
Runway Incursion and Collision, Northwest Airlines, Inc. Flights 1482 and 299, Detroit Metropolitan/Wayne County Airport, Romulus, Michigan, December 3, 1990

Micro-summary: A Boeing 727 on its takeoff roll collided with a Douglas DC-9 that had taxied onto the runway.

Event Date: 1990-12-03 at 1345 EST

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

Investigative Body's Web Site: <http://www.nts.gov/>

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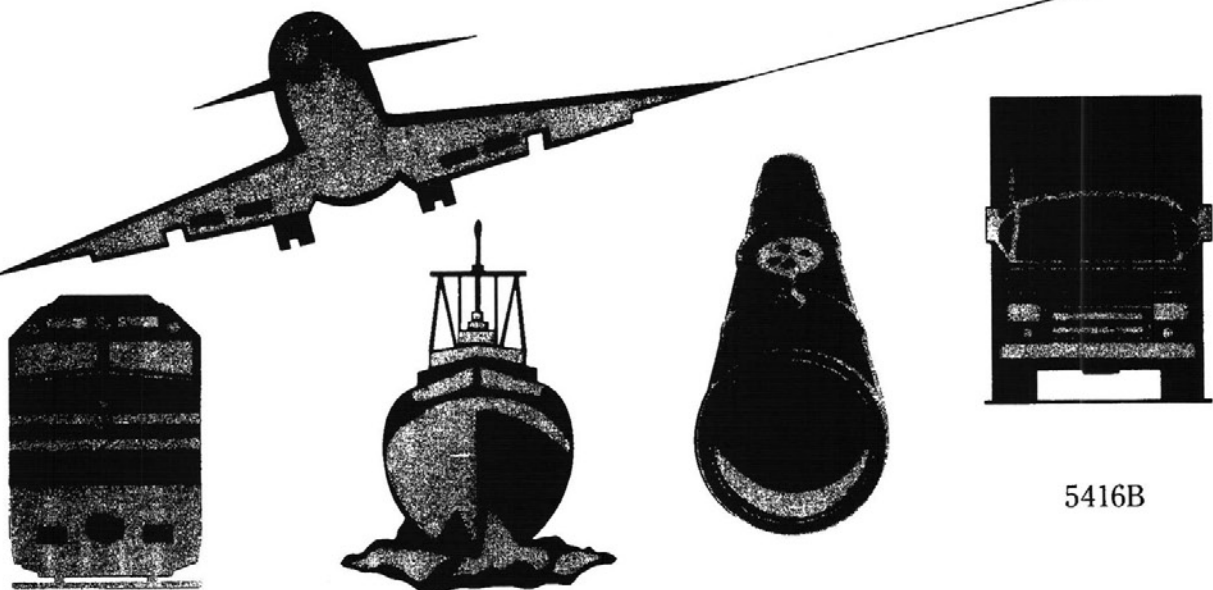
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NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

**NORTHWEST AIRLINES, INC.
FLIGHTS 1482 AND 299
RUNWAY INCURSION AND COLLISION
DETROIT METROPOLITAN/WAYNE COUNTY AIRPORT
ROMULUS, MICHIGAN
DECEMBER 3, 1990**



5416B

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DECEMBER 3, 1990**

**ADOPTED: June 25, 1991
NOTATION 5416B**

Abstract: This report explains the runway collision of two Northwest Airlines aircraft on a runway at the Detroit Metropolitan/Wayne County Airport, Romulus, Michigan, on December 3, 1990. The safety issues discussed in the report are airport marking and lighting, cockpit resource management, air traffic control procedures in low-visibility conditions, flight attendant procedures during evacuations; and design of the DC-9 tailcone emergency release system. Safety recommendations concerning these issues were made to the Federal Aviation Administration, the Detroit Metropolitan/ Wayne County Airport, and Northwest Airlines, Inc..

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EXECUTIVE SUMMARY

On December 3, 1990, at 1345 eastern standard time, Northwest Airlines flight 1482, a McDonnell Douglas DC-9, and Northwest Airlines flight 299, a Boeing 727, collided near the intersection of runways 09/27 and 03C/21C in dense fog at Detroit Metropolitan/Wayne County Airport, Romulus, Michigan. At the time of the collision, the B-727 was on its takeoff roll, and the DC-9 had just taxied onto the active runway. The B-727 was substantially damaged, and the DC-9 was destroyed. Eight of the 39 passengers and 4 crewmembers aboard the DC-9 received fatal injuries. None of the 146 passengers and 10 crewmembers aboard the B-727 were injured.

The National Transportation Safety Board determines that the probable cause of this accident was a lack of proper crew coordination, including a virtual reversal of roles by the DC-9 pilots, which led to their failure to stop taxiing their airplane and alert the ground controller of their positional uncertainty in a timely manner before and after intruding onto the active runway.

Contributing to the cause of the accident were (1) deficiencies in the air traffic control services provided by the Detroit tower, including failure of the ground controller to take timely action to alert the local controller to the possible runway incursion, inadequate visibility observations, failure to use progressive taxi instructions in low-visibility conditions, and issuance of inappropriate and confusing taxi instructions compounded by inadequate backup supervision for the level of experience of the staff on duty; (2) deficiencies in the surface markings, signage, and lighting at the airport and the failure of Federal Aviation Administration surveillance to detect or correct any of these deficiencies; and (3) failure of Northwest Airlines, Inc., to provide adequate cockpit resource management training to their line aircrews.

Contributing to the fatalities in the accident was the inoperability of the DC-9 internal tailcone release mechanism. Contributing to the number and severity of injuries was the failure of the crew of the DC-9 to properly execute the passenger evacuation.

The safety issues raised in this report include:

1. Airport marking and lighting;
2. Cockpit resource management;
3. Air traffic control procedures in low-visibility conditions;
4. Flight attendant procedures during evacuations;
5. Design of the DC-9 tailcone emergency release system.

Recommendations concerning these issues were addressed to the Federal Aviation Administration, the Detroit Metropolitan/Wayne County Airport, and Northwest Airlines, Inc.

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DECEMBER 3, 1990**

1. FACTUAL INFORMATION

1.1 History of the Flights

1.1.1 General

On December 3, 1990, at 1345 eastern standard time, Northwest Airlines (NWA) flight 1482, a McDonnell Douglas DC-9, and Northwest Airlines flight 299, a Boeing 727 (B-727), collided near the intersection of runways 09/27 and 03C/21C at Detroit Metropolitan/Wayne County Airport (DTW), Romulus, Michigan. The DC-9 was to be a regularly scheduled passenger flight to Pittsburgh, Pennsylvania, and the B-727 was to be a regularly scheduled passenger flight to Memphis, Tennessee. Both airplanes were operating under Federal Aviation Regulations (FAR) Part 121 and instrument meteorological conditions prevailed at the time at DTW. The B-727 was on its takeoff roll on runway 3C at the time of the collision, and the DC-9 had taxied onto the runway just prior to the accident. The B-727 was substantially damaged, and the DC-9 was destroyed during the collision and subsequent fire. Of the 40 passengers and 4 crewmembers aboard the DC-9, 7 passengers and 1 flight attendant received fatal injuries. None of the 146 passengers and 8 crewmembers on the B-727 were injured.

1.1.2 B-727 Taxi and Takeoff Activity

Flight 299 was initially scheduled to depart at 1210, but an airplane change delayed the flightcrew from boarding the incoming airplane until 1245 at Gate F11. Following normal turnaround procedures, the flight was pushed back for taxi around 1331. The flight was initially cleared by the west ground controller to runway 3C via a right turn from the gate, and to hold short of Oscar 7, a taxiway just short of the C concourse. (See figures 1 and 2.) The flightcrew noted that the visibility was 3/4 mile, as reported on Automatic Terminal Information Service (ATIS) information Delta. They also noted that the visibility was deteriorating as they began taxiing.

The flightcrew of the B-727 was instructed to contact the east ground controller near Oscar 9 and was then instructed to taxi to runway 3C via Oscar 6, to Foxtrot taxiway, and to advise the east ground controller when crossing runway 9/27. The captain then asked the first officer to monitor the radio for updated ATIS information and to check the company

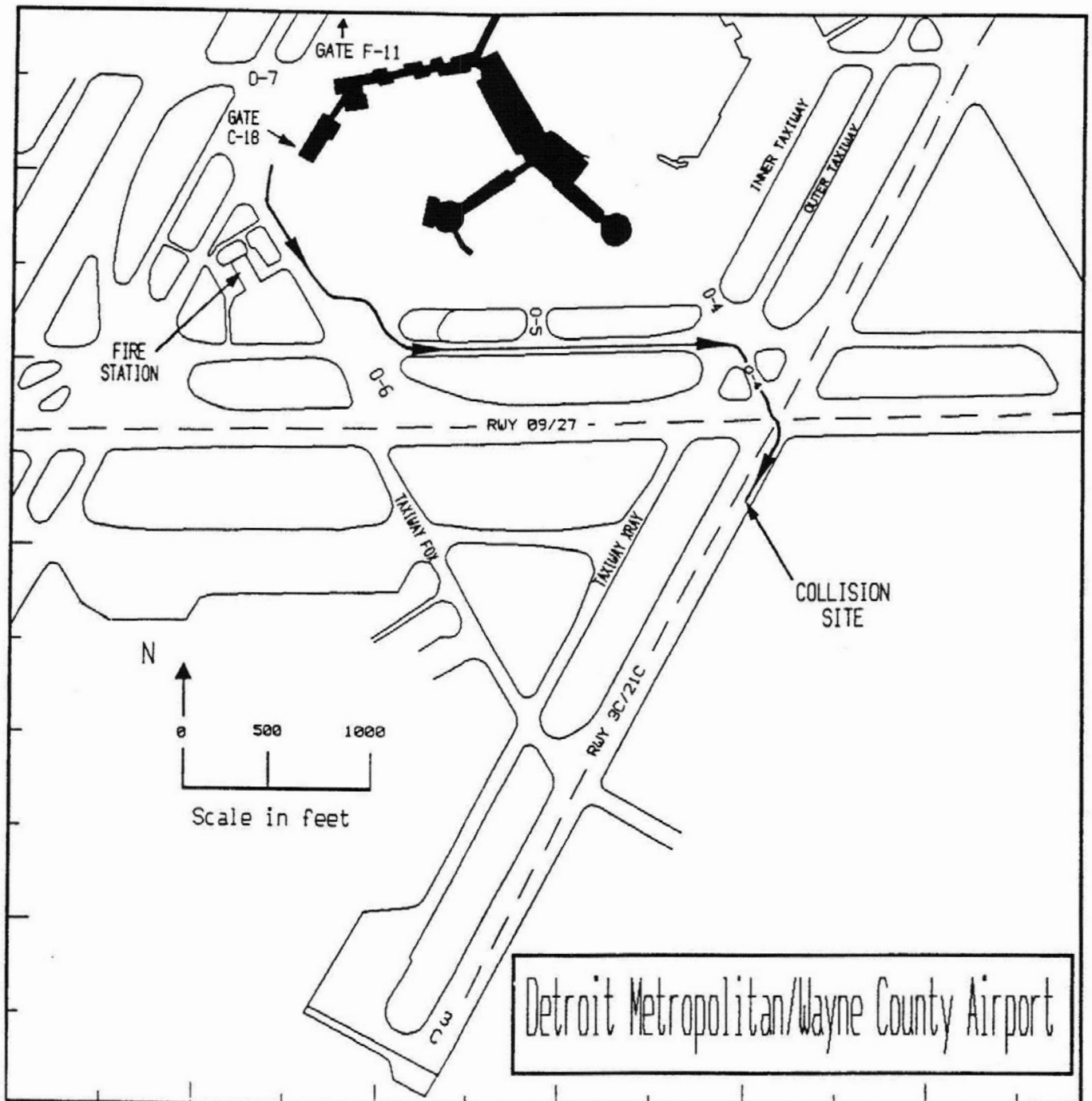


Figure 1.--DTW layout and DC-9 taxi route.

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takeoff visibility minimums for runway 3C. The takeoff minimum for runway 3C was 1/4 mile visibility, which coincided with the 1/4 mile visibility then being broadcast as part of the new ATIS information Echo. As they taxied through the Oscar 6 area, the flightcrew observed an NWA DC-9 taxiing eastbound on the Outer taxiway toward Oscar 4. This airplane was NWA flight 1482, the DC-9 involved in this accident. The B-727 captain stated, "I lost sight of this aircraft as it taxied away from me. It appeared to be entering an area of lower visibility." Shortly thereafter, they also heard a discussion on east ground control frequency concerning a taxiing airplane missing the Oscar 6 intersection.

The B-727 then crossed runway 9/27 and the crew reported to the ground controller that they were clear of that runway. They continued taxiing along Foxtrot taxiway as the No. 3 engine was started. As they turned onto Xray taxiway, ground control requested their position, then cleared them to the local control frequency. At this time, the captain noted that he could see, "...the end of the apron of 3C...", a distance of approximately 1,800 feet. The second officer commented around that time that the weather was deteriorating significantly. The B-727 then stopped at the hold line for runway 3C and reported to the local controller at 1344:08 that they were ready for takeoff. The flight was cleared for takeoff at 1344:15. Power was advanced at 1345:03, 48 seconds after the receipt of takeoff clearance. The captain later testified at the Safety Board's public hearing that since the ATIS was reporting 1/4 mile visibility and he had adequate visual references to maintain the runway centerline, he believed that his decision to take off was correct.

Five seconds into the takeoff roll the first officer stated, "Definitely not a quarter mile, but ah, at least they're callin' it." According to the flightcrew, the airplane entered an area of reduced visibility as it accelerated through about 100 knots. The captain stated that the DC-9 suddenly appeared on the right side of the runway in the path of the right wing of his airplane. He then shouted and moved his body to the left while moving the yoke to the left and slightly aft. Following the impact at 1345:40, he rejected the takeoff and stopped the airplane using maximum braking. The collision occurred 1 minute and 25 seconds after the tower cleared the B-727 for takeoff.

1.1.3 DC-9 Preflight Activity

This flight was the captain's first without supervision after an extended period off flying status for medical reasons. Both flight crewmembers arrived at NWA operations several hours early. The captain said that he wanted to pay a "courtesy visit" to the NWA chief pilot, and also to review the paperwork for the flight. During this period, the first officer made revisions to his flight manuals. The pilots first met at the gate, and the captain advised the first officer that he was calling for a mobile crane to check for ice on the empennage of the DC-9. The flightcrew completed their prestart activities about 40 minutes before scheduled departure. They spent this 40 minutes discussing their aviation backgrounds, expected flight duties, and briefing for the takeoff.

Also, according to the first officer's postaccident testimony, shortly after he met the captain, he was asked by the captain whether he was experienced in DTW operations. The first officer responded, "yes." According to the first officer's postaccident statement, the first officer indicated that what he had meant by his response to the captain's question was that he was familiar with pushback procedures and radio frequency change-over points at DTW rather than the surface operations and physical layout of the airport.

1.1.4 DC-9 Taxi Activity

At 1335:31, the DC-9 was cleared to taxi from Gate C18 by the west ground controller with the following instructions:

1482, right turn out of parking, taxi runway 3 Center, exit ramp at Oscar 6, contact ground now 119.45.

The captain stated that the visibility was deteriorating as they began taxiing, but he was able find and follow the "yellow line" [the taxiway centerline]. The captain testified that he intercepted the taxiway centerline at or near the point where it forks to the left to become the centerline of the Outer taxiway heading east. About this time, the first officer stated, "Hey, it looks like it's goin' zero zero out here." Shortly thereafter, ground control requested their position. The first officer reported that they were abeam the fire station. At this time, they were given an additional taxi clearance: "Roger, Northwest 1482, taxi Inner, Oscar 6, Fox, report making the, ah, right turn on Xray." About 1/2 minute later, the first officer stated, "Guess we turn left here." When the captain expressed some doubt about this left turn, the first officer replied, "Near as I can tell. Man, I can't see [expletive] out here."

At 1339:22, the captain stated, "Well anyway, flaps twenty and takeoff check when you get the time." The first six items on the takeoff checklist were then completed by the crew.

In a subsequent discussion with ground control about their position, the first officer stated to the controller: "approaching the parallel runway on Oscar 6...headed eastbound on Oscar 6 here...." He then said that they had missed Oscar 6 and that they "...see a sign here that says, ah, the arrows to Oscar 5. Think we're on Foxtrot now." According to the first officer, he realized that they had missed taxiway Oscar 6 after he observed the sign for that taxiway behind him. The controller then stated "Northwest 1482, ah, you just approach[ed] Oscar 5 and you are you on the Outer?" The first officer then responded "yeah, that's right."

Ground control then gave the additional taxi instruction:

Northwest 1482, continue to Oscar 4, then turn right on Xray.

The captain continued to taxi eastbound on the Outer taxiway at a very slow rate. The first officer estimated later that during this period the visibility was about 500 to 600 feet. (See figure 3.)

Figure 3.--DTW taxiway signs in the Oscar 4, Oscar 5 and Oscar 6 areas.

