.9671	0.9671	0.9671	1.0253	1.0108	0.9671	0.9671	0.9671
			1260.	144.87	274.47	1.0108	0.9816	0.9671	0.9671	1.0253	1.0108	0.9525	0.9671
			1248.	144.87	274.47	0.9525	0.9525	0.9525	0.9671	0.9671	0.9671	0.9671	0.9671
725.	00:48	01:01	1225.	144.87	274.02	0.9671	0.9671	0.9525	0.9525	0.9525	0.9962	0.9671	1.0253
			1213.	144.87	274.02	0.9671	1.0108	0.9816	0.9816	0.9671	0.9671	0.9525	0.9816
			1213.	144.87	274.02	0.9816	0.9671	0.9671	0.9816	0.9816	0.9671	0.9816	0.9525
			1178.	145.18	274.47	0.9816	0.9671	0.9671	0.9816	0.9816	0.9816	0.9671	0.9671
726.	00:48	01:01	1154.	145.18	274.02	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9816	0.9671
			1154.	145.18	274.02	0.9671	0.9816	0.9671	0.9671	1.0108	0.9671	0.9671	0.9816
			1143.	145.80	274.02	0.9816	0.9671	0.9816	0.9816	0.9816	0.9671	0.9671	0.9816
			1119.	145.80	274.47	0.9816	0.9671	0.9671	0.9525	0.9671	0.9671	0.9671	0.9671
727.	00:48	01:01	1108.	145.18	274.02	0.9671	0.9671	0.9671	0.9816	0.9671	0.9816	0.9671	0.9671
			1085.	144.87	274.47	0.9671	0.9525	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671
			1061.	144.87	274.02	0.9671	0.9671	0.9380	0.9671	0.9525	0.9671	0.9525	0.9380
			1050.	144.87	274.02	0.9671	0.9671	0.9671	0.9525	0.9671	0.9671	0.9525	0.9671
728.	00:48	01:01	1049.	143.93	274.47	0.9671	0.9671	0.9671	0.9671	0.9380	0.9671	0.9816	0.9671
			1026.	142.98	274.02	0.9671	0.9671	0.9671	0.9671	0.9671	0.9816	0.9816	0.9816
			1015.	142.35	274.47	0.9671	0.9671	0.9671	0.9671	0.9525	0.9525	0.9671	0.9671
			991.	142.98	274.47	0.9380	0.9525	0.9671	0.9671	0.9671	0.9525	0.9671	0.9525
729.	00:48	01:01	992.	142.35	274.47	0.9816	0.9671	0.9816	0.9962	0.9671	0.9671	1.0108	0.9525
			980.	142.98	274.91	0.9671	0.9671	0.9671	1.0108	0.9671	0.9671	0.9671	0.9816
			980.	142.03	274.91	1.0108	0.9816	0.9671	0.9525	0.9671	0.9671	0.9671	0.9671
			957.	142.35	274.91	0.9671	0.9671	0.9671	0.9671	0.9816	0.9962	0.9671	0.9380
730.	00:48	01:01	945.	142.35	275.36	0.9671	0.9671	0.9525	0.9671	0.9671	0.9671	0.9671	0.9671
			910.	142.98	274.91	0.9671	0.9671	0.9816	0.9525	0.9671	0.9671	0.9671	0.9671
			922.	142.35	274.47	0.9671	0.9525	0.9671	0.9671	0.9671	0.9671	0.9525	0.9671
			910.	142.35	274.47	0.9671	0.9816	0.9525	0.9671	0.9671	0.9671	0.9525	0.9671
731.	00:48	02:02	887.	142.98	274.47	0.9671	0.9671	0.9671	1.0108	0.9671	0.9671	0.9816	0.9816
			876.	142.98	274.02	0.9671	0.9671	0.9671	0.9671	0.9816	0.9816	0.9671	0.9671
			853.	142.35	274.02	0.9671	0.9671	0.9816	0.9671	0.9671	0.9816	0.9671	0.9671
			853.	142.35	274.02	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671
732.	00:48	02:02	818.	142.98	274.47	0.9671	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671
			806.	142.98	274.91	0.9525	0.9671	0.9671	0.9671	0.9671	0.9671	1.0253	0.9671
			783.	142.35	274.91	1.0108	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	0.9671
			783.	142.35	275.80	0.9671	0.9380	0.9525	0.9380	0.9088	0.9088	0.9088	0.9380
733.	00:48	02:02	749.	143.30	276.24	0.8943	0.9088	0.8943	1.0690	0.9380	0.9380	0.9380	0.9525
			737.	144.87	276.24	0.9671	0.9525	0.9380	0.9671	0.9671	0.9671	0.9525	0.9380
			737.	143.30	276.24	0.9671	0.9380	0.9380	0.9380	0.9380	0.9525	0.9525	0.9234
			714.	142.35	275.80	0.9380	0.9380	0.9525	0.9380	0.9525	0.9380	0.9234	0.9380
734.	00:48	02:02	691.	142.03	275.80	0.8943	0.9380	0.9088	0.9088	0.9088	0.9088	1.0836	1.1272
			680.	141.07	275.36	0.8797	1.3456	1.3311	1.2583	0.9671	0.9380	0.9671	1.0108
			691.	140.43	275.36	0.8943	0.9671	1.0108	0.9088	0.9380	0.9088	0.9234	1.0108
			691.	139.46	275.36	1.1855	0.8943	1.1855	1.1272	0.9671	0.9234	0.8797	0.9234
735.	00:48	02:02	691.	139.13	275.80	0.9380	0.9671	0.9380	0.9088	1.1564	0.9671	1.1272	0.9816
			714.	137.50	276.24	0.9380	0.9088	0.9671	0.9816	0.9088	0.9671	0.9088	1.1272
			714.	134.83	275.80	1.1127	0.8652	0.9380	1.0108	1.0399	0.9816	1.0399	0.9088
			714.	131.43	274.91	0.9380	0.8506	0.8943	0.9671	0.8943	0.9671	0.9671	0.9380