Beginning at 1342:00, as the airplane was nearing the Outer/Oscar 4 intersection, the following dialogue occurred between the captain and first officer (F/O):

- Captain: This, this a right turn here, Jim?
- F/O: That's the runway.
- Captain: Okay, we're goin' right over here then [possible query].
- F/O: Yeah, that way. [pause of 21 seconds] Well, wait a minute. Oh, # this, uh, ah. [pause of 8 seconds] I think we're on ah, Xray here now.
- Captain: Give him a call and tell him that, ah....
- F/O: Yeah, this is nine. We're, we're facing one six zero yeah. Cleared to cross it.
- Captain: When I cross this which way do I go? Right?
- F/O: Yeah.
- Captain: This, this is the active runway here, isn't it?
- F/O: This is, should be nine and two seven. [pause of 5 seconds] It is. [pause of 3 seconds] Yeah, this is nine two seven.
- Captain: Follow this. [Unintelligible word] we're cleared to cross this thing. You sure?
- F/O: That's what he said, yea. [pause of 2 seconds] But this taxi light takes us....[pause of 2 seconds] Is there a taxiway over there?

At this point, the captain of the DC-9 set the parking brake. Also at this time, 1343:24, the B-727 crewmembers were performing their takeoff checklist and were 1 minute and 36 seconds from beginning their takeoff roll. Intracockpit dialogue in the DC-9 continued:

- Captain: Nah, I don't see one. [pause of 11 seconds] Give him a call and tell him that, ah, we can't see nothin' out here. [pause of 32 seconds until the captain released the parking brake, followed by 16 second pause] Now what runway is this? [pause of 7 seconds] This is a runway.
- F/O: Yeah, turn left over there. Nah, that's a runway too.

Captain: Well tell him we're out here. We're stuck.

F/O: That's zero nine.

At this time, 1344:40, the B-727 flight engineer was calling the takeoff checklist complete, and the airplane was about 24 seconds from beginning its takeoff roll. At 1344:47, the captain of the DC-9 attempted to contact ground control. However, because he was initially transmitting on some unknown frequency or over the interphone, he was unable to make contact until 11 seconds later. The dialogue in the cockpit of the DC-9 and radio transmissions beginning at 1344:47 are as follows:

Captain to ground: Hey, ground, 1482. We're out here we're stu....we can't see anything out here.
[lapse of 8 seconds] Ah, ground, 1482.
[unsuccessful transmissions]

Ground control: Northwest 1482, just to verify, you are proceeding southbound on Xray now and you are across nine two seven.

Captain to ground: Ah, we're not sure, it's so foggy out here we're completely stuck here.

Ground control: Okay, ah, are you on a ru- taxiway or on a runway?

Captain to ground: We're on a runway we're right by ah zero four.

Ground control: Yeah, Northwest 1482 roger, are you clear of runway 3 Center?

F/O [to captain]: We're on runway 21 Center.

Captain to ground: Yeah, it looks like we're on 21 Center here.

Captain or F/O: [expletive]

[Pause of 10 seconds from captain's last transmission to ground control]

Ground control: Northwest 1482, y'say you are on 21 Center?

Captain to ground: I believe we are, we're not sure.

F/O [to captain]: Yes we are.

[Pause of 5 seconds from captain's last transmission to ground control]

Ground control: Northwest 1482 roger, if you are on 21 Center exit that runway immediately sir.

The two airplanes collided 7 seconds after this last instruction from the ground controller. Concerning the actual runway incursion, the captain stated during postaccident interviews that he initiated a right turn at Oscar 4 and, after several seconds, stopped taxiing. About this time, ground control advised the flight to report crossing runway 9/27. The captain said that he continued taxiing in a right turn following the yellow line, which subsequently disappeared. In his written statement, the captain said that at that point:

I stopped the aircraft and could just see the beginning of a white line. [The first officer] was talking to ground control, and I saw off to my left side what looked like a flashlight or a small diamond. I realized it was a white light, which told me I could be on an active runway. I taxied the airplane to the left of the runway edge and stopped. I picked up the mike and told ground control we do not know where we are, or we are lost (something like that). I then looked up and saw the Boeing 727 coming right at us.

In his written statement, the first officer said:

When we reached 0-4, [the captain] had slowed our taxi speed to a crawl, as warranted by the low visibility and commenced a right turn. I remember proceeding onto a runway during this turn which I thought was RW 9-27. However, I was unable to see across the runway at this point. As we crossed a RW centerline I could now see there was no taxiway on the other side. I checked my heading indicator to confirm that we were on RW 21-03. Visibility at this time at our location was 200' or less. As I reached for the mike to relay this to ground (they) called and asked our position. I believe my response was, I think we are on RW 21, or words to that effect. At that instant ground said exit that runway or get off that runway immediately. Simultaneous to that transmission I heard, then immediately saw the B-727. He was on centerline, all gear on the ground with its right wing tip tracking right at our cockpit.

Following the collision, the captain shut off the fuel control levers. The first officer stated that he instinctively ducked over to the left as the B-727 wing tip grazed his side of the cockpit. An evacuation of passengers was ordered immediately over the airplane public address system by the captain. The tailcone exit was not opened during the evacuation. The external tailcone release was not activated by any flight crewmember or airport rescue and fire fighting (ARFF) personnel. The internal tailcone release mechanism was later found to have been mechanically inoperable. A flight attendant and a passenger succumbed in the tailcone.

1.1.5 Tower Activity During Taxi and Takeoff Sequence

Controllers involved in the accident sequence were the east ground controller, the local controller, and the area supervisor. An off-duty controller, about to come on duty, asked the local controller if he wanted to change the reported prevailing visibility but did not directly participate in the control of airplanes.

1.1.5.1 East Ground Controller

The east ground controller stated that the first time he became unsure of the DC-9's position was when the flightcrew advised that they were "completely stuck here." This transmission was from the captain at 1345:02, 37 seconds prior to impact, and 1 second before the increasing engine noise was recorded on the B-727 cockpit voice recorder (CVR). The controller stated that when the flightcrew advised him that they were "right by 0-4" 5 seconds later, he became more concerned because he was aware that taxiway Oscar 4 led onto runway 3C. In his written statement taken on December 4, 1991, he stated that he loudly announced to the local controller "I've got a lost aircraft out here, he might be on the runway" after the 1345:29 transmission from the DC-9. During public hearing testimony, he stated that he made this statement to the local controller after the 1345:17 transmission from the DC-9. He said that the area supervisor then "stood up" and told everybody to stop their traffic.

During postaccident interviews, he could not recall if he had heard the B-727 receive its takeoff clearance from the local controller. He said that he was aware that the Federal Aviation Administration (FAA) DTW Facility Operational Position Standards (OPS) Handbook had identified Oscar 4 as a potential area for runway incursions.

1.1.5.2 Local Controller

The local controller heard the east ground controller state that an aircraft was lost and that the ground controller thought he was on the runway. He made the determination that the B-727 was already airborne based on the engine sounds and the time that had elapsed since he had cleared that flight for takeoff. He did not observe the B-727 on the bright radar indicator tower equipment (BRITE) but stated that he did make an announcement that the airplane was airborne.

He said that he did not try to warn the B-727 about the runway incursion because he believed that the B-727 was airborne when he became aware of the lost airplane. He further stated that his belief that the airplane was airborne was based on engine sounds and the "time span since the takeoff clearance had been issued." When asked whether he had ever issued an abort instruction to an airplane on the runway, he answered in the affirmative but could provide no details.

1.1.5.3 Area Supervisor

During her initial interview with the Safety Board, the area supervisor stated that prior to the accident she was standing by the cab coordinator position, observing the overall operation, but that she was not wearing a headset to listen to controller activity. During hearing testimony, however, she stated that she was seated at a desk, doing paperwork when she first noticed that something was amiss. She observed that all runway and taxiway lights were on with the exception of the runway lights for the inactive runway 9/27. She also stated that the centerline lights for runway 3C were on and set to step 5 but that she could not actually observe these lights. Centerline lighting is bidirectional only.

She said that her first indication that something was wrong was when the east ground controller stated "[expletive], I think this guy's lost." She then directed all controllers to, "Stop all traffic." When the ground controller advised that the airplane might be on the runway, she said, "I said stop everything" in a loud voice. She stated that she did not hear engine noises that she would have associated with a departing airplane.

In a later interview, when asked if her statement to stop all traffic included the supposition that she wanted airplanes on takeoff roll to abort, she stated, "It meant everything, when I say stop all traffic, everything gets stopped." When she was asked why the local controller had not complied with her statement, she replied that the local controller was the only person who knew where the traffic was and that he was the only one who could make the decision.

The accident occurred in daylight instrument meteorological conditions (fog) at 42° 12.9 minutes north latitude, and 083° 20.9 minutes west longitude.

1.2 Injuries to Persons

1.2.1 The DC-9

<u>Injuries</u>	<u>Crew</u>	<u>Passengers</u>	<u>Others</u>	<u>Total</u>
Fatal	1	7	0	8
Serious	0	10 ¹	0	10
Minor/None	3	23 ²	0	26
Total	4	40	0	44

¹Medical records have not been received for three passengers who were admitted to a burn center and, for the purposes of this report, they are assumed to have received serious injuries.

²Medical records have not been received for the copilot and six passengers who were treated and released from area hospitals. For the purposes of this report, they are assumed to have received minor injuries.

1.2.2 The B-727

<u>Injuries</u>	<u>Crew</u>	<u>Passengers</u>	<u>Others</u>	<u>Total</u>
Fatal	0	0	0	0
Serious	0	0	0	0
Minor/None	<u>8</u>	<u>146</u>	<u>0</u>	<u>154</u>
Total	8	146	0	154

1.3 Damage to Aircraft

The B-727 received substantial damage to its right wing during the collision with the DC-9. Boeing technicians estimated that repairing the airplane would cost about \$4,850,000.

The DC-9 was destroyed during the collision and subsequent ground fire. The insurance company representative that handled the claim stated that the hull loss amount was \$1,200,000.

1.4 Other Damage

No other significant damage occurred.

1.5 Personnel Information

1.5.1 Cockpit Crewmembers

1.5.1.1 The DC-9 Captain

The captain, 52, was hired by Pacific Airlines, Inc., on August 1, 1966, as a first officer on the Fokker F-27. In accordance with several merger contracts, this was also considered his date of employment with NWA. He progressed to captain, check airman, and senior check airman on this airplane as Pacific Airlines merged with Airwest, Inc., an airline that eventually became Hughes Airwest, Inc. He became a captain on the DC-9 on December 27, 1978, and flew in that capacity with Hughes Airwest and during the subsequent Hughes Airwest merger with Republic Airlines until February, 1984, when he was medically disqualified from flying because of kidney stones. Republic Airlines merged with NWA on October 1, 1986. He received regular disability stipends during his period of medical disability. According to the captain, these payments lessened the effect of a financial bankruptcy he experienced during his layoff.

He was reissued a first-class airman medical certificate on October 11, 1990, with the limitation that the "Holder shall wear glasses that correct for distant vision, and possess glasses that correct for near vision." He held an airline transport pilot certificate with ratings for the DC-9, F-27, and airplane multiengine land, and commercial privileges for airplane single-engine land. He also held a noncurrent flight instructor certificate that was issued on March 30, 1967. He had accumulated about 23,000 total flying hours, 4,000 of which were in the DC-9.

Following his return to flight status by NWA, he completed the DC-9 Initial Pilot Training Course on November 6, 1990. He began his flight simulator training 6 days later. He completed that training on November 20, 1990, by passing a proficiency check in the simulator. He completed his Initial Operating Experience (IOE) of 22.8 flight hours from November 29 through 30, 1990, and his line check (a continuation of his final IOE flight) also on November 30. The subsequent departure involved maneuvering the airplane below 3,000 feet within a 3-mile distance measuring equipment (DME) arc, in turbulent air. The check airman for this line check stated, "I was pleased with [his] performance."

NWA retraining requirements for an individual who has not received a captain's assignment for more than 6 years exceed those required by FARs for routine captain upgrades and are more comprehensive than those of the NWA training plan for routine captain upgrades. The captain of the DC-9 attended a 10-day, 80-hour ground school, whereas NWA usually requires a 5-day, 40-hour course for routine upgrades. The FARs require no ground school. The captain was required to accomplish a full 6-session flight simulator course and a simulator proficiency check ride, whereas NWA usually only requires training to proficiency in the simulator prior to a flight check. FAR flight training requirements in this area are "recent experience" and the completion of a proficiency check ride. Also, NWA required the captain to complete 12 IOE flights, whereas NWA usually requires none. The FARs also do not require IOE flights for new captains. During his training, the captain accomplished four departures and arrivals at DTW. NWA did not offer its line captains formal Cockpit Resource Management (CRM) training at the time of the accident. Subsequent to the accident, Northwest began requiring a 1-day course in CRM for all pilots during training.³

1.5.1.2 The DC-9 First Officer

The first officer, 43, retired from the US Air Force (USAF) on October 31, 1989 at the rank of major. His Air Force line assignments included copilot, aircraft commander and instructor pilot duties in the B-52 Stratofortress heavy bomber, as well as instructor pilot duties in the T-38 Talon jet trainer. His first line assignment was to a B-52 squadron in 1971, and he accumulated about 3,254 hours in various models of that airplane, 1,380 of which were as an instructor or evaluator pilot, prior to his retirement with the rank of major. Between B-52 assignments, he was also a pilot in T-38 airplanes, accumulating about 1,025 flying hours, about 780 hours of which were as an instructor. A review of his military flying records revealed no accidents, and his record of military flying evaluations dating back to 1975 revealed no failed check rides or written examinations.

The first officer was hired by NWA on May 25, 1990. He held an airline transport pilot certificate with ratings for the CE-500 (Cessna Citation) and airplane multiengine land, issued November 6, 1978. He also

³A discussion of CRM was included in NTSB/Aviation Accident Report-88/05: "Northwest Airlines, Inc., McDonnell Douglas DC-9-82, N312RC, DTW, August 16, 1987."

held flight engineer certificate No. 507560424, with a rating for turbojet-powered airplanes, issued on March 21, 1979. His FAA first-class airman medical certificate was issued on April 30, 1990, with no limitations. He estimated that he had accumulated about 4,685 total flying hours, 185 of which were in the DC-9.

The first officer completed his initial DC-9 training on July 5, 1990, and successfully passed a simulator proficiency check the next day. The check airman commented, "Good initial proficiency check." He was then given a Line Oriented Flight Training (LOFT) period of normal procedures in the simulator on July 7, and aircraft flight training (three takeoffs, including one with a VI cut; three landings; and four instrument approaches) on July 11, 1990. His IOE and line check flight were completed on July 27, 1990. NWA did not offer formal CRM training to its line first officers at the time of the accident.

The first officer testified that he had flown 22 departures and arrivals at DTW. He believed that one or two of them had been under instrument flight rules (IFR).

1.5.1.3 The B-727 Captain

The captain of the B-727, 42, was hired by NWA on May 9, 1983, and held an airline transport pilot certificate with ratings for B-727, airplane multiengine land, and commercial privileges for the L-300 and airplane single-engine land, issued April 6, 1989. He completed his last proficiency check on October 27, 1990, and his last line check was completed on May 30, 1990. His FAA first-class airman medical certificate was issued on August 2, 1990, with no limitations. He also held a flight engineer certificate. At the time of the accident, he estimated that he had approximately 10,400 total flying hours, 5,400 of which were in the B-727.

1.5.1.4 The B-727 First Officer and Second Officer

The first officer on the B-727, 37, was hired by NWA in September, 1985, and held an airline transport pilot certificate. His FAA first-class airman medical certificate was issued on July 9, 1990, with no limitations. At the time of the accident, he estimated that he had accumulated about 5,400 total flying hours, of which 2,350 were in the B-727.

The second officer on the B-727, 31, was hired by NWA in July, 1989. He held an airline transport pilot certificate and a flight engineer certificate issued on September 27, 1989, with a turbojet-powered airplane rating. His FAA first-class airman medical certificate was issued February 20, 1989, with no limitations. At the time of the accident, he had accumulated about 3,300 total flying hours, of which 900 were in the B-727.

1.5.2 The Flight Attendants

1.5.2.1 The DC-9 Flight Attendants

The lead flight attendant on the DC-9 was hired by NWA on June 17, 1988, and received her last recurrent emergency procedures training on August 11, 1990. The second flight attendant was initially hired by North Central Airlines (an airline that also later merged with Republic, then NWA) on March 15, 1968, and received her last recurrent training on February 27, 1990. Both of them were qualified for flight attendant duty on B-747-200/400, B-727, B-757, McDonnell Douglas DC-10, DC-9 and Airbus A-320 airplanes. The lead flight attendant testified that although she had not entered a tailcone or a tailcone exit mockup in training, she had pulled a tailcone exit release handle in training in August 1989. Training records of the second flight attendant indicated that she pulled the exit release handle during training in February 1989.

An off-duty flight attendant aided in the evacuation of the airplane. She was hired by NWA on March 10, 1990. She had not received recurrent training because she had only been employed by the company for about 9 months at the time of the accident.

1.5.2.2 The B-727 Flight Attendants

All flight attendants on the B-727 were current in the airplane and received recurrent training during 1990.

1.5.2.3 NWA Flight Attendant Training

The FAA-approved NWA flight attendant initial training program lasts 6 weeks. The DC-9 specific training consists of 8 hours and 45 minutes of instruction and a 30-minute written examination. The training includes instruction in emergency evacuation, emergency procedures, emergency equipment, water survival and ditching procedures. One hour of training is allotted to "hands-on practice" in which each flight attendant is required to open a cabin door and an overwing exit, and "simulate operations of the control for the aft exit hatch and tailcone." At the time of the accident, the tailcone exit training device was a platform that included a tailcone exit release handle positioned at the end of a rod that was attached to the platform. The tailcone release handle was not installed in retaining clips. NWA used a 9-minute Hughes Airwest-produced video tape describing the DC-9 tailcone operation. The film shows the operation of the tailcone's external release handle and states:

Crewmembers should know the location of the handle. It could be important to free passengers or flight attendants who may be trapped in the tailcone.

Aside from information provided by this video tape, NWA training does not specifically instruct flight crewmembers to activate the tailcone external release handle.

Following the accident, NWA flight attendant onboard service managers [supervisors] gave a 15-question DC-9 exit operations quiz to 238 flight attendants who were scheduled to fly on DC-9-type airplanes. Four of the 238 individuals tested required retraining.

1.5.3 The Air Traffic Controllers

1.5.3.1 The Area Supervisor

The area supervisor, 35, entered on duty with the FAA on July 25, 1982, and began working at DTW on November 10, 1985. She became a full-performance-level (FPL) controller and was certified in her current position in September 1990. Her last over-the-shoulder evaluation⁴ and tape talk session⁵ occurred in October, 1990. She was certified to take prevailing visibility observations on May 26, 1990.

1.5.3.2 The Local Controller

The local controller, 25, entered on duty with the FAA and began working at DTW on June 5, 1988. He became an FPL controller and was certified as a local controller in January, 1989. His last over-the-shoulder evaluation was in September, 1990, and his last tape talk session was in October, 1990. He was certified to take visibility observations on April 7, 1990.

He had no prior FAA assignments before DTW, but he had 5 years of earlier military air traffic control (ATC) experience with the US Army. He was medically qualified as a controller with no waivers or limitations and was not a pilot.

1.5.3.3 The East Ground Controller

The east ground controller, 26, entered on duty with the FAA on February 20, 1985, and began working at DTW on July 1, 1990. He was certified on the east ground control position on September 30, 1990, and was not an FPL controller. His last over-the-shoulder evaluation was in April, 1990, and his last tape talk session was in May, 1990.

His only previous controller assignment was in the ATC tower at Saginaw, Michigan, where he was an FPL controller. He was medically certified as a controller with no waivers or limitations. He was also a noncurrent private pilot with about 80 total hours of flying time.

⁴An evaluation by the supervisor while the controller is actually controlling traffic.

⁵A training method involving a critique of ATC recording tapes of the controller's activities related to the actual control of aircraft.

1.5.3.4 The West Ground Controller

The west ground controller, 28, entered on duty with the FAA on April 29, 1986, and began working at DTW on May 7, 1989. He became an FPL controller on November 12, 1989. His last over-the-shoulder evaluation was on August 20, 1990, and his last tape talk session was on March 25, 1990.

His only previous FAA assignment prior to DTW was in the Willow Run, Michigan, ATC tower, where he was an FPL controller. He was medically certified by the FAA with no waivers or limitations.

1.5.3.5 The Tower Cab Observer

The tower cab observer, 32, entered on duty with the FAA on December 13, 1981, and began working at DTW on October 10, 1989. She became an FPL on April 13, 1990. Her last over-the-shoulder evaluation was on December 2, 1990, and her last tape talk was on November 14, 1990. Her other FAA assignments included the towers in Pontiac, and Flint, Michigan, and Indianapolis, Indiana. She was certified to take visibility observations on May 26, 1990.

1.6 Aircraft Information

1.6.1 The DC-9

N3313L, a DC-9-14, was acquired by NWA on August 1, 1986. It was operated exclusively by NWA until the accident, at which time it had a total of 62,253.2 operating hours and had undergone 88,255 cycles. It was equipped with two Pratt and Whitney JT8D-7 engines. FAA service difficulty reports (SDRs) on emergency equipment and exits revealed two writeups. One, in July 1989, concerned a low-pressure indication on the service door slide bottle, and the other, in July 1990, involved an inoperative emergency light by the main cabin door. There were no open items in the maintenance logs for the airplane.

1.6.1.1 DC-9 Tailcone Maintenance

The Safety Board examined NWA DC-9 maintenance at its Atlanta maintenance base. The examination included interviews with maintenance and quality control shift foremen and managers, inspection of the airline's computer-generated maintenance and inspection forms (CITEXT cards), which were used while performing routine maintenance, and reviews of personnel training records. Several deficiencies were found concerning the airline's DC-9 maintenance program.

During a "C" check concluded on the accident DC-9 on November 19, 1990, 66 operating hours prior to the accident, the tailcone was reportedly jettisoned twice and reinstalled without any apparent problems. Replacement of the top left slider block/latch was the only maintenance performed in the tailcone area. During the replacement of the slider block/latch, its cabling was misriggered and neither the mechanic who replaced the latch nor the general inspector who inspected the work noted that the latch cabling was not

properly rigged in accordance with the DC-9 maintenance manual. Examination of the CITEXT cards containing procedures and instructions for conducting maintenance during a DC-9 "C" check did not accurately reflect information found in the DC-9 Maintenance Manual.

The final quality control inspection, after completion of the "C" check, was not conducted by a quality control inspector, as outlined on the appropriate CITEXT card. Rather, this inspection was accomplished by a mechanic who had been designated by his crew chief to conduct the inspection and who had no formal training on the maintenance, operation and inspection of the DC-9 tailcone. It was also learned that some newly hired mechanics had not received formal DC-9 training for as long as 18 months after being hired by NWA. The position of DC-9 maintenance training manager had been created 2 months prior to the accident and was still vacant at the time of the accident.

An NWA senior foreman with 13 years experience stated that about 40 percent of DC-9 tailcone release handles that were pulled during routine maintenance checks had failed to jettison the tailcones when the specified 25 to 35 pounds of tension were exerted. In postaccident interviews, neither the quality control inspectors nor the mechanics who worked on the accident airplane's tailcone during the "C" check recalled whether the tailcone release handle shaft was fractured at that time. Also, they recalled that during the "C" check the handle had been safety wired in its stowed position. Investigators found no records of anyone having entered the tailcone between the final "C" check inspection and the accident.

1.6.2 The B-727

N278US, a B-727-251-2A, was purchased by NWA from Boeing in November, 1975. It was operated exclusively by NWA until the accident, at which time it had a total of 37,710.2 operating hours and 27,933 cycles. It was equipped with three Pratt and Whitney JT8D-15A engines. The single deferred maintenance item in the airplane maintenance logs concerned an inoperable quantity gauge on the potable water system.

Interviews with flight attendants on N278US revealed that the cabin interphone was inoperative. Although a mechanic was called to investigate this discrepancy before the flight departed the gate, the interphone was not repaired and the item was not entered into either the cabin or cockpit maintenance logbooks. The B-727 Minimum Equipment List (MEL) states that the airplane can be flown with an inoperative cabin interphone if the public address system is operating properly, which it was on this airplane. However, FAA regulations require that a known deficiency either be corrected or entered into the maintenance logbook according to MEL procedures before pushback.

1.7 Meteorological Information

1.7.1 National Weather Service Activity

National Weather Service (NWS) weather observations at DTW are made by weather observers (Meteorological Technicians). Observations are made at the NWS facility in the Executive Terminal Building about 3,100 feet northeast of the approach end of runway 21C. The DTW tower is about 7,210 feet southwest of the NWS office. Weather observers maintain a Basic Weather Watch as defined in Federal Meteorological Handbook No 1.

The NWS observations up to and after the time of the accident (1345 eastern standard time) were as follows:

Time--1250; type--record special; sky partially obscured; ceiling--measured 200 feet overcast; visibility--3/4 mile; fog; temperature 41⁰ F; dewpoint--40⁰ F; winds 120⁰ at 11 knots; altimeter--29.55 inches; RVR not available, .4 of the sky hidden by fog, 1 inch of snow on the ground, rain ended 1210.

Time--1330; type--special; ceiling--indefinite 100 feet, sky obscured; visibility--1/4 mile; fog; winds--120 degrees 11 knots; altimeter--29.52 inches; RVR not available.

Time--1348; type--local; ceiling--indefinite 100 feet, sky obscured; visibility--1/4 mile; fog; temperature--46⁰ F; dewpoint--46⁰ F; winds--110 degrees 11 knots; altimeter--29.49 inches; RVR not available.

1.7.2 Automatic Terminal Information Service (ATIS)

Until about 1335, Detroit ATIS information Delta was being broadcast as follows:

Detroit ATIS information Delta. 1750 Zulu [1250 eastern standard time] weather, sky partially obscured, measured ceiling 200 overcast, visibility three quarters, fog, temperature 41, dewpoint 40, wind 120 at 9, altimeter 29.54, pressure falling rapidly. ILS approach runway 3 right, plan runways 3 right 3 center. Notice to airmen: runway 3 left closed, runway 9/27 closed, metro VOT out of service, southside taxiway uniform pad closed, use caution for a 110 foot crane south of T hangars and also a 310 foot crane south runway 9/27 between runways 3 center and 3 left, runway 3 right outer marker out of service, runway 3 center runup pad closed, braking action advisories are in effect. Field conditions: caution is advised of for [sic] the outer edges of the ramp has snow piles up to 6 feet, flow procedures are in effect for numerous airports. Initial contact advise controller you have ATIS information Delta.

About 1322, the NWS office received a message from the DTW tower, via its electrowriter, that the prevailing visibility was 1/4 mile. About 1335, the following new ATIS recording was broadcast:

Detroit Metro ATIS information Echo: 1830 Zulu [1330 eastern standard time] special weather, indefinite ceiling 100, sky obscured, visibility one quarter, fog, temperature 41, dewpoint 40, wind 110 at 9, altimeter 29.50, ILS runway 3 right approach in use, departing runways 3 right and 3 center. Notice to airmen: runway 3 left runway 9/27 closed, runway 3 right outer marker out of service, Detroit Metro VOT out of service, southside taxiway uniform pad closed, runway 3 center runup pad closed, braking action advisories are in effect, use caution for a 310 foot crane south of runway 9/27 between runways 3 left and 3 center, use caution for a 110 foot crane in the south "T" hangars, gatehold procedures are in effect for Chicago Midway, Minneapolis/St. Paul, Charlotte, Atlanta Hartsfield, LaGuardia, JFK, Newark, Greater Cincinnati, Syracuse, Toronto International and Rochester. Advise controller on initial contact that you have information Echo.

1.7.2.1 SIGMET Foxtrot 3

SIGMET (significant meteorological information) Foxtrot 3 was valid from 1230 to 1630 and called for severe turbulence below 8,000 feet for an area that included DTW. Information from this SIGMET was not placed on the DTW ATIS as required by FAA directives. In addition, information from this SIGMET was not included in the weather data provided by NWA meteorologists to the flightcrews of the B-727 or the DC-9 involved in this accident.

1.7.3 Weather Observations in the DTW Tower

DTW controllers, who are trained and tested as visibility observers by the FAA, are allowed to take prevailing visibility observations and relay them to aircrews and the DTW NWS office. A checklist in the DTW tower states that a visibility chart, annotated with visibility markers, such as concourses, terminals, towers, and antennas, must be used to determine prevailing visibility. According to Federal Meteorological Handbook No. 1, prevailing visibility is defined as the greatest visibility equaled or exceeded throughout at least half the horizon circle. The 180° arc of the circle having the greatest visibility need not necessarily be continuous.

The on-duty local controller, the on-duty tower supervisor, and an off-duty controller stated that they made prevailing visibility observations just prior to the accident. The on-duty ground controller also had comments concerning the visibility.

The local controller stated that he made a 1/4 mile prevailing visibility observation around 1320, 25 minutes prior to the accident. He did not use the visibility reference chart or have the visibility reference markers memorized. He testified that his observation was based on the fact that he used the visibility reference chart to determine a 1/4 mile prevailing visibility a few times in the past and was very familiar with what a prevailing visibility of 1/4 mile looked like.

The tower supervisor testified that she checked his observation within "minutes" prior to the accident. The local controller said he actually made his observation some time prior to 1322. She concurred with his 1/4 mile call and, in hearing testimony, was quite specific concerning the visibility markers she used for this verification. However, she also stated that she did not use the visibility reference chart. In addition, she said that she did not know the visibility that the NWS was reporting prior to and at the time of the accident. Federal Meteorological Handbook No. 1 states that the lower of the tower or the surface visibility is the controlling factor for airplane operations on an airport.

An off-duty controller, preparing to come on duty, made a visibility observation using the reference chart between 1330 and the time of the accident. She determined that the prevailing visibility at that time was 1/8 mile. Following her observation, she asked the local controller whether he wanted to change the visibility reading (without elaborating that she believed the visibility was then 1/8 mile) and the local controller responded that the 1/4 mile call was good.

The east ground controller stated that he concurred with the 1/4 mile call. However, he also said that he could not see aircraft at the ends of A, B, or C concourses around the time of the accident. The ends of the concourses, which are visibility markers, are less than 1/4 mile from the DTW tower.

1.8 Aids to Navigation

No navigation aids were used by either airplane during the accident sequence of events. DTW's ATC tower is not equipped with Airport Surface Detection Equipment (ASDE).

1.9 Communications

A review of FAA Form 7230.4, Daily Record of Facility Operation for the DTW air traffic control tower, did not disclose any recent transmitter or receiver problems affecting the abilities of either airplane to communicate with the tower prior to the accident. Subsequent to the accident, all primary and secondary (main and standby) radios using frequencies 119.45 (east ground control), 121.8 (west ground control), 118.4 (local control east) and 135.0 (local control west) were found to be operating within normal parameters. In addition, the controllers and flight crewmembers involved in this accident stated that no radio problems existed that hampered their ability to communicate.

1.10 Aerodrome Information

1.10.1 General

DTW is about 15 miles south of downtown Detroit, Michigan. The field elevation is 639 feet above sea level. The airport is certificated in accordance with the applicable provisions of Title 14 CFR Part 139. DTW is served by four runways: 3L/21R, 3C/21C, 3R/21L and 9/27. At the time of the accident, runway 9/27 was closed for snow removal. Runway 3C/21C is 8,500 feet long and 200 feet wide. The first 4,387 feet of runway 3C is grooved concrete, and the remaining 4,113 feet is grooved asphalt.

DTW Airfield Inspection forms of daily airfield inspections, which were conducted between November 21, 1990, and December 3, 1990, and weekly airfield runway lighting reports made between November 28, 1990, and December 3, showed no discrepancies in airfield marking, lighting circuits, or runway and taxiway signage. FAA annual airport/safety certification inspection records for 1988-1990 show several discrepancies. On September 17, 1990, a Letter of Correction was written by the FAA Certification Inspector as a result of her inspection. It stated that the lights on runway 3C/21C were in need of repair and that daily airfield inspection reports had omissions in them. The lighting discrepancies were corrected on September 18, 1990. The FAA inspector assigned to DTW at the time of the accident was not a pilot.

The National Aeronautics and Space Administration's Aviation Safety Reporting System (NASA's ASRS) issued an alert bulletin (ASRS Alert Bulletin 91:01) on January 3, 1991, concerning a near incursion on runway 21R at DTW. The event occurred after the accident and ASRS personnel received the anonymous report from an airline aircrew some time later. Although the bulletin was directly addressed to the Airport Manager at DTW, the Deputy Director of the Wayne County Division of Airports testified that his office received a copy of the bulletin from the Airport Certification Office that oversees DTW. It could not be determined why Detroit Metropolitan/Wayne County Airport did not receive the bulletin directly from NASA's ASRS.

1.10.2 Runway 3C/21C Lighting

Lighting on runway 3C/21C pertinent to this investigation includes high intensity runway edge lights (HIRLs) and bidirectional centerline lighting (CL). The distance between runway edge lights is 200 feet, except at the western edge of runway 3C/21C near the intersection of runway 9/27, taxiway O-4 and the outer taxiway, where the edge lights are 584 feet apart. FAA Advisory Circular (AC) 150/5340-24, Runway and Taxiway Edge Lighting System, dated September 3, 1975, states: "Where a runway is intersected by other runways or taxiways, a semiflush light...should be installed to maintain the uniform spacing for HIRLs."

The distance between runway centerline lights is 50 feet. Neither the National Oceanic and Atmospheric Administration, nor the Jeppesen Sanderson, Inc., flight information publications depicted centerline lights on runway 3C/21C at DTW. NWA pilots use Jeppesen Sanderson documents.

Witnesses in the runway 3C/21C area at the time of the accident did not note whether the runway centerline lighting was illuminated. Because of the directional nature of this system, these lights are not visible from the DTW control tower. The FAA tower supervisor stated that prior to the accident, the centerline lights were turned on by means of a toggle switch and set to step 5 (the highest setting) via a rotating rheostat switch. Postaccident testing of the centerline lighting panel in the tower revealed the following:

1. The "on-off" toggle switch was spring loaded and could be placed between the "on" and "off" positions; however, it was difficult to get the switch to remain in the center position. When in the center or the "off" position, the centerline lights were not illuminated.
2. The panel behind the rheostat was labeled with a felt-tipped marker indicating the 5 intensity steps (the numbers 1 through 5), two "off" positions, and an unidentified "hashmark."
3. When the rheostat was placed in the two "off" positions and at the hashmark, the centerline lights on the runway were at their lowest intensity level.
4. When the rheostat was placed between the numbers corresponding to the 5 intensity steps, the centerline lights were at their lowest intensity level; however, as the switch was rotated to the next highest setting, the lights brightened to that setting.
5. The switch detents corresponded to the 5 intensities. When the switch was in a detent, the lights illuminated to the level corresponding to that detent.
6. The rheostat did not conform to FAA specifications outlined in AC 150/5345-3D, dated August 8, 1986, because it did not have a stop to prevent rotation past the last intensity setting (step 5) and to prevent continuous rotation in either direction. The provisions of this document are mandatory for Federally funded projects.
7. The runway 3C centerline lights were on a separate electrical circuit and therefore were not part of any other airport lighting that was intentionally turned off prior to the accident.