NTSB DATA DUMP PROGRAM
22-JAN-90 EAL,FLT.111,AT ATL,1-18-90,B-727-200

TRIP DATE

S FRAME	LAPSE	UCT	ALT	IAS	HEAD	VERG1H	VERG1H	VERG1H	VERG1H	VERG2H	VERG2H	VERG2H	VERG2H	
736.	00:49	02:02	714.	127.21	274.91	0.9671	0.9525	0.9671	0.9671	0.8506	0.9380	0.9671	0.9671	
			714.	122.47	274.91	0.8506	0.9671	0.9671	1.1127	0.9380	0.9671	0.9671	0.9088	
			714.	117.92	274.91	0.9671	0.9088	1.1855	1.2000	1.1709	0.9234	0.9234	0.9380	
			714.	113.98	274.02	0.9671	0.9525	0.9816	0.8215	0.8943	0.8215	0.9380	0.8506	
737.	00:49	02:02	714.	109.48	271.34	0.9671	1.0981	0.9380	1.0399	0.8360	0.9088	0.8797	1.2437	
			737.	105.65	267.43	1.0981	0.9088	0.9380	0.8943	1.0981	1.0981	0.8652	0.9088	
			691.	101.66	270.90	0.9380	0.8360	1.0108	0.8943	0.9380	0.9671	1.0690	0.9816	
			714.	97.50	274.91	1.0253	1.1709	0.9525	0.8360	0.9671	0.9671	0.8943	0.9671	
738.	00:49	02:02	737.	94.14	276.24	0.9380	0.9380	0.9671	0.9671	0.9816	1.0253	0.9671	0.9671	
			714.	90.64	275.80	0.9525	0.9088	0.9671	1.0108	0.8797	0.9525	0.8943	0.8943	
			737.	86.98	274.91	0.9525	1.0399	0.9088	0.9088	0.9088	0.9671	0.9671	0.9234	
			737.	82.56	274.91	0.9234	0.9671	0.9525	0.9671	0.8943	0.9234	0.9234	0.9671	
739.	00:49	02:02	737.	77.90	276.68	0.9380	0.9671	0.9671	0.9380	0.9816	0.9525	0.9380	0.9671	
			737.	75.46	278.00	0.8943	0.9088	0.9671	0.9671	0.9671	0.9088	0.9234	0.9671	
			737.	70.33	278.44	0.9525	1.0108	0.9380	0.9671	0.9671	0.9816	0.9671	0.9671	
			737.	65.51	278.00	1.1272	0.9234	0.9234	0.9088	0.9671	0.9671	0.9380	0.9380	
740.	00:49	02:02	737.	61.84	277.57	0.8652	0.9380	0.9525	0.9380	0.9380	0.9671	0.9380	0.9816	MIC KEY
			737.	57.12	276.68	0.8506	0.9816	1.0690	1.1272	0.9671	0.9671	0.8797	0.9380	MIC KEY
			737.	54.60	276.68	0.9671	0.9380	0.8943	0.9380	0.9671	0.9234	0.9234	0.9816	MIC KEY
			737.	50.14	277.13	0.9380	1.0981	0.9380	0.9380	0.8506	0.9088	0.9380	1.1418	MIC KEY
741.	00:49	02:02	738.	48.24	277.13	0.9088	1.0981	0.8069	0.9671	0.9380	1.0690	0.9380	1.0253	
			738.	45.23	277.13	0.9380	0.9525	1.0836	0.8943	0.9671	0.8360	0.9380	0.9380	MIC KEY
			738.	42.01	276.68	0.8360	0.9234	0.9088	0.9671	1.0690	0.9380	0.9525	0.9380	MIC KEY
			738.	38.53	276.24	0.9671	1.0399	1.0690	0.9380	0.9671	0.9816	0.9671	0.9816	MIC KEY
742.	00:49	02:02	737.	34.69	275.80	0.9525	0.9234	0.9816	0.9525	0.9234	0.9525	1.0253	0.9671	
			737.	30.37	274.91	1.0690	0.9671	0.9525	1.0108	0.9380	0.9380	0.9525	0.9525	
			737.	25.32	273.58	0.8943	0.9671	0.9380	0.9088	0.9816	0.9671	0.9380	0.9380	
			737.	18.98	271.79	0.9671	0.9671	1.0108	0.9234	0.9234	0.9380	1.0253	0.8943	
743.	00:49	02:02	738.	13.14	269.66	0.9380	1.0108	0.9671	0.9671	0.9380	0.9816	0.9525	0.9234	
			738.	8.88	267.87	0.9380	0.9671	0.9671	0.9234	0.9525	0.9380	0.9380	0.9671	
			738.	8.88	266.54	0.9234	0.9671	0.9671	0.9525	0.9671	0.9671	0.9671	0.9671	
			738.	8.88	265.64	0.9671	0.9671	0.9671	0.9671	0.9380	0.9962	0.9234	0.9671	
744.	00:49	02:02	738.	0.00	264.76	0.9671	0.8943	0.8943	0.8797	1.0399	1.0253	0.9088	1.0108	
			738.	0.00	263.87	0.9671	0.9380	0.9671	0.9380	0.9671	0.9671	0.9671	0.9671	
			738.	0.00	262.11	0.9380	0.9671	0.9671	1.0690	0.9671	0.9962	1.0399	1.0399	
			738.	0.00	260.36	0.9525	0.9671	0.9380	1.0108	0.9671	0.9671	0.9671	0.9525	
745.	00:49	02:02	738.	0.00	258.20	0.9671	0.9671	0.9380	0.9671	0.9525	0.9525	0.9671	0.9525	
			738.	0.00	256.49	0.9671	0.9671	0.9525	0.9525	0.9671	0.9380	0.9671	0.9671	
			738.	0.00	254.81	0.9525	0.9671	0.9380	0.9671	0.9671	0.9380	0.9525	0.9816	
			738.	0.00	253.57	0.9816	0.9671	0.9671	0.9671	0.9671	0.9816	0.9816	0.9671	
746.	00:49	02:02	738.	0.00	252.34	0.9671	0.9671	0.9671	0.9816	0.9525	0.9671	0.9671	0.9816	
			715.	0.00	251.53	0.9525	0.9671	0.9671	0.9671	0.9671	0.9671	0.9525	0.9671	
			738.	0.00	250.73	0.9671	0.9525	0.9671	0.9525	0.9671	0.9671	0.9525	0.9525	
			738.	0.00	249.94	0.9816	0.9671	0.9671	0.9525	0.9816	0.9525	0.9380	0.9671	MIC KEY
747.	00:49	02:02	738.	0.00	249.15	0.9671	0.9671	0.9816	0.9525	0.9671	0.9671	0.9671	0.9380	MIC KEY
			715.	0.00	248.37	0.9671	0.9671	0.9525	0.9671	0.9525	0.9671	0.9671	0.9380	MIC KEY
			738.	0.00	247.60	0.9671	0.9525	0.9671	0.9671	0.9671	0.9671	0.9525	0.9671	MIC KEY
			738.	0.00	247.22	0.9671	0.9380	0.9671	0.9525	1.0108	0.9380	0.9380	0.9816	MIC KEY
748.	00:49	02:02	738.	0.00	246.84	0.9671	0.9671	0.9671	0.9671	1.0253	0.9671	0.9671	0.9671	
			738.	0.00	246.46	0.9816	0.9816	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	
			715.	0.00	246.09	0.9671	0.9816	0.9671	0.9816	0.9671	0.9671	0.9816	0.9816	
			738.	0.00	245.72	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	
749.	00:49	02:02	738.	0.00	245.35	0.9671	0.9671	0.9671	0.9671	0.9671	0.9671	0.9525	0.9671	
			738.	0.00	244.98	0.9671	0.9671	0.9671	0.9671	0.9671	0.9816	1.0253	0.9671	
			738.	0.00	244.98	0.9671	0.9671	0.9671	0.9671	0.9525	0.9671	0.9816	0.9816	MIC KEY
			738.	0.00	244.98	0.9671	0.9671	0.9671	0.9671	0.9816	0.9816	0.9671	0.9671	MIC KEY
750.	00:49	02:02	738.	0.00	244.61	0.9671	0.9816	0.9816	0.9671	0.9671	0.9671	0.9816	0.9671	MIC KEY
			738.	0.00	244.61	0.9816	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671	MIC KEY
			738.	0.00	244.61	0.9671	0.9671	0.9816	0.9816	0.9816	0.9671	0.9671	0.9671	MIC KEY
			738.	0.00	244.25	0.9671	0.9671	0.9671	0.9671	0.9816	0.9671	0.9671	0.9671	MIC KEY