On May 31, 1991, the Safety Board issued Safety Recommendation A-91-39 to the FAA concerning airport lighting panel rotary switches. A response is pending. The recommendation asked the FAA to inspect all lighting panel rotary switches to ensure that they comply with the specifications outlined in AC 150/5345-3D. This AC states in part:

The switches shall have a minimum angular throw of 30° between detents and be equipped with a stop to prevent rotation past the last position and continuous rotation in either direction.

A taxiway hold position light (damaged and inoperable prior to the accident) was installed on the island between the outer taxiway and runway 3C/21C. This assembly is a dual, alternately flashing set of yellow lights, intended to delineate the entrance to runway 3C/21C. The taxiway hold position light was not required airport equipment under the FARs.

1.10.3 Airfield Guidance Signs

All taxiway identification signs (informational signs with yellow backgrounds and black lettering) and runway identifier signs (mandatory signs with red backgrounds and white lettering) observable along the route taken by the NWA DC-9 met or exceeded the specifications concerning size and coloration, as stated in AC 150/5345-44D, Specification for Taxiway and Runway Signs, dated April 30, 1984. After the accident, investigators were unable to agree on the precise taxiway segment identifications near Oscar 4 after reading the available signs in that area.

1.10.4 Airfield Surface Markings

Reflective paint was not used for taxiway centerline or hold line markings, and its use was not required. The inner taxiway centerline from gate C18 eastbound past the fire station was visible. However, about 200 feet of the centerline as it curved through the Oscar 6 area varied in conspicuity between "very faded" to "not visible" under day VFR conditions, according to investigators who observed the taxiway. The taxiway centerline that led from the inner taxiway to taxiway Oscar 6 toward runway 9/27 was visible. The inner taxiway centerline between Oscar 6 and Oscar 4 varied in conspicuity from "faded" to "visible." On the Outer taxiway, the painted taxiway centerline was observed to vary in visibility from "faded" to "visible" between Oscar 4 and Oscar 6. About 50 feet of the centerline on the Outer taxiway near Oscar 5 was unpainted because of recent pavement surface maintenance. An airport management official stated during the public hearing that taxiway centerlines are painted twice a year and that because of weather, the lines were to be repainted in the spring of 1991.

Concerning hold lines between taxiways and runways, AC 150/5340-1F, Marking of Paved Areas on Airports, dated October 22, 1987, states in part: "the hold markings are installed perpendicular to the taxiway centerline." The runway hold line on the extended portion of Oscar 4 between the two islands was parallel with runway 9/27 rather than perpendicular to the taxiway centerline.

1.11 Flight Recorders

1.11.1 Digital Flight Data Recorders (DFDRs)

The DFDRs on both airplanes were Fairchild Model F800 devices. There was no evidence of any internal damage to either recorder. An examination of the recovered data from both recorders indicated that they operated within established parameters and that there was no abnormal loss of synchronization during the pertinent portions of the recordings.

The DC-9 data plot covers 11 minutes and 52 seconds and contains all data recorded during the taxi sequence. The altitude and airspeed inputs for the DC-9 were not plotted because the data did not display any significant changes during the entire taxi operation. The B-727 data plot contains the 2-minute segment of the data set that covers the turn onto the runway through the takeoff roll and subsequent takeoff abort. All parameters for the B-727 during this period were plotted.

1.11.2 Cockpit Voice Recorders (CVRs)

Both CVRs were Fairchild Model A-100A devices. Neither CVR received any internal damage during the collision sequence. The recordings obtained from both the recorders were of good to excellent quality. On the B-727 recorder, a power interruption of unknown origin occurred at 1346:57.5, about 1 minute and 18 seconds after the collision. The DC-9 recording ended at impact.

Appendix D contains the full transcript of the DC-9 recording and the last 5 minutes of the B-727 recording (initiation of the takeoff checklist to the end of the recording). The flightcrews from each of the accident airplanes suggested clarifications and additions to the transcripts. They are also in appendix D.

1.12 Wreckage and Impact Information

1.12.1 The B-727

The B-727 was only damaged on its right side, most of which affected the right wing. Approximately 13.5 feet of the outboard wing had been sheared off during the collision. Much of the debris from this wing area was found in and around the DC-9. The remaining portion of the wing was attached to the fuselage but was heavily damaged. Most of the Nos. 4, 5, and 6 leading edge flaps had broken off, but the actuators were still in place. Most of the forward, lower fixed leading edge panels aft of the No. 4 leading edge flap had also broken off. The Nos. 7 and 8 leading edge slats and slat tracks had separated from the wing and were found on the runway beside the DC-9. The mid fairing and most of the aft fairing for the outboard flap track of the inboard trailing edge flap had been torn off during the collision and were found lodged in the leading edge of the right wing of the DC-9. Among other wing components, the lower, outboard end of the inboard aileron was slightly damaged, as was the outboard end of the outer spoiler.

The three fuselage-mounted engines did not appear to sustain any damage as a result of the collision. They were not examined internally. Both right tires exhibited several cuts on their treads and sidewalls. (See figure 4.)

1.12.2 The DC-9

1.12.2.1 General Damage Description

The interior of the passenger cabin was extensively damaged by the fire. All cabin sidewall and ceiling panels, stowage bins and seat cushions, except for some small pieces, were destroyed by fire. The remains of double seat frames from about their bottom seat pans to the floor were intact and in place from the left overwing hatch to the aft lavatory. All other seat frames were generally not as intact and had more fire damage. Many of the seat frames on the right side of the cabin were displaced rearward from their normal positions.

The airplane's fuselage was cut in a straight line just below the bottom of the windows on the right side of the airplane. The cut line remained along the right side of the fuselage, and the fuselage structure above this cut line to the top was destroyed by fire. The majority of the fuselage was burned from just aft of the cockpit to just forward of the aft bulkhead, from the top to just above the window line on the left side of the airplane.

The accessory compartment between the aft pressure bulkhead and the fiberglass tailcone contained considerable amounts of soot. Plastic electrical wiring support loops and insulation on some small wires in that area had melted. The thermal insulation on the aft side of the pressure bulkhead was not fire damaged.

The right horizontal stabilizer's bottom surface and the right side of the vertical stabilizer contained heavy amounts of soot. The outside of the tailcone area contained soot, mostly on the right and lower sides, but fire did not burn through. The outside of the tailcone exhibited a 1- to 1/2-inch mark that exposed a fiber matrix surface.

The left wing was undamaged and all left wing control surfaces were intact. The right wing was heavily damaged, and about 3.5 feet of the wing tip was missing. Portions of the right wing tip were found in the right main landing gear door of the B-727. Several areas of the wing's top skin just aft of the leading edge were torn. Scrape marks existed on several areas of the upper surface of the DC-9 right wing. These scrape marks and those on the right wing of the B-727 indicated a collision angle between the two airplanes of approximately 50°.

The interior of the cockpit contained a light amount of soot and exhibited some charring of the ceiling and sidewall just inside the folding entrance door. The folding entrance door was found in several pieces with the cockpit side of the door relatively clean and the cabin side of the door charred. The first officer's middle window was cracked but intact, and the



Figure 4.--Photographs of the DC-9 and the B-727.

first officer's instrument panel was deformed aft. Small pieces of debris from the wing tip of the B-727, including shards of green glass from the right navigation light lens, were found in the cockpit of the DC-9. The right side of the nose of the airplane exhibited a large gash beginning just under the first officer's middle window and extending aft to the galley service door.

The left engine was intact and did not exhibit any external damage except for soot found in the inlet and exhaust areas. The right engine was knocked off its pylon by the B-727 during the collision sequence. It was found beside the DC-9 in a heavily battered and burned condition. Neither engine was examined internally.

1.12.2.2 Forward Exit Systems

The L-1 door could not be closed because of interference between the upper aft corner of the door and the door fuselage jamb. The door's operating handle could not be rotated to its fully closed position. The L-1 evacuation slide cover was found inside the cabin near the L-1 exit lying loosely on top of the wadded up R-1 slide, with no fire or smoke damage. Black shoe prints were found on the aft side of the cover. The L-1 evacuation slide was deflated and found wadded up on the cabin floor next to the L-1 exit. The girt bar was found installed in its floor fittings. The slide's manual inflation handle was twisted inside the girt skirt. When the slide was unfolded by investigators, the manual inflation handle was still attached to the top of the girt in its stowed position.

The R-1 galley service door was found in three pieces on the cabin floor. The R-1 slide cover was found undamaged on top of the wadded up L-1 slide. The R-1 girt bar and its floor fittings were not damaged; however, foreign material was found inside the aft floor fitting. The R-1 slide was not inflated and the girt end of the slide was in the girt sleeve in its proper position. The slide cover latch and cable assembly were properly installed around the girt bar in the center girt skirt cutout. The entire right side of the valise was missing and the edges of the slide were charred.

1.12.3 Collision Sequence

Based upon the locations of various DC-9 components imbedded in the structure of the B-727, and vice versa, and various impact marks and scratches on both airplanes, a collision sequence of events was established.

The first contact occurred when the right wing tip of the B-727 struck just below the first officer's middle window on the DC-9. Exact magnetic headings of the two airplanes at the time of impact could not be determined because one or both of them may have slewed slightly because of pilot input or during the collision. However, it was established that the B-727 was nearly on the centerline and the DC-9 was near the right edge of runway 3C.

As the B-727 passed the DC-9, tearing of the DC-9 fuselage began, and simultaneously the wing tip of the B-727 began to disintegrate. As the wing tore through the DC-9 fuselage, the outboard mid-canoe fairing of the inboard flap on the underside of the B-727 right wing came in contact with the right wing leading edge of the DC-9. About the same time, the B-727 right main landing gear door impacted the right wing tip of the DC-9. The DC-9 wing tip was sheared off and a portion of it remained lodged in the B-727 gear door. The B-727 right wing continued to cut through the right side of the DC-9 fuselage until its No. 8 leading edge slat came in contact with the right engine cowl of the DC-9. The right wing of the B-727 then sheared off at the 13.5 foot point as it came in full contact with the right engine of the DC-9, which then separated from its pylon. See figures 5a and 5b for a graphic presentation of the impact sequence.

1.13 Medical and Pathological Information

1.13.1 General

Interviews with crewmembers in both airplanes and air traffic controllers involved in this accident suggested that they received proper rest before duty. With the exception of the captain on the DC-9, all of them had eaten breakfast and lunch prior to the accident. The DC-9 captain stated that his last meal prior to the accident consisted of chicken, a bowl of chili and cheese stick appetizers and was completed at about 2100 on December 2. The captain decided to skip breakfast the following morning in order to report early to the airport, and he ate no other food before the accident.

1.13.2 Postaccident Toxicological Testing

Federal regulations require Part 121 air carriers to have a drug testing program to prevent illegal drug use in the workplace. NWA has a postaccident drug testing program that was approved by the FAA under 14 CFR 121.457. According to FAA regulations, urine is collected for drug analysis; alcohol is not one of the drugs identified in the testing procedure. Further, urine collected under this authority and procedure may not be used for any reason not covered in 49 CFR Part 40, "Procedures for Transportation Workplace Drug Testing Program." These procedures are essentially the drug testing guidelines developed by the Department of Health and Human Services (DHHS) for federal employee drug-free workplace programs, which require tests of urine for 5 drugs or drug classes: opiates, amphetamines, cocaine, PCP, and marijuana at cutoffs specified by DHHS.

Alcohol abuse prevention in the transportation industry was the subject of an Advance Notice of Proposed Rulemaking issued in the Federal Register on November 12, 1989, by the Office of the Secretary of the Department of Transportation (DOT).

In addition to the FAA-mandated testing program, NWA has its own postaccident drug testing program for its employees. This program includes the collection of blood for alcohol measurements and the collection of urine to test seven drugs or drug classes. The drugs include the five drugs or

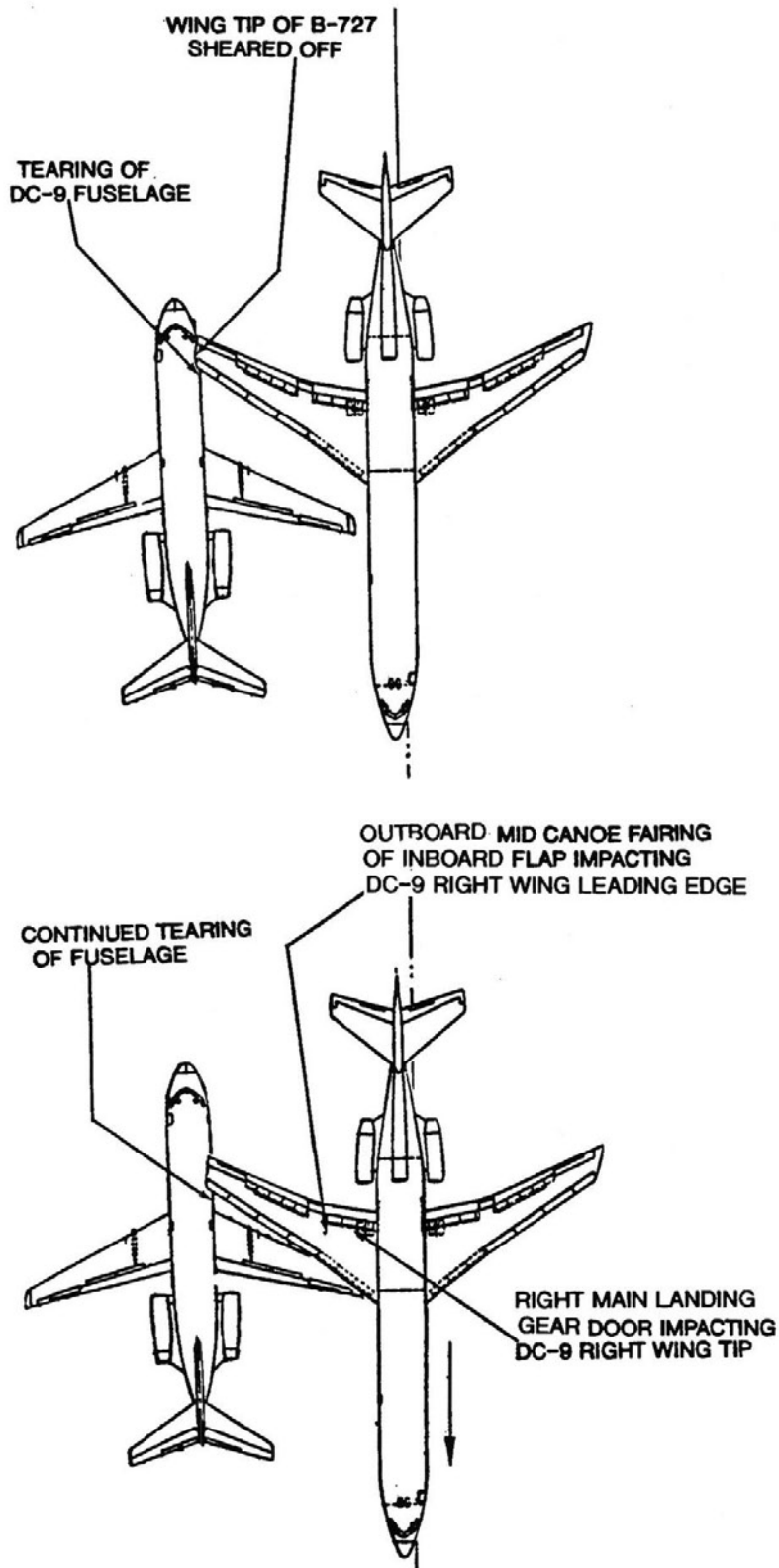
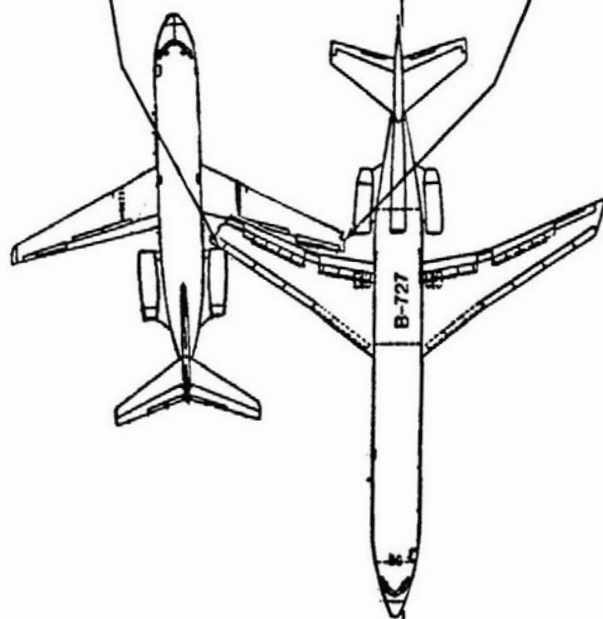


Figure 5a.--Impact sequence.

No. 8 LEADING
EDGE SLAT COMING
IN CONTACT WITH RIGHT HAND
ENGINE COWL

DC-9 WING TIP SHEARS OFF
AND LODGES IN B-727 GEAR DOOR



DC-9 ENGINE SHEARED OFF

RIGHT HAND WING SHEARED
WHEN IMPACTING DC-9 ENGINE

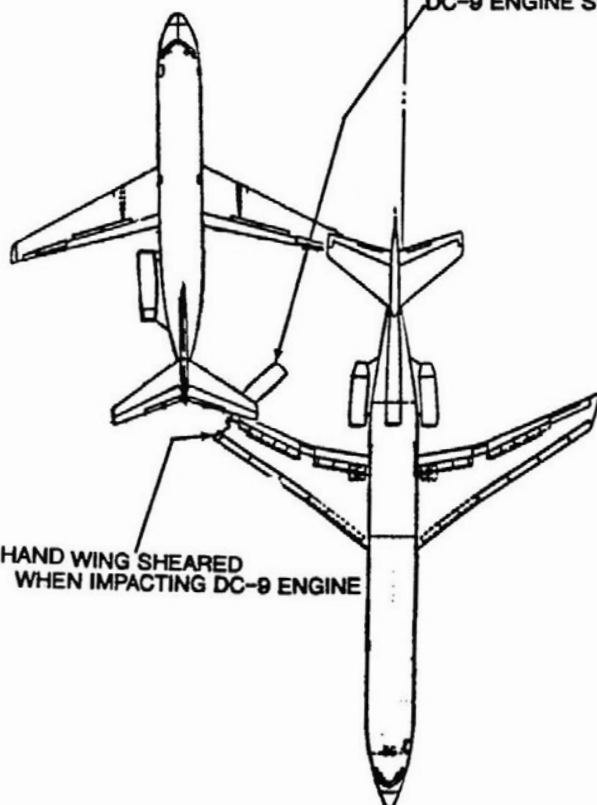


Figure 5b.--Impact sequence.

drug classes in the FAA-mandated program and benzodiazepines and barbiturates. Because 49 CFR 40.21(c) states that the urine specimen may only be used to test for the five approved drugs, NWA obtained separate specimens (urine and blood) from its employees to test for the additional two drug classes and alcohol.

1.13.2.1 NWA Postaccident Testing Program

Under NWA's in-house drug testing program, the cockpit crews of both aircraft and two flight dispatchers provided blood and urine specimens for drug testing. The captain and first officer of the DC-9 provided these specimens at 2010 and 1910, respectively. The captain, first officer, and flight engineer on the B-727 submitted specimens at 1950, 2010, and 2025, respectively. The cockpit crewmembers of both aircraft and the flight dispatchers tested negative for all drugs, including alcohol. Flight attendants on the two aircraft were not requested to provide specimens.

1.13.2.2 FAA-Mandated Postaccident Drug Testing Program

Urine specimens were collected from the cockpit crewmembers of both aircraft separately for the FAA-mandated postaccident drug testing program. Urine specimens were collected from the captain and first officer of the DC-9 and the captain, first officer and flight engineer of the B-727 at the same time the specimens were taken for the NWA program. According to FAA representatives, the specimens were negative for the five drug types.

1.13.2.3 Drug Testing of Air Traffic Controllers

Federal employees in safety-sensitive positions, such as air traffic controllers, are subject to postaccident drug testing under DOT Order 3910.1A. This order prescribes DOT's policy and procedures for implementing Executive Order 12564, Drug-Free Federal Workplace. The Executive Order and the Drug Free Workplace do not include testing for alcohol use. The DOT Drug Testing Guide sets forth the procedures to be followed in determining who is to be selected for drug testing following an incident or accident. For air traffic controllers, the following steps are to be followed:

1. The Flight Standards Division Manager (FSDM), or the Air Traffic Division Manager (ATDM), or the Airway Facilities Division Manager (AFDM) will be notified of an accident or event by the regional communication center. Upon such notification, the appropriate manager will determine whether the event qualifies as a covered event, described in section II.A.1. This determination shall be based on all available facts.
2. Following a determination that the event qualifies as a covered event, the appropriate division managers shall take all practical steps to identify each employee whose work performance may have been a contributing factor to the event.

3. After identification of each employee, as specified in Paragraph 2, the appropriate division manager shall exclude from testing any employee so identified when specific and objective information collected in the course of review of the known facts surrounding the event shows that the employee's work performance at or about the time of the event could not have been a contributing factor in the event.

In this accident, the decision about which controller to test was made by the manager of the Air Traffic Division (ATD), FAA Great Lakes Region, whose office is in Des Plaines, Illinois. According to his testimony at the Safety Board's public hearing on this accident, he reviewed the sequence of events of each controller by phone conversations just prior to and at the time of the accident and concluded that only the east ground controller would be subject to drug testing. This decision was made in conjunction with legal counsel at FAA Headquarters in Washington, D.C. The ATD manager stated that based on information available, he decided to test only the east ground controller. The manager reviewed the time sequence of events and decided that the local controller should not be tested because the controller thought that NWA flight 299 had already taken off when the supervisor told everyone to stop their traffic. Although the manager determined that the flight had not taken off before the ground controller made the statement that an aircraft was lost on the airport and the supervisor ordered all flights to be halted, the manager stated in testimony, "there were no acts he [local controller] could have taken that would have stopped it."

According to the manager's testimony, after he decided to test the ground controller, a urine specimen was obtained around 1730 (about 4 hours after the accident). To do this in a timely manner, the manager testified that he had the urine specimen collected by a doctor in the Detroit area rather than using the DOT urine collection contractor, Upjohn Corporation, which would have required an individual to travel to Detroit from the east coast. According to verbal reports from the FAA, the controller tested negative for the drugs (opiates, cocaine, marijuana, PCP, and amphetamines).

The ATD manager testified at the public hearing that he has a few employees involved in an alcohol rehabilitation program. However, he made it clear that he does not have the authority to test for alcohol use.

The Safety Board formally requested that the FAA provide blood and urine samples from all FAA personnel in the tower at the time of the accident. This request was made several times prior to the investigative team's arrival in Detroit. The controllers declined to provide specimens for such testing. Because the local controller refused to provide urine or blood samples to the Safety Board for further independent testing, the local controller's use or nonuse of alcohol and other drugs not in the National Institute of Drug Abuse (NIDA) protocol immediately before the accident could not be determined.

1.13.3 Injury and Fatality Descriptions

No persons on the B-727 were injured. Seven passengers and one flight attendant on the DC-9 died. The flight attendant was found face down on the tailcone catwalk with her head directly under the tailcone release handle and the male passenger who had sustained a minor head injury was found aft of the tailcone slide pack with his buttocks resting partially on the tailcone access panel and his upper torso near the tailcone's lower right latching mechanism. Both victims died of asphyxia secondary to smoke and soot inhalation and both were within reach of the tailcone emergency release handle.

Three male passengers who occupied seats 7F, 9F, and 12F were the only persons to die from massive blunt force trauma. A female passenger seated in 6F and a male passenger originally seated in 12D died of asphyxia secondary to smoke and soot inhalation. The male was found in the aisle at row 11, and both of these victims were severely burned. A male passenger assigned to seat 10D, who was found in the aisle at row 9, died of thermal injuries; no traumatic injuries or smoke and soot inhalation were detected.

1.14 Fire

1.14.1 Fire Initiation

The cabin of the DC-9 was consumed by fire. The fuel vent surge tank in the right wing of the B-727 was probably ruptured as the wing sliced through the fuselage of the DC-9. Examination of impact marks on wing components revealed that the No. 3 (outboard) fuel tank in the right wing was ruptured as that area of the wing struck the right engine of the DC-9. Fuel lines that were feeding fuel to the DC-9's right engine under pressure from wing tank fuel pumps were ruptured when the engine separated from the fuselage. Electrical components in the right wing tip of the B-727 include the right navigation light (illuminated by the pilots prior to beginning the takeoff roll). Wiring to these components was compromised during the collision. On the DC-9, electrical components within the cabin included reading lights, overhead lighting, and the public address system.

Personnel on the first ARFF units to arrive at the DC-9 noted that the detached right engine was burning and that, aside from the fuselage fire, a ground fire existed around the engine and under the empennage of the airplane.

The passenger in seat 11D stated that flames erupted "almost immediately." The passenger in seat 6B said that after the impact he saw a flame that looked like a "blow torch" coming into the cabin at the right rear. The passenger in seat 15A saw flames along the right side of the fuselage immediately after impact.

1.14.2 Emergency Response

Upon notification of the accident by the DTW tower around 1345, 13 DTW Fire Department (DTWFD) personnel responded from Fire Stations 1 and 2 with five vehicles, two engine companies and two ambulances. One of these ambulance was delayed because it was involved in an earlier response to a local hospital. All but one of the fire fighting vehicles initially responded to the B-727. That response was somewhat delayed because of low visibility in the fog, possibly as low as 50 to 100 feet, according to DTWFD personnel. The fire trucks were also slowed because they had to maneuver around various aircraft on the taxiways. Upon arrival at the B-727, ARFF personnel saw fuel leaking from the damaged right wing, and they blanketed the wing and fuel spill area on the ground with foam.

At 1350, Fire 1, which was at the B-727, asked the ground controller for the location of the second airplane. The controller replied that he was unsure but that the last report he had was that the airplane was at "Oscar 4 and runway 9/27." The airplanes were about 2,100 feet apart. All ARFF units at the B-727, except Fire 2 (directed to stay with the airplane) proceeded to search for the DC-9. The driver of Engine 6 (a small vehicle with no heavy fire fighting equipment) had previously elected to search for the DC-9, upon initial notification, rather than proceed to the B-727. It was the first ARFF vehicle to reach the burning airplane. Engine 6 radioed to the other units at the B-727 that the airplane cabin was fully involved with fire and requested all vehicles to respond to the DC-9. The Fire Chief so ordered, with the exception of Fire 2, which stayed with the B-727.

A short time later, Fire 1 ordered Fire 2 to move to the DC-9. The driver of Fire 2 advised the captain of the B-727, through an open cockpit window, that he was leaving. The captain requested that Fire 2 remain, but the driver told him that he had been ordered to leave and proceeded to do so.

1.14.3 Fire Fighting

Fire 1 directed arriving units to extinguish fires located at the separated No. 2 engine and underneath the DC-9. Following this effort, an interior attack was attempted on the left side of the aircraft using hand lines and bumper turrets through the cabin window openings. This attack was abandoned because of the intensity of the fire and the hazard to the fire fighters, according to DTWFD personnel. A short time later, fire breached the roof of the DC-9 and overhead turrets applied foam into the fuselage. The Fire Chief later estimated that the cabin fire was extinguished about 3 minutes after the ARFF vehicles arrived. DTWFD incident reports estimated that the first ARFF unit arrived at the DC-9 at 1348. However, ATC tape recordings indicate that they arrived about 3 minutes later.

The Fire Chief stated that although it had no detrimental effect on the rescue, an attempt to replenish water at a fire hydrant located at the taxiway Xray and runway 9/27 intersection was unsuccessful because the water supply to this hydrant had been shut off for maintenance and the DTWFD had not been notified that the hydrant was out of commission.

Also, the Fire Chief stated that he decided not to have his fire fighters attempt to jettison the DC-9 tailcone externally because the cabin was totally engulfed in fire and the cabin environment appeared to be nonsurvivable. He also said that flames on the ground in the area of the tailcone presented an unacceptable risk to his fire fighters. At the public hearing for this investigation, he stated that another reason why he did not want the tailcone jettisoned was because it would vent the fire within the fuselage. When he was asked about leaving the B-727 without fire protection, the Fire Chief stated that he made a "tactical judgment" that all ARFF equipment was needed at the burning DC-9, since the fuel leak at the B-727 was "slight." He added that he believed having the passengers remain on board the B-727 was unsafe and that the captain should have expeditiously deplaned the passengers.

Shortly after the arrival of ARFF units at the DC-9 and prior to the extinguishment of the cabin fire, the Fire Chief directed a fire fighter/emergency medical technician to establish and oversee a triage site. A primary triage area was selected but not implemented because, according to the Fire Chief, a number of the most seriously injured had already been transported to local hospitals in police vehicles, which arrived shortly after the ARFF units.

1.15 Survival Aspects

1.15.1 B-727 Deplaning

As the B-727 came to a stop on the runway centerline, the captain shut down all three engines and confirmed from the lead flight attendant that no one was injured. A deadheading NWA captain advised that there was no fire but that a small fuel leak existed on the right wing tip. He was instructed to return to his seat to monitor that problem. The captain announced to the cabin that passengers should remain seated, and he asked the tower to send out the fire trucks, busses, and mobile stairways. He later stated that he determined that the airplane was safe for the "short term" and that an emergency evacuation might be avoided.

Several fire trucks then arrived and applied foam to both sides of the airplane. As the fire trucks were leaving for the DC-9, the driver of the last truck advised the captain that "You look good, you're all foamed, and you're OK," according to the captain. Shortly after the ARFF vehicles departed, he deenergized the battery circuitry. About this time, a heavy rain shower began, and the captain leaned across the first officer to observe the fuel leak. He stated that the wind was blowing the fuel spray from the leak away from the aircraft and that the crown of the runway was draining fuel on the ground away from the airplane.

About 15 to 17 minutes after the collision, the captain told the second officer to lower the ventral stairway in the rear of the airplane to assist in deplaning the passengers. He had the jump seat rider reenergize the battery, made a public address announcement to direct the deplaning, told the first officer to secure the cockpit, and then went aft to assist in the

deplaning. The passengers were allowed to collect their carry-on baggage before their departure from the airplane.

1.15.2 DC-9 Evacuation

1.15.2.1 Pilot Activity

After shutting off the fuel control levers, the captain of the DC-9 announced three times on the public address (PA) system to evacuate the airplane. As he looked to the rear of the airplane while replacing the handset, he saw people blocking the cockpit doorway while trying to exit the airplane. He stated that he heard a woman scream that the door was jammed. He exited through his sliding window and used the escape rope so that he could open the door from the ground. He discovered that the L-1 passenger entry door was open and believed that the woman was referring to the R-1 galley door as the one that was jammed. He then assisted passengers in moving away from the airplane and escorted one passenger to a parked police car.

The first officer said he thought to conduct the evacuation checklist following the collision but only remembered pulling the engine fire shutoff switches. After extricating his injured right leg from the area between the control column and the deformed instrument panel, he entered the cabin and saw five or six people standing at the L-1 door. He pushed one passenger out the door and the others followed. He then exited through the L-1 door and later inflated the emergency evacuation slide from the ground. After assisting a passenger off the wing, he attempted to climb up the slide to reenter the airplane but fell down and was subsequently restrained by a fireman.

1.15.2.2 Cabin Evacuation Activity

Passengers evacuated the airplane through the L-1 and R-1 doors and the left overwing exit. The lead flight attendant, the first officer, and two off-duty flight attendants exited through the L-1 door also. None of the crewmembers inflated the L-1 evacuation slide prior to exiting the airplane. The captain used his escape rope and evacuated through the left cockpit window. The right overwing exit was not used. One passenger and the flight attendant assigned to the aft jump seat entered the tailcone but they were unable to deploy the tailcone exit and did not survive the accident.

The lead flight attendant stated that she left her jump seat to secure the galley and was standing in the cockpit doorway when the impact occurred. She dropped to the floor, and when she stood up and turned around people were rushing to the front of the airplane. A woman fell at her feet and, after she helped her up, the flight attendant opened the L-1 door. She stated that the escape slide pack had fallen off the door, and she bent down and pushed the slide through the door with her left hand while opening the door with her right hand. When the door was open about 2 feet, she jumped out of the airplane to get out of the way. She shouted commands from the ground for passengers to jump out of the airplane. She stated that she looked for the slide's inflation handle but could not find it. She testified

that if she had found the handle while she was still in the cabin, she would have inflated the slide even though the door was not completely open.

A passenger seated in 6D stated that following the collision he reached the L-1 exit and saw a uniformed flight attendant standing at the door trying to open it. The passenger said that the flight attendant could not lift the handle and he and another man told her that they would open it. He stated that she bent down to the floor and said something like, "I'm going to pull the chute." When the door was open about 1 1/2 to 2 feet, the other man jumped out and the passenger sat on the door sill and pushed the door open further with his feet. When the door was about halfway open he pushed himself off the door sill and jumped to the ground.

An off-duty NWA flight attendant who had been seated in seat 1D saw that the woman in 2D had a head injury and was not attempting to exit. She assisted that woman to the L-1 exit. The door was partially open, and she thought that the first officer pushed the door open. She assumed that the slide had malfunctioned because the lead flight attendant was on the ground and did not attempt to inflate it. She said that in order to minimize the risk to the passengers who were jumping from the door in a "crazy" manner, she held onto the door with her right hand and lowered passengers to the ground with her left arm. Her only injuries were muscle strain as a result of lowering passengers to the ground. After she exited the airplane, she placed three injured passengers in a sheriff's patrol car. When she could not find the operator of the vehicle, she commandeered it to move the injured passengers away from the burning airplane. She did not see ambulances, so she urged the police to transport the three passengers to the hospital.

The left overwing exit was opened by the passenger in seat 13B. The passengers in seats 9D and 10A initially headed for the forward exits and then turned around and exited through the left overwing exit. The passenger in seat 7D joined the crowd that was "surging forward" but then turned around and exited through the left overwing exit also. The passenger in seat 6B said he went back toward the overwing exit and used it because he did not want to "wait in line."

The flight attendant in the aft cabin and the passenger seated in 15D entered the tailcone through the tailcone access hatch but were unable to deploy the tailcone. They both died as a result of smoke inhalation.