APPENDIX E

RADAR DATA STUDY

March 19, 1990

Radar Data Study
DCA-90-MA-017

A. ACCIDENT

Location: Hartsfield International Airport, Atlanta, Georgia
Date : January 18, 1990
Time : 0005 Universal Coordinated Time
Aircraft: Eastern Airlines Flight No. 111, a Boeing 727-231, N8867E, (EAL111) and N44UE, an EPPS Air Service Beechcraft BE-A100, (N44UE)

B. GROUP

Not Applicable.

C. SUMMARY

A radar reconstruction of the flightpaths of the accident aircraft (EAL111 and N44UE) and an additional aircraft (COA9687) in the vicinity at the time of the accident was performed. Ground track depictions were produced along with data describing the relative spacing between the aircraft involved and plots of the calculated groundspeeds of those aircraft. Abridged radio transmissions between the Atlanta tower and aircraft involved are included on the ground track plots.

The radar data and the communications tape recording were furnished by Atlanta Terminal Radar Approach Control (TRACON) to the National Transportation Safety Board from the Automated Radar Terminal Systems (ARTS) III for the time interval surrounding the accident. The data were read, processed, reformatted and plotted at the Safety Board's computing facilities.

D. DETAILS OF INVESTIGATION

The radar data obtained from Atlanta TRACON were read from magnetic tape then processed and reformatted at the computing facilities of the Engineering Services Division. The beacon target reports obtained from the extractor tape were converted from the range (in nautical miles) and azimuth (in degrees from magnetic North) format to an X (in nautical miles true East) and Y (in nautical miles true North) coordinate system. In both formats, the origin remained the Airport Surveillance Radar at