1.16 Tests and Research

1.16.1 Tailcone Release System Examination and Testing

The fuselage station frames, associated longerons and the attaching rivets of the fuselage adjacent to the tailcone were not damaged during the collision. However, tears and wrinkling of the fuselage skin was evident in this area. The tailcone evacuation slide pack was found in place and intact. Its slide deployment lanyard was found properly attached to the tailcone, but it was lying to the left of the pack, out of its normal position.

The interior tailcone release handle was found out of its normally stowed position, free of its retaining clips, and its safety wire was not found. The handle was also rotated about 60° clockwise from its normal stowed position. Because of soot deposits on the handle, the lifting and identification of fingerprints was impossible. The red and white colored placard on the fuselage sidewall near the handle was readable through an even coating of soot, and the soot was not disrupted.

Although the routing of the tailcone release mechanism cabling was found to be in accordance with the Douglas DC-9 Maintenance Manual, there was excessive slack in the cable. Three of the four tailcone release latches were in their fully closed positions. The upper left latch was engaged but rotated counterclockwise 1/2 inch from its fully closed position. When tested, all four latches rotated within the limitations imposed by the cable system.

According to the DC-9 Maintenance Manual, the maximum amount of pull required to release the tailcone was 35 pounds. However, two pull tests of the internal release handle of 60 pounds and more than 90 pounds, respectively, did not release the tailcone. Following these tests, the four latch mechanisms were examined. The top right and the bottom left latches were fully closed. The bottom right latch was rotated clockwise 1/2 inch from its fully closed position. The top left latch was rotated counterclockwise 1/2 inch from its fully closed position. The interior tailcone release handle would not return to the position in which it was found. Instead, it drooped over the side of the release assembly. When the bottom right latch was returned to its fully closed position as it was found during the initial examination, the interior tailcone release handle returned to its position as originally found. During a subsequent pull test of the exterior tailcone release handle, the tailcone deployed after 30 pounds of pull tension were exerted and the evacuation slide deployed normally. Maintenance Manual specifications state that the cone should release between 25 and 35 pounds of tension.

When an intact tailcone release handle is properly stowed, its shaft is retained in a lock housing, which prevents motion of a locking cable by trapping the cable ball end fitting within the lock housing. If the cable cannot move, the tailcone release latches cannot rotate far enough to allow the tailcone to drop. This prevents an inadvertent release of the tailcone. When the handle is pulled, its shaft comes out of the lock housing, thereby releasing the locking cable end fitting. Continued motion of the handle pulls the attached release cable, the release cable rotates the latches, and the tailcone is released.

During an attempt to reinstall the release handle into its housing for further testing, handle's shaft was found to be fractured and separated near where the shaft jointed the main portion of the handle. The separated piece of the shaft remained within the lock housing and prevented the locking cable from being released. The main portion of the interior release handle was attached only through the release cable, which passes through the handle shaft.

Video tapes of the original pull tests of the interior handle showed that the handle shaft was broken before any tests were conducted. However, this fact was unknown to investigators at that time.

The interior release handle lock housing was disassembled from the support structure so that the handle shaft piece could be removed and examined along with the inside surfaces of the lock housing. The steel ball end fitting on the end of the locking cable had worn a 0.145-inch-deep dimple or depression into the aluminum alloy handle shaft piece. Also, the ball end fitting had worn a lens-shaped depression on the inside of the aluminum alloy lock housing. The maximum depth of this depression was 0.008 inch.

Pull testing of handles with simulated dimples in the handle shaft revealed that the presence of a dimple caused the ball end fitting to interfere with removal of the shaft from the lock housing, thereby increasing the load necessary to pull the handle out of the support clips. Tensile testing of an intact handle showed that when a handle is pulled in the proper direction (handle shaft pulled directly out of the lock housing), the handle can sustain more than 1,900 pounds without fracturing. During a bend test of a handle in a lock housing, the shaft fractured when 159 pounds of side load were applied.

Examination of the fracture surface on the separated shaft from the handle on the accident airplane revealed features typical of an overstress separation.

1.17 Additional Information

1.17.1 FAA Surveillance of NWA DC-9 Pilot Training and Operations

The FAA Certificate Management Office in Minneapolis is responsible for operational and maintenance surveillance of NWA. Primary operations responsibility is assigned through an NWA Unit Supervisor, a Principal Operations Inspector (POI), two Assistant POIs, and six Aircrew Program Managers (APMs). They are assisted in their activities by about 54 NWA Aircrew Program Designees (APDs) and 573 NWA check airmen (about 10 percent of the NWA pilot workforce).

Although numbers vary, the FAA DC-9 APM is assisted by 8 NWA APDs and 106 check airmen in the surveillance of about 846 captains and 756 first officers based at Minneapolis, Detroit, and Memphis.

1.17.2 FAA Surveillance of NWA Maintenance

NWA has main maintenance operations bases in Minneapolis, Minnesota, and Atlanta, Georgia. The Atlanta maintenance base is devoted to DC-9 maintenance. An FAA Principal Maintenance Inspector (PMI) and several assistant PMIs are assigned to the Minneapolis Certificate Management Office (CMO) to provide maintenance surveillance of NWA. The PMI and one assistant are responsible for the Atlanta maintenance base. Limited routine surveillance of NWA Atlanta maintenance activity is accomplished by an inspector who is based in the Atlanta Flight Standards District Office (ASO

FSDO 11). This individual reports to the NWA Certificate Maintenance Office only for purposes of this surveillance work and has other airline operators within the Atlanta area that he also oversees.

The FAA conducted a National Aviation Safety Inspection Program (NASIP) inspection at the NWA Atlanta maintenance facility between January 3 and January 17, 1991. The inspection focused on various aspects of NWA DC-9 maintenance, and the inspection report cited 62 findings, 11 of which were determined by the Certificate Management Office to be "class one" deficiencies, worthy of immediate corrective action. At the Safety Board's public hearing, the PMI for NWA testified that prior to the NASIP report he was unaware of these deficiencies. Seven FAA inspectors conducted the inspection. Three persons from the Atlanta FSDO, including the PMI's representative, and two individuals assigned to the Minneapolis CMO were inspectors on this team. The team leader and one other inspector were from FAA offices that had no direct surveillance responsibility for NWA.

1.17.3 Pre- and Postaccident Corrective Actions

1.17.3.1 Safety Board Runway Incursion Safety Recommendations

Because of a potentially disastrous runway incursion involving two NWA DC-10s at Minneapolis/St. Paul Airport on March 31, 1985, and the frequency and potential severity of similar incidents, the Safety Board initiated a special investigation of runway incursion incidents and accidents. The purpose of the investigation was to investigate selected incursions to determine their underlying causes and to recommend appropriate remedial actions.

The result of this investigation was a report entitled "Runway Incursions at Controlled Airports in the United States" (NTSB/SIR-86-01, May 6, 1986). In that report, 33 recommendations concerning this subject were proffered or reiterated. The earliest of these recommendations was originally issued on May 17, 1973.

In general, the report indicated that controller operational errors accounted for about 70 percent of the incursions. These errors involved coordination breakdowns between local and ground controllers or distractions that diverted a controller's attention from an established conflict situation. Pilot deviations accounted for the remaining 30 percent of the sample of 26 incursions investigated by the Safety Board staff. They primarily involved misinterpretation of taxi clearances leading to unauthorized runway crossings.

Since the report was published, the Safety Board has developed six more recommendations concerning runway incursions and related subjects. Some of these recommendations have been for specific airports, but the majority of them have involved suggested system-wide changes. A summary of Safety Board recommendations concerning runway incursions is included as appendix F.

1.17.3.2 Tailcone Safety Recommendations

On January 8, 1991, the Safety Board issued six urgent action and priority action safety recommendations concerning DC-9/MD-80 series tailcones (A-91-3 through A-91-8). In summary, these recommendations asked the FAA to:

1. require a fleet-wide inspection of all DC-9/MD-80 tailcone assemblies.
2. require that DC-9/MD-80 maintenance manuals include inspection procedures for potential broken handles.
3. require that investigation findings thus far be disseminated to operators and aircrews.
4. require training programs to include hands-on tailcone release training.
5. require that McDonnell Douglas redesign the tailcone release mechanism to correct its propensity for damage and malfunction.
6. require operators to place periodic tailcone release system inspections into their maintenance procedures.

The FAA responded to these safety recommendations favorably on March 18, 1991, citing the following actions:

called for a fleet-wide inspection directed by Notice 8300.86, which involved insuring that specific maintenance procedures and inspection intervals were included in the maintenance program for all operators of DC-9/MD-80 airplanes;

advised McDonnell Douglas to include procedures in the DC-9/MD-80 maintenance manuals for visual examinations of interior and exterior release handles;

issued Notice 8300.86 to operators and crewmembers concerning the Safety Board's findings;

announced its intention to issue an air carrier operations bulletin to ensure that adequate training guidance is available to principal operations inspectors and operators;

requested McDonnell Douglas to redesign the DC-9/MD-80 tailcone internal release handles to withstand a significant side load;

issued an AD to require repetitive inspections and functional checks of the DC-9 tailcone release system for proper operation;

proposed an AD for the MD-80 that will include these repetitive inspections actions; and

distributed two telegraphic messages concerning Notice 8300.86 and periodic inspection of the tailcone assemblies and release handles.

1.17.3.3 Douglas Aircraft Company

Douglas Aircraft Company distributed four Alert Service Bulletins concerning the tailcone on the DC-9/MD-80 series airplane following the accident:

1. Alert Service Bulletin A53-242, issued on January 10, 1991, asked DC-9 operators to check their fleets for broken internal tailcone release handles.
2. Alert Service Bulletin (ASB) A53-243, issued on February 8, 1991, was revision 1 of A53-242, and asked DC-9 fleet operators to functionally check the tailcone release system to determine whether the release system was operating properly. If proper operation could not be accomplished, the ASB called for a reworking of the shaft of the release handle to remove an indentation caused by the swaged steel ball of the safety cable system in the tailcone. It also asked operators to recheck the internal and external release handles for cracks or broken shafts and to examine the interior and exterior "EMERGENCY EXIT" markings for possible repainting.
3. Alert Service Bulletin A53-244, distributed on January 22, 1991 (with revision 1 on February 8, 1991), concerns DC-9-80 (MD-80) series airplanes, and recommends essentially the same checks and reworking as ASB A53-243, but for the MD-80. The design of the tailcone release mechanism on the MD-80 is similar to that of the DC-9.
4. Alert Service Bulletin A53-245, issued on May 2, 1991, asked operators to modify the tailcone release systems of both series of airplanes via two options:

Option 1 replaces the tailcone release system cable and handle assemblies.

Option 2 replaces the cables and modifies or replaces the two types of tailcone release handles.

McDonnell Douglas recommended that DC-9-10 through -50 airframes be modified according to this service bulletin within 6 months of receipt and that MD-80 through -88 airframes be modified within 12 months of receipt. McDonnell Douglas has not devised a redesign of the aluminum shaft/safety cable arrangement on MD-80 series airplanes. This arrangement is identical in function to the release handle/safety cable array on the DC-9 series but is mounted remotely from the release handle.

1.17.3.4 The FAA

1.17.3.4.1 Tailcone Airworthiness Directives

The FAA issued Airworthiness Directive (AD) 91-02-13 effective on February 11, 1991. This AD requires repetitive inspections and functional checks of the tailcone release system on DC-9-10 through -50 passenger or passenger/cargo airplanes for proper operation. The steps taken to accomplish these inspections and checks were required to be in accordance with previously distributed Douglas Aircraft Company Service Bulletins A53-242 and A53-243. This AD is considered an interim action until final action is identified, at which time the FAA may consider further rulemaking. The FAA also issued AD 91-07-06, with similar requirements for the MD-80 series of airplanes.

1.17.3.4.2 Runway Incursion Prevention Plan

In 1987, the FAA Assistant Administrator for Aviation Safety (ASF) was directed to identify the causes of runway incursions and formulate measures for alleviating this problem. The first phase of this effort resulted in the publishing of an Aviation Safety Bulletin and the creation of an informational video tape on incursions. These products were completed in March and June, 1988.

As part of the second phase of this project, a multidisciplinary team of FAA personnel from the Office of the Associate Administrator for Air Traffic, the Office of Airport Safety and Standards, the Office of Flight Standards, and the Advanced System Design Service was formed under the overall direction of the ASF. A report entitled "Reducing Runway Incursions: An FAA Report" was issued. The purpose of this report was to combine the various perspectives on the runway incursion problem, and to provide a basis for coordinating the efforts of the various FAA organizations into an integrated FAA program for reducing runway incursions. The report states:

The team reviewed the various source materials related to runway incursions. They also talked to representatives of the user community (general aviation and commercial pilots, airport operators, and airports personnel); air traffic control (ATC) personnel; and field personnel. They reviewed the ongoing problems and surveyed the activities of the agency--recent, ongoing and planned, and made recommendations--aimed at addressing these problems.

Three general recommendations resulted from the above effort:

1. Establish a steering committee on runway incursion reduction.
2. Accelerate development and field deployment of the Airport Movement Area Safety System (AMASS).
3. Emphasize the analysis of pilot-related causal factors in runway incursions.

Specific recommendations were in five main areas:

1. Procedures in the cockpit and the control tower;
2. Training of ground vehicle drivers and airplane pilots;
3. Awareness of the runway incursion problem;
4. Signs, markings and lighting on airports;
5. Simplification of surface traffic movements.

Following this accident, in January 1991, the FAA published a report entitled "Runway Incursion Plan" that:

Established a National Program Manager for Runway Incursions as the official within the FAA who is accountable for executing the plan.

Created an industry working group under the Research, Engineering, and Development Advisory Committee, and local Airport Runway Incursion Action Teams.

Designated four demonstration airports--Boston, Seattle-Tacoma, Pittsburgh, and the new Denver Airport--for purposes of demonstrating to pilots and controllers state-of-the-art marking, lighting and signage.

Reflected priority treatment of airport standardization projects within the Airport Improvement Program (AIP), and placed increased emphasis on providing Federal grant assistance to airports for upgrading visual aids to ground navigation and other projects to achieve standardization.

Provided emphasis on the need to involve human factors scientists in the design and execution of ongoing and new initiatives.

Recognized the need to support improved controller and pilot training to prevent runway incursions.

Called for alternative technology solutions to provide warning of runway incursions, as well as to aid pilots in ground navigation.

According to the report, the FAA has 25 initiatives currently underway to address runway incursions and improve safety involving the surface movement of aircraft and ground vehicles. They range from short-term measures, such as the production of a color brochure on airport signs and markings to be distributed by November, 1991, to very long-term measures, such as the Airport Surface Traffic Automation (ASTA) program, to be completed by April 2001. All of these initiatives, with the exception of the development of new technology equipment (ASDE-3, AMASS, and ASTA), have implementation dates of 1993 or earlier.

1.17.3.5 Detroit Metropolitan/Wayne County Airport

On December 20, 1990, in a letter to the Director of Airports, Wayne County Department of Public Services, the FAA Facility Manager of the air traffic control tower requested that taxiway Oscar 4 be barricaded and closed and that a Notice to Airmen (NOTAM) be issued to reflect this action. On January 11, 1991, the Director of Airports closed Oscar 4 between runway 9/27 and taxiway Victor. A NOTAM was issued reflecting this closure.

1.17.3.6 Northwest Airlines

Following the accident, NWA added a new section to its Flight Operations Manual, that is applicable to all airplane types flown by that airline. It concerned taxiing in low-visibility conditions and emphasized the following points, among others:

1. A warning not to taxi an airplane if the pilot is unsure of the safety of the operation.
2. A direction to plan the taxi route prior to moving the airplane.
3. A warning that runway and taxiway markings vary from airport to airport.
4. The advice that communication in and out of the cockpit is the key to safe taxiing at all times.

1.17.4 Advanced Runway Incursion Prevention Systems

1.17.4.1 Advanced Airport Surface Detection Equipment (ASDE-3)

The ASDE-3 is a ground-search radar surveillance, acquisition, processing, and display system. Its purpose is to provide tower controllers with real-time, high-resolution radar displays on the location of surface traffic in the airport ground control area. Controllers will use this information to control the movement of aircraft and authorized vehicles on the surface of the airport during conditions of low visibility. This

includes the movement of aircraft in takeoff or landing and aircraft taxiing to and from terminal areas. According to the FAA Runway Incursion Plan, the program is funded up to \$130.5 million from prior year funds. The plan states that the system will be operational in all four demonstration airports after January 31, 1994.

1.17.4.2 Airport Movement Area Safety System (AMASS)

AMASS is an ASDE-3 radar system enhancement which uses the radar data to identify and monitor runway traffic and to issue alerts in potential or actual runway incursion situations. These alerts will consist of visual warnings on the ASDE-3 radar screen and audible warnings in the tower cab. According to the Runway Incursion Plan, the "first operational readiness" date is November 30, 1994.

1.17.4.3 Airport Surface Traffic Automation (ASTA)

This system is intended to augment ASDE radar processing developed under AMASS. It will integrate the enhanced ASDE surveillance with Mode S surface surveillance and the Mode S, E-Scan and airport surveillance radar (ASR) air surveillance sensors to provide continuous coverage in the terminal area airspace and the ground movement area. It will provide airplane identity tags on ASDE radar screens and data link communications to airplanes in the air and on the ground.