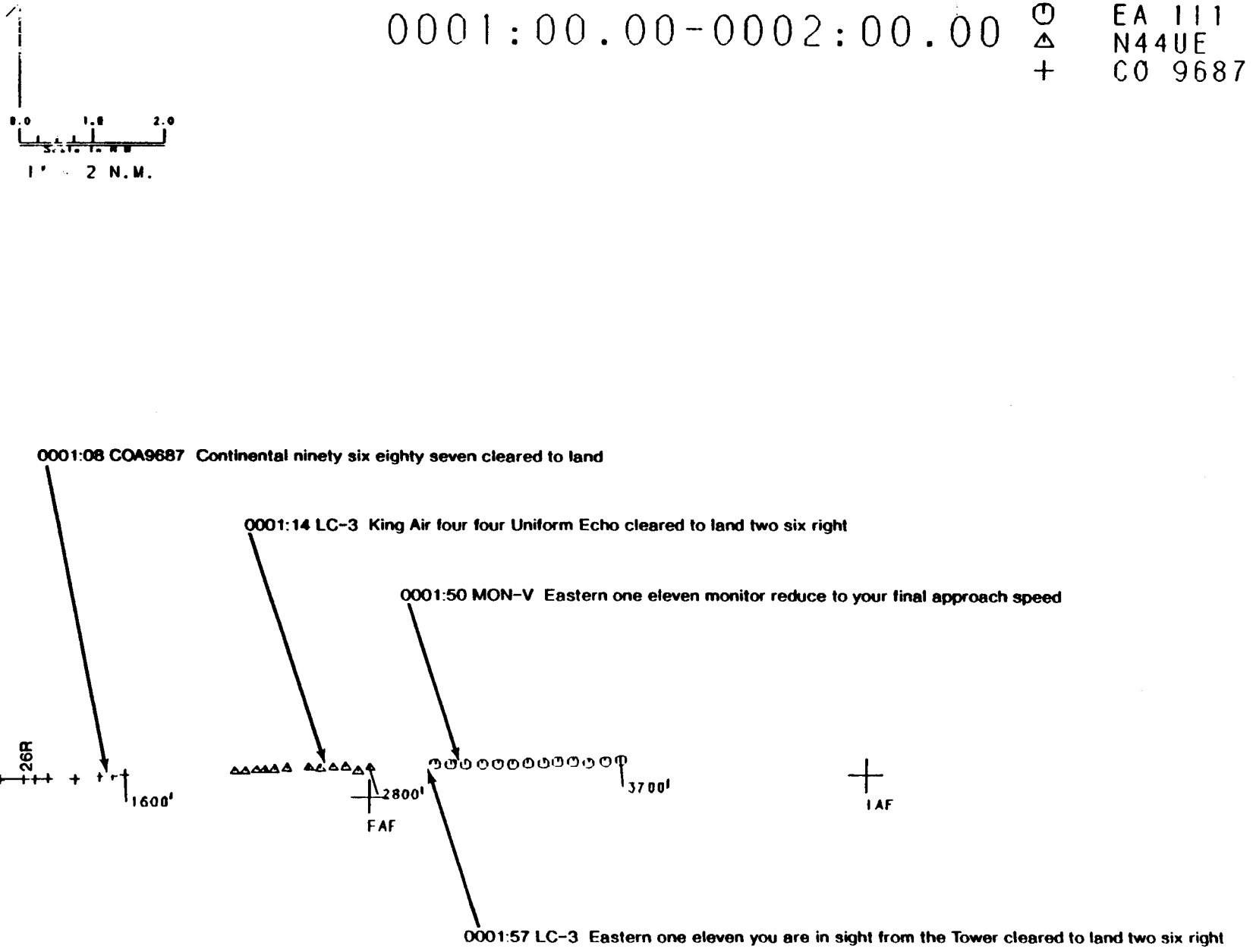
Hartsfield International Airport (ATL). The radar-only (primary) target reports were examined, but revealed no additional pertinent information.

The ground tracks of EAL111, N44UE, and COA9687 were plotted as single overall ground tracks and as a series of ground track plots of varying lengths of time (30 seconds or 1 minute) over the time interval of 2358:00 - 0005:00 UTC. Relevant excerpts from the radio transmissions between each of these aircraft and ATL tower are marked at the proper times and locations. The plots found in Appendix I contain the location of runway 26R, the initial approach fix (IAF), the final approach fix (FAF), the scale of the plot and the time interval depicted.

Calculated distances between two aircraft, or between a single aircraft and the runway 26R threshold are presented in Appendix II. This information is based on the relative coordinates derived from the radar data. Distances are given in Nautical Miles. Column headings contain either two aircraft identifiers or a single aircraft identifier and the word 'RUNWAY'. For the case of two aircraft identifiers in the column heading, the value given is the straight line distance between the two aircraft. For the case of a single identifer and 'RUNWAY', the value given is the straight line distance between the aircraft and the threshold of Runway 26R at the centerline. In both cases differences in altitude are disregarded.

The plots of the calculated groundspeeds as a function of time for aircrafts EAL111, N44UE and COA9687 are contained in Appendix III. The groundspeeds have been calculated from the processed radar data with the aid of a standard Safety Board computer program. The program performs some smoothing on the input data and it should therefore be noted that the calculated values are estimates and are not exact.

Laura Levy
Engineering Services Division



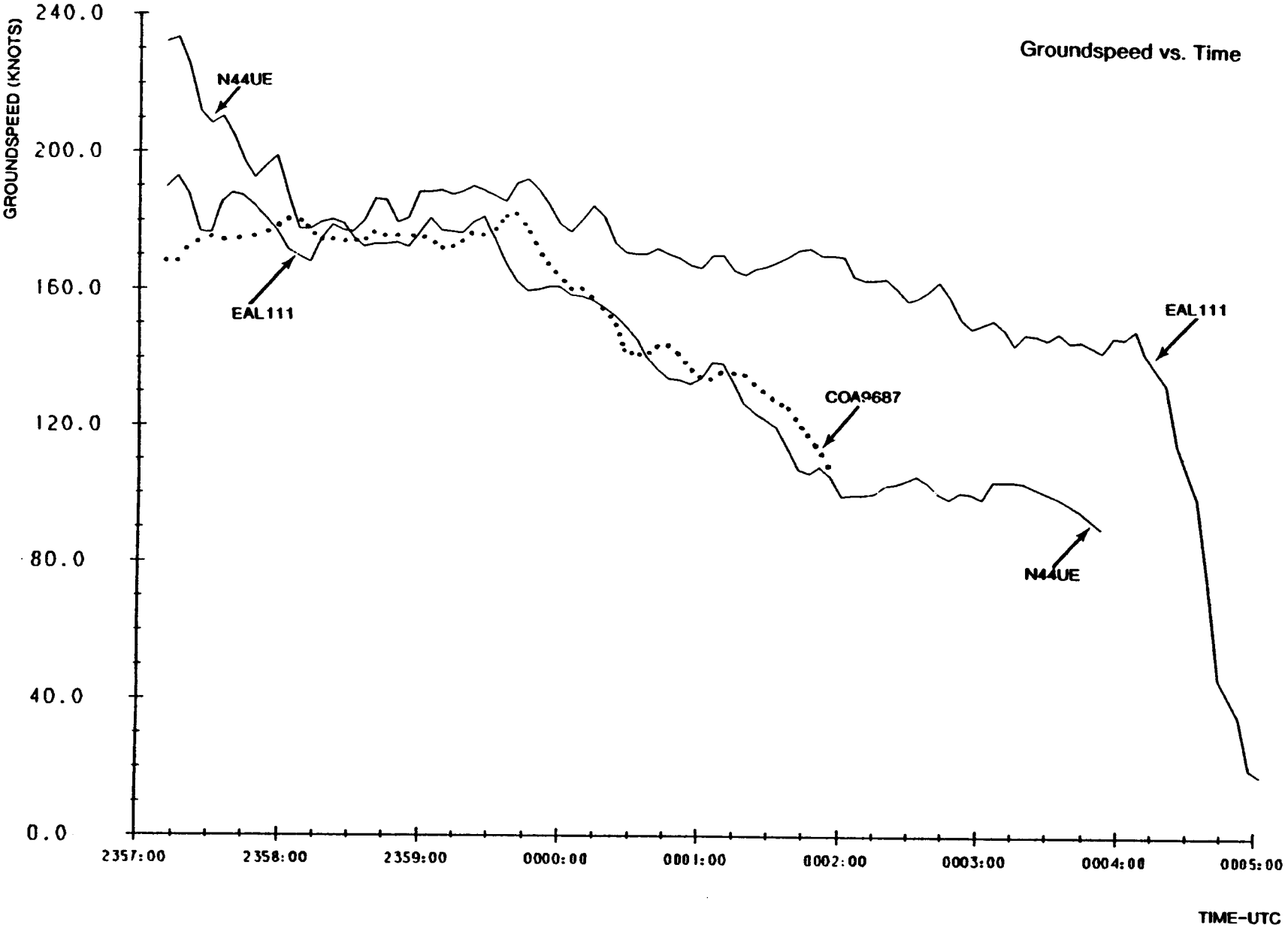
Overall Ground Track Plot of EA 111, N44UE, and CO 9687 and Series of Time Interval Plots

TIME UTC	RUNWAY-COA9687	COA9687-N44UE	RUNWAY-N44UE	N44UE-EAL111	RUNWAY-EAL111
2357:11	12.113	3.239		4.728	
2357:16	11.916	3.124		4.659	
2357:20		3.032			
2357:21	11.702			4.594	
2357:25	11.487	3.008		4.472	
2357:30	11.256	3.002		4.402	
2357:34		3.048		4.273	
2357:35	11.040				
2357:39	10.805	3.134		4.132	
2357:44	10.587	3.179		4.062	
2357:49	10.354	3.261		4.014	
2357:53	10.133	3.275		4.019	
2357:58	9.894	3.284		4.074	
2358:02		3.288			
2358:03	9.677			4.078	
2358:07	9.435	3.313		4.081	
2358:12	9.202	3.328		4.120	
2358:17	8.977	3.351		4.108	
2358:21	8.756	3.336		4.127	
2358:26	8.518	3.341		4.118	
2358:31	8.299	3.328		4.133	
2358:35	8.077	3.328		4.137	
2358:40	7.839	3.345		4.125	
2358:45	7.619	3.350		4.110	
2358:49	7.381	3.334		4.164	
2358:54	7.161	3.369		4.128	
2358:59	6.924	3.357		4.172	
2359:03		3.358		4.189	
2359:04	6.704				
2359:08	6.469	3.360		4.190	
2359:13	6.251	3.337		4.215	
2359:17		3.119		4.213	
2359:18	6.031				
2359:22	5.791				
2359:27	5.570	3.332		4.218	
2359:31		3.335		4.189	
2359:32	5.344				
2359:36	5.118	3.329		4.203	
2359:41	4.880	3.367		4.157	
2359:45	4.642	3.385		4.127	
2359:50	4.415	3.421		4.069	
2359:55	4.190	3.429		4.046	
2359:59	3.969	3.444		4.000	
0000:04	3.775	3.432		3.987	
0000:09	3.537	3.461		3.974	
0000:13		3.435		3.937	
0000:14	3.358				
0000:18	3.130	3.460		3.891	
0000:23	2.940	3.447		3.874	
0000:27		3.448		3.832	
0000:28	2.743				
0000:32	2.561	3.437	5.993	3.818	
0000:37	2.378	3.430	5.802	3.786	
0000:41				3.741	
0000:42	2.194	3.426	5.614		

Chart of Relative Spacing between
Aircrafts EA 111, N44UE, and CO 9687 and Runway 26R.

TIME UTC	RUNWAY-COA9687	COA9687-N44UE	RUNWAY-N44UE	N44UE-EAL111	RUNWAY-EAL111
0000:46	2.008	3.458	5.459	3.693	
0000:51	1.819	3.455	5.263	3.653	
0000:55	1.641				
0000:56		3.474	5.105	3.590	
0001:00	1.464	3.478	4.932	3.559	
0001:05	1.292	3.486	4.765	3.507	
0001:09	1.117	3.482		3.453	
0001:10			4.592		
0001:14		3.475	4.415	3.423	
0001:19	0.772	3.477	4.242	3.373	
0001:23		3.504		3.334	
0001:24			4.079		
0001:28	0.396				
0001:33	0.230	3.551	3.771	3.201	
0001:37	0.070	3.544		3.164	
0001:38			3.597		
0001:42		3.572	3.454	3.088	
0001:47	0.276	3.632	3.339	2.965	
0001:51	0.452			2.914	
0001:52		3.651	3.181		
0001:56	0.593	3.639	3.033	2.840	
0002:00	0.698				
0002:01			2.919	2.720	5.632
0002:05				2.659	
0002:06			2.773		5.424
0002:10			2.655	2.556	
0002:11					5.201
0002:15			2.523	2.491	5.009
0002:20			2.397	2.386	4.783
0002:24			2.259	2.330	4.589
0002:29			2.129	2.237	4.365
0002:34			2.001	2.175	4.176
0002:38			1.855	2.112	3.967
0002:43			1.720	2.045	3.756
0002:47				1.936	
0002:48			1.615		3.546
0002:52			1.466	1.875	3.335
0002:57			1.339	1.808	3.142
0003:02			1.216	1.752	2.964
0003:06			1.084	1.671	2.750
0003:11					2.550
0003:16			0.824	1.563	2.382
0003:20			0.685	1.496	2.167
0003:25			0.560	1.453	2.001
0003:30					1.797
0003:34			0.293	1.325	1.612
0003:39					1.439
0003:43			0.033	1.208	
0003:44					1.219
0003:48					1.054
0003:53			0.208		
0003:53					0.871
0003:58					0.666
0004:02					0.517
0004:07					0.307
0004:12					0.121