Other features include automatic incursion alerting in the tower cab, automatic runway status lights integrated into International Civil Aviation Organization (ICAO) type runway stopbars, active taxi route guidance delivered to the cockpit and direct cockpit incursion alerts. This system will be linked to terminal, enroute, and flow control facilities. The development of this system will be ongoing, and the most advanced feature (direct cockpit alerts) is expected to be available after March 31, 2001, according to the Runway Incursion Prevention Plan.

1.17.4.4 Tower Information Presentation System (TIPS)

The TIPS, also referred to as a control tower heads-up display (tower HUD), is a device that will project information concerning air traffic control tower activity directly on the inside of the tower window. It will enable tower controllers to obtain information without interrupting visual surveillance of the airport. Although the final decision to develop the system has not been made, a preliminary demonstration of the concept was accomplished in October, 1990. A final report on requirements for the system is due to be published by December 1, 1991.

1.17.4.5 Surface Movement Guidance Control System (SMGCS)

The SMGCS consists of enhanced runway and taxiway markings and lighting that will allow airplanes to taxi and take off and land in visibility conditions down to runway visual ranges (RVRs) of 300 feet. Airplanes that will be allowed to use minima such as this will be equipped with electronic aids such as HUDs and fail-operational autoland systems.

1.17.4.6 Short-Term FAA Plans for Signs and Marking Improvements

According to the FAA Runway Incursion Prevention Plan:

Current standards for airport signs and markings in AC 150/5340-18 are not implemented consistently at airports. FAR Part 139 was amended January 1, 1988, to require signage and marking systems acceptable to the FAA. These systems were to be in place by January 1, 1991. Complete compliance has been delayed because of current FAA/industry efforts to change certain standards. This has resulted in some projects being held in abeyance pending completion of the revised standard by 7/31/91. The regional airports' offices have been directed to initiate a coordinated plan of action to ensure that standardization is achieved. This plan of action includes national guidance to achieve expeditious compliance, ensuring that AIP grant programmers work with airport engineers and certification inspectors to see that marking, lighting and signage projects are identified and given high priority for grant funding.

In addition, an FAA/industry group is revising and expanding the current signage standards contained in AC 150/5340-18. This group requested that FAA standards not be finalized until they can be made to parallel ICAO recommendations concerning signage to the maximum extent possible. The ICAO Visual Aids Panel met on May 27-31, 1991, and the FAA/industry group's concerns were largely met. Also, a senior expert position was created in the FAA's Office of Airport Safety and Standards to work exclusively on designated high priority marking, lighting and signage projects. According to the FAA, immediate attention has been given to completion of AC 150/5340-18. Once these standards are finalized, the FAA would require airports to be in compliance by December 31, 1993.

1.17.5 Tailcone Description and Operation

The following, and Figure 6, are excerpted from the Douglas Aircraft Company's DC-9 Maintenance Manual:

Tailcone - Description and Operation

1. Description:

- A. The tailcone is attached to the aft end of the fuselage and can be jettisoned. The tailcone is constructed of glass fiber laminated skins which are separated by flutes which form a hollow core. An access door is located in the lower forward section and provides access to the aft accessory compartment from outside the airplane without jettisoning the tailcone.

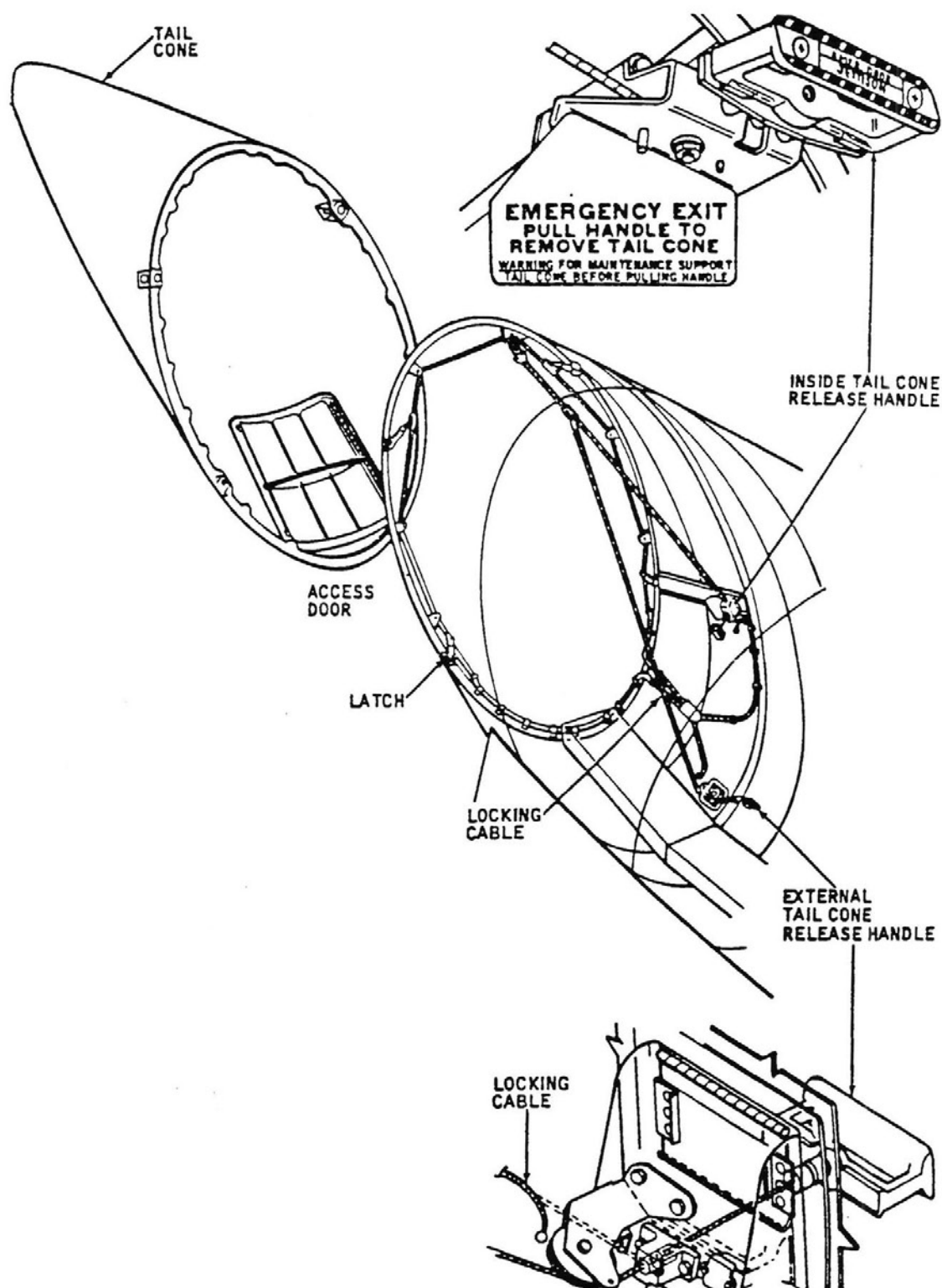


Figure 6.--Tailcone assembly.

Four spring-loaded latches, attached to the aft fuselage attach frame, engage four locks on the tailcone attach ring and secure the tailcone to the fuselage. A locking cable locks the latches in the closed position.

2. Operation:

- A. The latches are actuated by pulling the internal release handle, located in the left side of the aft accessory compartment, or pulling the external release handle located in the fuselage lower structure forward of the tailcone.
- B. When a release handle is pulled, the locking cable is released and cables attached to the release handle and latch levers rotate the lockpins to the open position. The two lower lockpins release first to prevent the weight of the tailcone from binding the lockpins. The lockpins disengage from locks on the tailcone. Compression springs on the lockpins push the tailcone away from the fuselage and the tailcone falls free.

2. ANALYSIS

2.1 General

The investigation clearly indicated that when the accident occurred the DC-9 was positioned on active runway 3C/21C and the B-727 was on its takeoff roll.

The CVRs from both airplanes contain exclamations before the collision. The first exclamation was from one of the DC-9 pilots, starting 2 seconds before impact. Examination of the DFDR data revealed that the B-727 was traveling at 211 feet per second at that time. The DC-9 pilots stated in interviews that they heard engine noise before the B-727 suddenly appeared out of the fog. When a reaction time of 1 second is assumed between the sighting of the airplane and the exclamations, the distance between the aircraft when the DC-9 crew saw the other airplane was about 630 feet, or about 1/8 mile. The Safety Board therefore concludes that the visibility was so poor at the runway intersection that neither airplane had time to visually acquire and evade the other prior to the collision.

The evidence revealed no component malfunctions or design features on the B-727 or the DC-9 that contributed to the accident sequence of events, with the exception of the DC-9 tailcone release mechanism. Documentation of the DC-9 cockpit light switches indicated that all exterior lights were on except the landing lights. The B-727 exterior light switches were off when they were examined by the Safety Board because the crew secured the cockpit

following the accident. The pilots on that airplane stated that appropriate lights were on during the takeoff roll.

The crewmembers onboard both airplanes were apparently in good health and appeared to be well rested for the intended flights. The results of the postaccident toxicological tests indicated, within the limits of the testing procedures, that the crewmembers were not under the influence of drugs or alcohol at the time of the flights.

The Safety Board believes that the specific DC-9 flight training received by the pilots involved in this accident was adequate to perform the intended flight. According to NWA officials, the negative effect of numerous company mergers had appeared, for the most part, not to have adversely affected the DC-9 training program. Interviews with other NWA personnel revealed, however, that the assimilation of the Republic Airlines' DC-9 pilot force into the NWA training philosophy was somewhat difficult. NWA's concept of checklist usage, flight maneuver parameter tolerances, and general airmanship was significantly stricter than that of Republic Airlines. This stricter training philosophy caused friction between the Republic DC-9 pilots and their new NWA supervisors. The DC-9 pilots involved in this accident were not recent Republic employees, however, and appeared to have reacted favorably to the NWA training program. The lack of comprehensive CRM training for the pilots of flight 1482 played a role in their actions during the taxi operation. This lack of CRM training was examined by the Safety Board.

As is the case in the vast majority of accidents, the chain of events leading up to the runway incursion and subsequent collision had many links, involving not only the flightcrews but the air traffic control system and the layout and upkeep of DTW. Actions in the aftermath of the collision were also of concern to the Safety Board. All of the following will be examined as they pertain to the circumstances of the accident:

The performance of the involved flightcrews.

The CRM training program at NWA.

The distribution of airport directional signs and upkeep of surface markings and tower lighting switches at DTW.

The actions of the ground and local controllers in the tower.

The role of the supervisor in the DTW tower.

The methods that NWA pilots use to determine the advisability of a takeoff in low-visibility conditions.

The emergency evacuation of the aircraft.

The broken DC-9 tailcone release handle.

ARFF decisionmaking during the fire fighting and rescue operation.

2.2 DC-9 Pilots' Preflight and Taxi Actions

2.2.1 Pilot Background Information

Because the DC-9 captain had recently returned to airline service and the first officer was relatively new to airline operations, it is likely that both of them had a high desire to perform well in their respective assignments. The DC-9 captain had experienced a series of significant life events before the accident that included a financial bankruptcy, news that he was medically recertified for airline operations, and reassignment to the NWA workforce. From interviews, it appears that he appeared to handle these stressful events well and was very happy to return to flying duties. As a result of regular disability stipends he received during his medical leave of absence, his financial situation appeared to have been stable despite the bankruptcy. At the time of the accident, the most significant stressor was probably the anxiety caused by his unfamiliarity with current NWA line operations and procedures.

On returning to NWA after his medical leave, the captain was in an unfamiliar environment of new manuals, checklists, and procedures, resulting from the airline mergers that occurred during this absence. He was an experienced captain but, because of his 6-year layoff, he may not have had full confidence in his ability to carry out some of his line flying duties. Thus, on the evening before the flight, he spent time trying to thoroughly familiarize himself with his trip sequence route, and possible instrument approaches to be flown. Also, before the accident flight, he spent a considerable amount of time briefing the first officer on expected procedures during the proposed trip sequence. The captain clearly attempted to include the first officer in the conduct of the flight. However, there is no evidence that the captain studied the airport layout or discussed it with the first officer before they began to taxi.

The first officer was beginning his second flying career and was still in his employment probation period of 1 year. During this probation period, he was to be evaluated by each captain with whom he flew. Such evaluations were great incentives to perform well. They were also stressful situations because failure to perform well would probably end his chances of flying with a major airline. A captain described the first officer as "maybe a little bit" more helpful than a typical new pilot and noted that the first officer spontaneously tried to assist him with taxiing actions at one airport.

A comparison of the first officer's military records and the CVR recording revealed that statements he made to the captain prior to pushback concerning his military accomplishments were exaggerated. However, his military records did confirm that he was an experienced B-52 aircraft commander and instructor pilot, accustomed to leading an aircrew of six people through some demanding flying situations.

The falsehoods that the first officer told the captain possibly affected the captain's opinion of the first officer's capabilities relative to his own. At the time the conversations took place, the pilots were probably still assessing each other's overall ability to perform the tasks necessary to complete the flight. These conversations led to a unique command/leadership situation. As a result, the captain could have become overly impressed by the capabilities of his first officer. A significant example of the first officer's tendency to embellish his stature in the eyes of the captain was the first officer's indication that he was familiar with the DTW airport.

The Safety Board believes that the first officer's exaggerations about his knowledge of DTW operations, and the distortions of his military flight experiences and career achievements, demonstrated a lack of professionalism on his part. The Safety Board believes that ethical conduct among professional flight crewmembers dictates that they provide accurate information about themselves. Such information is crucial to the performance of professional activities, particularly in situations where crewmembers are meeting and flying together for the first time--situations that are not uncommon in current airline operations. Consequently, under such circumstances, the Safety Board believes that to deliberately provide less than accurate information about one's flight experiences and career achievements is inimical to flight safety.

2.2.2 Role Reversal in Cockpit

The Safety Board believes that a nearly complete and unintentional reversal of command roles took place in the cockpit of the DC-9 shortly after taxiing began. The result was that the captain became overly reliant on the first officer. The captain essentially acquiesced to the first officer's assumption of leadership. This role reversal contributed significantly to the eventual runway incursion.

The sequence of events leading to the role reversal began when the captain asked the first officer if he was familiar with DTW and was told "yes." The captain then asked him to assist with the taxi clearances and taxiing. The captain's request for help from the first officer was entirely correct, and in keeping with a basic understanding of CRM. However, the first officer's acceptance of the request without reservation or qualification, coupled with his failure to clarify the extent of his actual knowledge of the airport, placed a considerable burden of responsibility on him.

Although the first officer may have been somewhat more familiar with the airport layout than the captain, he was not as familiar with the layout as he had led the captain to believe. He could have clarified the situation to the captain at this point by admitting (as he did after the accident) that he meant to convey the fact that he was familiar with the pushback and radio frequency changeover procedures after takeoff, rather than with the layout of taxiways. Again, the Safety Board believes that the first officer probably did not want the captain to think he was inexperienced. The first officer apparently realized that the captain was "new" and would need

more help than an experienced captain. He later stated that it had been more typical in his experience for airline captains to anticipate taxi clearances and that this occasion was the first time that a captain had asked him to actively assist. This new responsibility was one that the first officer appeared ready and willing to accept. As a result, by the time the crew began to taxi, the first officer began to dominate the decisionmaking in the cockpit.

Numerous examples of this domination were evident before and during the early part of the taxi sequence, as the pilots became lost in the fog. They are as follows:

1. At 1317, a nonrevenue passenger entered the cockpit and stated that she was a "jump seat rider." The first officer, without consulting the captain, stated, "Are you gunna ride up here or...?" The passenger stated her desire to ride in a passenger seat, and the captain agreed. The first officer then stated, "No, it's up to you but most captains I say fly, fly first class." [sic] The captain then told the passenger, "Whatever you want to do is fine."
2. About 1322, while the airplane was still parked, the first officer explained to the captain the most accurate way to determine weight and balance.
3. At 1325, the first officer stated to the captain that he had ejected from airplanes twice, and at 1328 he stated that he retired from the U.S. Air Force as a lieutenant colonel. Neither statement is supported by the first officer's military records.
4. At 1331, the first officer explained to the captain details concerning takeoff data for contaminated runways.
5. At 1336, as they were initially searching for the yellow taxi line, the first officer stated, "Just kinda stay on the ramp here." The captain replied, "Okay. Until the yellow line I guess, huh?" (This exchange may have been particularly significant since the airplane was never positioned on the taxiway centerline that paralleled the ramp area and led to the Oscar 6 throat)
6. About 1338, as the incorrect decision to turn left at the Oscar 6 sign was being made, the captain asked a series of questions about which way to turn. The first officer appeared to convince himself about their location, and then he told the captain to turn left and that they were on Oscar 6. The airplane was actually on the Outer taxiway.

Up to that point in the taxi sequence, neither pilot appeared to have referred to the directional indicators on the airplane to help determine their position. If they had checked the aircraft heading, the fact that they were then taxiing due east for hundreds of feet (an impossibility on taxiway Oscar 6 which was oriented northwest/southeast) should have been a sufficient cue to prompt the captain to stop taxiing, determine his exact position and request specific instructions from the ground controller to proceed. However, by the time the airplane was on the Outer taxiway, the captain apparently believed that the first officer knew what he was doing and where the airplane was located. Unfortunately, as was revealed later, the first officer was not aware of his location and did not inform the captain of this problem.