TIME UTC	RUNWAY-COA9687	COA9687-N44UE	RUNWAY-N44UE	N44UE-EAL111	RUNWAY-EAL111
0004:21					0.247
0004:25					0.405
0004:35					0.737
0004:39					0.850
0004:44					0.937
0004:53					1.087
0004:58					1.109
0005:02					1.135
0005:49					1.392
0006:08					1.402
0006:13					1.406



Plots of Calculated Groundspeed as a Function of Time
for EA 111, N44UE and CO/ 9687.

APPENDIX F

RUNWAY INCURSION/GROUND COLLISION SAFETY RECOMMENDATIONS

Since 1973, the National Transportation Safety Board has issued 42 safety recommendations regarding the problem of runway incursion/ground collisions of aircraft. Of these, 28 have been classified as "Closed--Acceptable (or Acceptable Alternate) Action;" and 8 as "Closed--Unacceptable Action." Five are being held as "Open--Acceptable Response;" and 1 as "Open--Unacceptable Response."

Those closed as unacceptable are:

A-73-25: Establish and publish taxi routes for arriving and departing aircraft to be used in restricted visibility.

A-73-26: Require pilots to obtain controllers approval before crossing a lighted runway during periods of restricted visibility.

A-73-55: Require read back of taxi clearances when operating in restricted visibility.

A-78-52: Require intersection signs at displaced threshhold or taxiways that enter runways at points other than the end of runway.

A-79-42: Perform a directed safety study on runway incursion problem and fix it.

A-84-101: Develop and require uniform signs at certificated airports with functional classifications i.e. size, shape, color to dipict different meanings.

A-86-39: Include near collisions near surface of airports in near-midair reports.

A-86-45: Provide local control coordinator position at O'Hare.

The one "open--unacceptable" safety recommendation is:

A-86-31: Establish a program for improved supervision of tower controller performance.

The 5 safety recommendations in "open--acceptable" status are:

A-86-30: Improved tower training.

A-86-32: Memory aids for controllers.

A-86-33: Require readbacks for all hold, takeoff, or crossing clearances and for clearances onto an active runway.

A-86-40: Reporting and analysis of runway incursion accidents.

A-86-43: Develop signs and markings for runways and taxiways.

All 42 of the safety recommendations are cited on the following pages listing current status assignments and the accidents/incidents from which the safety recommendations were derived.

On May 17, 1973, as the result of a ground collision accident at O'Hare International Airport in Chicago, Illinois, on December 20, 1972, the Safety Board issued 6 safety recommendations to the FAA. These safety recommendations are listed below with current status assignments.

A-73-21 **Closed--Acceptable Action**
August 16, 1974

Standardize configuration, alignment techniques, and equipment modifications at the three existing ASDE "Brite" facilities in an effort to improve the performance of that equipment.

A-73-22 **Closed--Acceptable Action**
August 16, 1974

Do not proceed with the scheduled installation of "Brite" displays at other ASDE-equipped facilities which now use the direct view radar display until satisfactory operation of "Brite" equipment is achieved at the three facilities where it is now installed.

A-73-23 **Closed--Acceptable Action**
August 16, 1974

Contingent upon favorable results of the evaluation of the new model ASDE "Brite" display currently being conducted by the Transportation Systems Center, install that equipment first at the three locations where "Brite" equipment is now used.

A-73-24 **Closed--Acceptable Action**
December 3, 1975

Establish standard procedures for the use of ASDE radar, and publish such procedures in appropriate air traffic handbooks.

A-73-25 **Closed Unacceptable Action**
August 16, 1974

Establish and publish taxi routes for arriving and departing aircraft to be used during periods of restricted visibility on the order of 1/2 mile.

A-73-26 **Closed--Unacceptable Action**
August 16, 1974

Require pilots to obtain the controllers' approval before crossing a lighted runway during periods of restricted visibility on the order of 1.2 mile.

On August 10, 1973, the Safety Board issued two runway incursion related safety recommendations as a result of ongoing investigations of three accidents. These accidents were:

United Air Lines Boeing 737 -- Chicago Midway Airport, December 8, 1972;

North Central Airlines DC-9 -- Chicago O'Hare Airport, December 20, 1972; and

Eastern Airlines Lockheed L-1011 -- Miami, Florida, December 29, 1972.

The safety recommendations issued at that time are listed below with the current status assignment:

A-73-54 **Closed--Acceptable Action**
August 14, 1974

Require flight crews to report their aircraft position on the airport when establishing radio communications with controllers, and require the controllers to read back the reported aircraft position when it cannot be verified either visually or by means of radar.

A-73-55 **Closed--Unacceptable Action**
November 16, 1973

Require flightcrews to read back taxi clearances when operating in visibilities of less than one-half mile.

On August 8, 1978, as a result of a June 3, 1977 accident at the Tucson International Airport, Tucson, Arizona, the Safety Board issued the following safety recommendation to the FAA: (shown with current status)

A-78-52 **Closed--Unacceptable Action**
April 10, 1979

Require that all operators of certificated airports where runway designs feature a displaced threshold and taxiways enter the runway at points other than the runway's end install an easily visible intersection sign which displays a displaced threshold notation.

On June 8, 1979, as a result of the investigation of three separate ground collisions, or near collisions, the Safety Board issued Safety Recommendations A-79-42 and -43 to the FAA. The accidents involved were:

North Central Airlines, DC-9 near-collision with a Cessna Citation at LaGuardia Airport, Flushing, New York on June 21, 1978;

Delta Airlines, Boeing 727 near-collision with a Flying Tiger Lines Boeing 747 at Chicago O'Hare Airport on February 15, 1979; and

Federal Express Falcon Fan Jet collision with a Beechcraft Model 18 at Memphis International Airport, Memphis, Tennessee on February 24, 1979.

The safety recommendations issued are listed below with the current status assignment:

A-79-42 **Closed--Unacceptable Action/Superceded**
(by A-86-30 through -44) May 13, 1986

Conduct a directed safety study, on a priority basis, to examine the runway incursion problem and to formulate recommended remedial action to reduce the likelihood of such hazardous conflicts.

A-79-43 **Closed--Acceptable Action**
May 22, 1984

Alert all controller/pilot personnel that runway incursion mishaps represent a serious safety problem which requires their immediate attention. Special emphasis should be placed on the need for both groups to maintain greater visual surveillance in those taxi operations involving any runway crossing.

On April 16, 1984, as a result of a special study of several accidents involving ground control at airports during times when the runways were contaminated, the Safety Board issued Safety Recommendation A-84-23. This safety recommendation was addressed to the FAA and reads as follows:

A-84-23 **Closed--Acceptable Alternate Action**
March 29, 1990

Revise FAA Order 5280.5, "Ground Vehicles," to include specific criteria for determining the adequacy of ground vehicle control, such as the number of ground vehicle accidents each year, disciplinary actions taken in accident cases, the number of repeat offenders, and an annual accident rate.

On August 23, 1984, as a result of the investigation of a head on collision between a Korean Air Lines cargo flight and a South Central Air commuter flight at Anchorage International Airport on December 23, 1983, the Safety Board issued five safety recommendations to the FAA related to ground control of aircraft. These five safety recommendations are listed below with the current status assignments:

A-84-98 **Closed--Acceptable Action**
March 29, 1990

Require that airports certificated for air carrier operations install signs at all runway and taxiway entrances, exits, and intersections that indicate the identity of the runway or taxiway.

A-84-99 **Closed--Acceptable Action**
July 12, 1989

Require that the graphics on taxiway/runway identification signs be standardized and of sufficient size to enable them to be legible to aircraft crewmembers in all meteorological conditions in which air carrier operations are authorized.

A-84-100 **Closed--Acceptable Action**
April 29, 1990

Require that airport operators inspect and maintain the light illuminating airport taxiway/runway identification signs as part of the daily airport inspection requirements

A-84-101 **Closed--Unacceptable Action**
August 11, 1986

Require at all airports certificated for air carrier operations that uniform signs be installed which are classified by function (e.g., runway entrance, runway exit, taxiway intersection) with each function having a unique shape, color, and/or size so that runway entrance signs are distinguishable from all other advisory signs on airport property.

A-84-102 **Closed--Acceptable Action**
September 12, 1985

Require that air carriers incorporate in training of their crewmembers procedures and responsibilities during ground operations in restricted visibility conditions, to enable them to operate safety in such conditions.

On February 22, 1985, as a result of the Safety Board's investigation of the December 19, 1983 collision between a Japan Airlines Boeing 747 and a pickup truck traversing a runway at Anchorage International Airport, Anchorage, Alaska on December 19, 1983, the Safety Board issued 3 safety recommendations to the FAA regarding ground control of vehicles. These three safety recommendations are listed below with the current status assignments:

A-85-15 **Closed--Acceptable Action**
November 4, 1987

Develop a mechanical/aural/visual (or combination thereof) alert device and require its use by local and ground controllers to coordinate their activities when a vehicle has been cleared to operate on the active duty runway for an extended period such as in snow removal operations.

A-85-16 **Closed--Acceptable Action**
July 25, 1988

Periodically emphasize in the training of air traffic control personnel providing airport advisory services the proper application of runway usage procedures stressing positive coordination between control positions.

A-85-17 **Closed--Acceptable Action**
July 25, 1988

Periodically emphasize in the training of air traffic controller personnel the requirements contained in the air traffic control handbook 7110.65D, March 1984, for restricted vehicle and aircraft operations in the ILS critical areas when the ILS is being used for approach/landing guidance and the reported ceiling, visibility or runway visual range are below the specified levels.

On April 19, 1985, as result of the investigation of an air traffic control operational error at Minneapolis-St. Paul International Airport on March 3, 1985, the Safety Board issued 2 safety recommendations to the FAA. These safety recommendations are listed below with the current status assignments:

A-85-32 **Closed--Acceptable Action**
January 24. 1986

Issue a General Notice (GENOT) directing the management of all terminal air traffic control facilities to immediately brief all traffic controllers on the importance of complete and accurate coordination between local and ground controllers before taxiing airplanes on or across an active runway.

A-85-33 **Closed--Acceptable Action**
February 17, 1987

Develop and implement, on a priority basis, specific procedures and standards, and specify responsibilities to be used during direct face-to-face and/or interphone coordination between local and ground controllers regarding requests and approvals to clear airplanes to taxi across an active runway.

On May 13, 1986, the Safety Board issued 14 safety recommendations as a result of a Special Investigation Report, "Runway Incursions at Controlled Airports in the United States." These safety recommendations are listed below with the current status assignments:

A-86-30 **Open--Acceptable Action**

Revise the current tower training curriculum at the ATC academy to include more emphasis on practical standardized "hands-on" tower training using dynamic laboratory and simulation facilities.

A-86-31 **Open--Unacceptable Action**

Establish a program for improved supervision of tower controller performance in which scanning, coordination, and use of proper phraseology is emphasized and which includes retraining of controllers who are deficient.

A-86-32 **Open--Acceptable Action**

Establish an ad hoc task force, including controller and human performance expertise, to develop effective memory aids that would reduce incidents of air traffic controllers forgetting traffic, and to incorporate a description of these memory aids and how they should be used in the ATC academy controller training syllabus and in the tower facility training program.

A-86-33 **Open--Acceptable Action**

Require controllers to obtain a readback for all hold, takeoff, or crossing clearances and for clearances onto an active runway.

A-86-34 **Closed--Acceptable Action**
October 14, 1987

Emphasize in operational bulletins, the Airman's Information Manual, general aviation seminars, and pilot training programs, the importance of reading back taxi, hold-short, runway crossing, and takeoff clearances in proper phraseology; the importance of reporting when unable to promptly cross, take off from, or clear a runway when so cleared; and the need to scan properly before entering or crossing a runway.

A-86-35 **Closed--Acceptable Action**
October 14, 1987

Emphasize in operational bulletins, the Airman's Information Manual, general aviation seminars, and pilot training programs, that a good operating practice for pilots of single-pilot airplanes is to monitor only assigned air traffic control communication frequencies after a clearance onto an active runway for departure, until flight from the airport traffic area is completed, or after receipt of clearance for landing, until the landing and taxi across all active runways is completed.

A-86-36 **Closed--Acceptable Action**
January 13, 1987

Revise controller phraseology for use when issuing takeoff and landing clearances to include the runway number (for example: "American 75, Runway 36, Cleared for takeoff").

A-86-37 **Closed--Acceptable Action**
January 13, 1987

Issue a general notice directing the management of all terminal air traffic control facilities to brief all controllers on the dangers of attempting to expedite traffic departing or crossing runways in order to accommodate arrival and departure traffic.

A-86-38 **Closed--Acceptable Alternate Action**
May 8, 1989

Issue an advisory circular delineating both the pilot and controller roles and responsibilities in the prevention of runway incursion incidents.

A-86-39 **Closed--Unacceptable Action**
August 3, 1987

Revise the near-midair collision reporting and investigating program to clarify the intent that near-collisions on or near the airport surface constitute and occurrence which must be investigated as a near-midair collision.

A-86-40 **Open--Acceptable Action**

Revise and enforce the requirements to report and to investigate operational errors, pilot deviations, and near-midair collisions that involve aircraft on the ground as well as in the air, and develop a combined data base for comprehensive procedural and human performance causal analyses of runway incursion incidents.

A-86-41 **Closed--Acceptable Action**

Issue and air carrier operations bulletin to require air carrier inspectors to review air carrier training and operations manuals and pilot training programs to ensure that they contain specific standardized information and guidance to pilots concerning their role in the prevention of runway incursions.

A-86-42 **Closed--Acceptable Action**
May 18, 1987

Disseminate copies of the Safety Board's Special Investigation Report on runway incursions at controlled airports in the United States to all terminal control facilities and to the ATC academy for use in their training programs.

A-86-43 **Open--Acceptable Action**

In cooperation with terminal air traffic managers, airport managers, airline representatives, and pilot groups, determine the most effective signs, markings, and procedures, from an operational and human performance perspective, to prevent pilot-induced runway incursions and issue an advisory circular to disseminate the information to airport managers and pilot organizations.

On May 27, 1986, as a result of the investigation of a May 17, 1986, air traffic control operational error at the Chicago O'Hare International Airport, the Safety Board issued three safety recommendations to the FAA. These safety recommendations are listed below with the current status assignments:

A-86-44 **Closed--Acceptable Action**
July 30, 1986

Issue a General Notice (GENOT) to all terminal facilities to require that every controller is briefed on the importance of issuing traffic information to airplanes that have been cleared into position to hold on a runway before takeoff as required by the controller's handbook 7110.65D, 3-103.

A-86-45 **Closed--Unacceptable Action**
August 3, 1987

Establish on a trial basis, for the north and for the south control operations in the Chicago O'Hare International Airport control tower, local control coordinator positions to monitor and supervise, directly, the local control positions; staff these positions whenever intersecting runways are in concurrent operation.

A-86-46 **Closed--Acceptable Action**
July 10, 1989

Evaluate the need for a local control coordinator position at all major airports that use intersecting runways in concurrent operations and establish the position where the need is evident.

On March 16, 1988, as a result of its investigation of another ATC operational error at the Chicago O'Hare International Airport (October 29, 1987) the Safety Board issued two safety recommendations to the FAA. These safety recommendations are listed below with the current status assignments:

A-88-47 **Closed--Acceptable Action**
July 14, 1989

Establish, for the north and for the sough control operations in the Chicago O'Hare International Airport control tower, local control coordinator positions to monitor and supervise, directly, the local control positions; staff these positions whenever intersecting runways are in concurrent operation.

A-88-48 **Closed--Acceptable Action**
May 18, 1989

Expand the current Chicago O'Hare tower notice, Order N7110.652, "Circling Procedures for Runways 9R/4R," dated November 6, 1987, to provide for application to any arriving aircraft whose flightpath will traverse the departure path of another aircraft.

On July 17, 1989, as a result of the investigation of a January 10, 1989 accident at the Houston Hobby Airport, the Safety Board issued Safety Recommendation A-89-74 to the FAA.

A-89-74 **Closed--Acceptable Action**
December 11, 1990

Assure that the "Normal Procedures" section of the operations manuals of all air carriers operating under Title 14 Code of Federal Regulations Parts 121 and 135 requires flightcrews to cross-check the heading indicator to the runway heading when the airplane is aligned with the runway for takeoff.