The Safety Board believes that if the pilots had admitted to themselves that they were lost at that point, and if they had acknowledged this to the ground controller around 1339, they might have prompted the controllers to take appropriate action, which could have prevented the accident. The captain, however, apparently believed that the first officer knew where he was, and the first officer apparently could not bring himself to admit, or was not aware, that his assertive directions had placed the airplane in this predicament.

At 1339, after a short discussion concerning the visibility (the captain thought the visibility was less than 600 feet, and the first officer was ambivalent), the captain decided to call for the takeoff checklist. This checklist occupied the pilots for about 1 minute and was interrupted at 1340 by the ground controller who asked the crew their position on the ramp. The first officer replied, "Ah, we're headed eastbound on Oscar 6 here." This transmission appears to have been the first time that either pilot used a heading indicator to determine the airplane's position since they began taxiing from the gate. The transmission also indicates that the crew was lost because taxiing east for any appreciable distance on Oscar 6 was impossible. At 1340, the first officer transmitted:

Okay I think we might have missed Oscar 6. See a sign here that says, ah, the arrows to Oscar 5. Think we're on Foxtrot now.

The Safety Board believes that these statements should have made it quite evident to the captain that despite the first officer's familiarity with the airfield, they were lost on the airport. "The arrows to Oscar 5" statement clearly referred to a taxiway identification sign, and taxiway Oscar 5 is not near taxiway Foxtrot. These events should have prompted the

captain to stop the aircraft, determine positively its position on the airport, and request detailed progressive taxi instructions.⁶

At 1340, the ground controller transmitted: "Northwest 1482, continue to Oscar 4 then turn right on Xray." This transmission, in retrospect, may have confused the flightcrew and adversely affected their subsequent actions because they did not have to go as far as the centerline for taxiway Oscar 4 to turn right onto taxiway Xray.

It appears likely that by 1341, the pilots had abandoned their attempts to compare what they saw on the Jeppesen airport diagram with their observations from the cockpit. They had begun to rely totally on the airfield signs and markings they observed through the fog to comply with the ground controller's instructions. The captain later testified that he had the Jeppesen airport diagram open on his left side panel, but in this position it would have been difficult or impossible to consult it while he was using the nosewheel tiller to steer the airplane. The captain was probably fully occupied maintaining the taxiway centerline and looking for taxiway signs. Within a period of about 12 seconds, the first officer saw a sign that indicated Outer/Xray and a sign that indicated Oscar 4. The Oscar 4 sign could have only been observed after the airplane was actually on that taxiway, by looking to the left, behind the airplane. During the investigation, the group assigned to evaluate airport signage in this area could not agree on what the signs meant when they examined them without time constraints and under day VFR conditions. Obviously, the pilots on the DC-9 faced a more difficult and demanding interpretation task under the conditions they encountered.

The Safety Board believes that the aircraft then taxied forward for a short distance as the pilots convinced themselves that they had taxied onto taxiway Oscar 4, in compliance with the ground controller's instructions. Their next task was to cross runway 9/27. The first officer confirmed permission to cross that runway, and the captain then taxied the airplane through a right turn a short distance on Oscar 4 and unwittingly crossed the single, angled hold line for both runways 3C/21C and 9/27.

⁶The Airman's Information Manual defines "progressive taxi" as precise taxi instructions given to a pilot unfamiliar with the airport or issued in stages as the aircraft proceeds along the taxi route. FAA Handbook 7720.2A, Operational Position Standards, states the following about progressive taxi, termed "progressive ground movement instructions:"

Progressive ground movement instructions are detailed routes issued to the pilot/operator. Occasionally, it may be necessary to issue these instructions step by step as the aircraft/vehicle proceeds along a route. Issue progressive ground movement instructions when the pilot/operator requests, is unfamiliar with [the] route issued, and when the specialist deems it necessary due to traffic or field conditions. Progressive ground movement instructions include step-by-step routing directions.

About 1342, the first officer said to the captain, "Well, wait a minute. Oh, [expletive], this, uh, ah...." The Safety Board believes that at this time the first officer may have realized that he was not sure of their position. He followed this comment with, "I think we're on, ah, Xray here now" in a last attempt to convince himself that nothing was amiss. At this point, just prior to entering the active runway, the captain apparently stopped the airplane but did not set the parking brake.

At 1342:35, apparently for the first time, the captain started to issue a command concerning the taxi of the aircraft and their precarious position. He told the first officer, "Give him a call and tell him that, ah...." This may have been the first time that the captain realized that they were confused and needed help from the tower to determine the airplane's location on the ramp. He was apparently not aware, however, that they were approaching the active runway and in danger. Immediately after this comment, the first officer stated, "Yeah, this is [runway] 9. Were, we're facing 160 [degrees], yeah. Cleared to cross it."

The only taxiway segment in the Oscar 4 area having a heading of 160° leads directly to the intersection of runway 9/27 and the active runway 3C/21C. However, neither the captain nor the first officer noticed this fact. The captain, his doubts apparently somewhat eased by the first officer's confidence, then asked, "We're cleared to cross?" The first officer replied confidently, "Yeah, we're cleared to cross." The captain then asked, "Which way do I go? Right?" The first officer responded, "Yeah."

This conversation was representative of the entire taxi sequence--the role reversal in the cockpit of the DC-9. The captain was about to complete a direct order to the first officer to make a radio call to the tower concerning their predicament. The first officer instead interjected his statement that they were on runway 9. The captain believed him and resumed a subordinate role when he asked the first officer more questions as he taxied the airplane southeasterly toward the active runway.

At 1342:56, the captain evidently began to have real doubts about their location when he stated, "This, this is the active runway here isn't it?" The first officer, perhaps by then less confident of his navigation, stated, "This is, should be 9 and 27. It is. Yeah, this is 9/27." The Safety Board believes that about this time, 1343:08, the airplane first entered the active runway, although it had crossed the hold line for the runway earlier. Shortly thereafter, the captain apparently saw white lines that convinced him that they were not on a taxiway. He stopped the airplane, setting the parking brake.

At 1343:35, he gave a complete order to the first officer to, "Give him a call and tell him that, ah, we can't see nothin' out here." The first officer did not comply with this order and, after a lapse of about 13 seconds, responded incorrectly to another ground control request for their position. The Safety Board believes that if the first officer had obeyed the captain immediately, the air traffic controllers might have taken more timely action to stop the B-727 takeoff. According to the captain's testimony and

the CVR transcript, he then released the parking brake and began to angle off to the left of the runway as he began to have more doubts about their location. At 1344:35, for the third time, he told the first officer to call the tower for assistance saying, "Well, tell him we're out here. We're stuck." The first officer still did not comply, but he did respond inaccurately (again) with, "That's 09."

At 1344:47, the captain finally asserted his authority. After two unsuccessful attempts on some unknown frequency or on interphone, he succeeded in informing the ground controller that they were on an [unidentified] runway. Less than 1 minute prior to the collision, the captain exercised his command responsibility. By 1345:14, the first officer was apparently convinced that they were not only on a runway but that it was the active runway and so informed the captain. The captain relayed this information to the ground controller at 1345:17. It was not until 1345:33, 7 seconds prior to the collision, that the ground controller ordered flight 1482 off the active runway.

When the captain transmitted, "Yeah, it looks like we're on 21 Center here," at 1345:17, he was asked to confirm this statement by the ground controller. The captain then stated, "I believe we are, we're not sure." Following the accident, the captain said that if he had been positive that he was on an active runway and that another airplane was bearing down upon him, he would have taxied off the runway onto the grass. In this instance, he was sufficiently aware that something was wrong that he intentionally taxied to the edge of the paved surface of the runway.

In a previous accident investigation report (NTSB/AAR-84-10) concerning a runway incursion and subsequent collision between a Korean Airlines' DC-10 and a Southcentral Air Piper PA-31 in 1983, the Safety Board addressed problems similar to the role reversal in the cockpit of the DC-9. That report stated:

The captain's statement indicates that he felt that the first officer, who had a higher level of recent experience at the airport than the captain, was more certain about the aircraft's location than the captain was.... The Safety Board believes that the first officer's strong belief about their location may have influenced the captain's decision to commence takeoff. The first officer's confidence regarding being on the correct runway in the face of the captain's uncertainties constituted a slight role reversal in that the captain's overall command authority when deciding to take off was influenced by the first officer's comments. In the past, the Safety Board has encouraged assertiveness training for first officers to exercise their responsibilities as part of the cockpit team; however, a companion responsibility for captains to exercise positive cockpit crew management must exist.

As a result of the investigation of the accident at DTW on August 16, 1987, involving NWA, the Safety Board issued Safety Recommendation A-88-71 to all Part 121 air carriers, including NWA. It stated the following:

Review initial and recurrent flightcrew training programs to ensure that they include simulator or aircraft training exercises which involve cockpit resource management and active coordination of all crewmember trainees and which will permit evaluation of crew performance and adherence to those crew coordination procedures.

On December 16, 1988, NWA responded to A-88-71, stating:

We...reviewed all of our initial, transition upgrade, and recurrent flightcrew training program exercises involving cockpit resource management and active coordination of all crewmember trainees.

Training programs in place...we have always stressed coordinated crew exercises....Whenever possible, captains and copilots, along with flight engineers...receive initial, transition, or upgrade training along with recurrent training as crews.

This response then discussed NWA's Line-Oriented Flight Training (LOFT) program:

Both of these training concepts (coordinated crew training and LOFT) teach and stress cockpit resource management using real time simulation. To further define and reinforce cockpit resource management, NWA is taking initial steps toward developing a classroom presentation designed to formally introduce this material to all pilots.

The Safety Board classified A-88-71 as "Closed--Acceptable Action" for NWA on February 23, 1989. Nearly 2 years passed between the time the Safety Board closed out this recommendation and the accident at DTW on December 3, 1990. The Safety Board believes that the role reversal evident in this flight indicates a need for NWA to substantially improve its CRM program. The Safety Board is disappointed that NWA did not, in fact, follow through on its CRM and LOFT programs.

In this accident, the captain was correct in using the first officer for assistance. However, his overreliance on the first officer without effectively using other available resources, such as the compass and the airport diagram, amounted to a relinquishment of his command responsibilities. Neither the captain nor the first officer had been provided with CRM training. Further, it is unclear whether NWA's training in CRM (if it had been provided to this crew) would have properly addressed the CRM deficiencies displayed by the flightcrew of the DC-9. To be effective, CRM training should strike a balance between an appropriate manifestation of

a captain's command authority and leadership abilities in delegating responsibilities, a first officer's ability to communicate effectively and carry out such duties, and the use of suitable resources to conduct a safe flight. The Safety Board concludes that if the captain and first officer had been exposed to a proper CRM training program, the captain might have recognized that the first officer was usurping his command authority and taken sufficient action, including stopping the aircraft before reaching the runway, and requesting help from the ground controller.

Further, the flightcrew should have studied the Jeppesen airport diagram more thoroughly prior to beginning the taxi. In addition, they should have taxied to intersect the Inner taxiway centerline before passing the fire house. If they had done so, the routing to Oscar 6 would have been more apparent.

2.3 Decisionmaking in DTW Tower

2.3.1 Visibility Observations

The Safety Board is concerned that the local controller and the area supervisor did not use the visibility reference chart to determine and reconfirm whether the prevailing visibility was actually 1/4 mile prior to the accident. Tower procedures specify the use of the chart. Although it is possible to determine the prevailing visibility from memory if visibility markers have been memorized, the local controller did not have them memorized. The Safety Board believes that the area supervisor was able to list them from memory only at the public hearing, months after the accident. The ground controller concurred with the 1/4 mile call but he also did not have the visibility markers memorized. If he had memorized them, he would have known that the visibility was less than 1/4 mile as he observed the concourses. The off-duty controller did not have the visibility markers memorized, but she properly used the required chart and determined that the visibility was 1/8 mile.

Therefore, the Safety Board believes that the only definitive measure of the visibility that was taken prior to the accident was that of the off-duty controller. However, because the visibility was varying considerably during the 30 minutes or so of the various observations, it is not conclusive that the observations of the other controllers were wholly inaccurate. It is possible that when the local controller took his observation, the visibility was 1/4 mile; that when the off-duty controller observed some minutes later, it was 1/8 mile; and that when the supervisor took her observation, the prevailing visibility was 1/4 mile. The Board believes, however, that when the off-duty controller asked the local controller if he was going to change the official visibility, the local controller should not have arbitrarily dismissed her query.

2.3.2 Ground Controller's Actions

In analyzing this accident in retrospect, the Safety Board examined the actions that could have been taken by the ground controller to prevent the runway incursion. After determining that the DC-9 had missed Oscar 6 and was in the vicinity of Oscar 5 after having inadvertently turned eastbound on the Outer taxiway, the controller had some options. First, because the Oscar 4 area had been identified as a potential runway incursion hazard in materials available to him, the controller could have kept the airplane away from that area by directing it back to the Oscar 6 throat via Oscar 5 and the Inner taxiway. The Safety Board does not believe that many controllers would have used this option, particularly when communicating with a professional airline crew presumably familiar with their hub airport. Having opted to route the flight toward the Oscar 4 area however, the controller could have taken other precautions. He could have begun issuing progressive taxi instructions, informing the crew to continue to the next taxiway intersection--identifiable by the sign for Outer/Xray--and hold short. Furthermore, recognizing the low-visibility conditions and the problems already experienced by the DC-9 crew, he could have requested the local controller to suspend takeoff activity until he was certain that the DC-9 was in fact across runway 9/27 clear of the Oscar 4 area and established on taxiway Xray.

In any event, the controllers clearance "continue to Oscar 4 and then turn right on Xray" was not precise because the airplane would not actually intersect the centerline of the Oscar 4 taxiway, nor would the DC-9 crew see any signs for Oscar 4, when negotiating the acute right turn onto taxiway Xray. The Safety Board does not believe however that the actual clearance should have confused the flightcrew since the designation Oscar 4 on the airport diagram available to the crew appears to encompass the intersection of the Outer taxiway and Xray.

Although the Safety Board believes that the ground controller could have selected a more conservative taxi routing, control technique, and clearance phraseology, it does not believe that his actions were deficient until he became aware that the flightcrew was encountering difficulty in the Oscar 4 area. This awareness occurred at 1345:02 when the captain of the DC-9 admitted an uncertainty about his position. This was 47 seconds after the B-727 was cleared for takeoff and only one second before the sound of increasing engine noise was audible on the B-727's CVR. The Safety Board recognizes that minimum time was available for controllers to act to prevent the accident. Nonetheless, the Board believes that the ground controller should have informed the local controller and his area supervisor immediately that he was unsure of the DC-9's position. If he had done so, the local controller might have reacted to warn the flightcrew of the B-727 about the potential hazard as they began their takeoff roll.

The Safety Board believes that by 1345:10, as the statement "We're on a runway we're right by ah zero four," was received by the ground controller from the DC-9 flight, the ground controller should have been even more aware that the DC-9 posed a potential threat to takeoff operations. In this case, this was particularly true because of the proximity of runway 9/27

to runway 3C/21C in the area of the airport that the ground controller believed the DC-9 to be located. Instead of issuing an immediate warning to the other controllers, he chose to confirm that the runway occupied by the DC-9 was in fact the active runway. According to the testimony of the controllers, the warning was issued as early as 1345:20 and as late as 1345:30 (between 10 and 20 seconds prior to the collision). Because the controllers provided conflicting testimony concerning the timing and exact nature of the warning, the Safety Board was unable to determine the amount of time consumed by the ground controller to formulate and issue the warning and the amount of time that remained for the local controller to relay the dangerous situation to the crew of the B-727.

2.3.3 Local Controller's Actions

Assuming that the ground controller used about 5 seconds to issue his warning, the local controller would have had only between 5 and 15 seconds prior to the collision to warn the B-727 about the runway transgression. If the local controller had taken an additional 5 seconds to formulate and issue a warning to the B-727, the warning would have been received by the B-727 crew 0 to 10 seconds prior to the collision.

The local controller testified that he decided not to issue a warning because he believed that the airplane was already airborne. However, his decision that the airplane was already airborne was based on a faulty assumption. Although enough time had elapsed since he issued the takeoff clearance to lead him to believe that the airplane was airborne, he had not observed the departure on the BRITE (bright radar indicator tower equipment) and had no valid reason to assume that it had indeed taken off.⁷ Although the crew of the B-727 performed their final checklist items in a normal time span, it took them a while to get into position on the active runway and begin the takeoff. Considering his inability to observe the airplane, the local controller could have asked the flightcrew to report "rolling." In fact, the local controller had cleared another aircraft into position before the B-727 began to roll. The local controller could have known that the airplane was airborne only by the receipt of a call from the flight or by an observation of the flight on the BRITE radar. Neither of these confirmations occurred, therefore the local controller should have considered that the airplane was still on its takeoff roll.

The local controller's concern that a warning call from him would confuse the B-727 pilots and could have caused more problems than it would have prevented has some merit. However, the B-727 pilots were trained to make go/no-go decisions during takeoff rolls and presumably would have performed a rejected takeoff (RTO) if they were going slow enough or would have performed a takeoff if they were going fast enough. In any event, the controller had a

⁷ FAA Handbook 7227.2A, Operational Position Standards, states:

Assumptions are Dangerous. Assumptions about what another controller or an aircraft is going to do can lead to an incorrect conclusion.

difficult decision to make, but the Safety Board believes that he should have heeded the area supervisor's command and immediately informed the B-727 that an airplane might be on the active runway. However, the Safety Board is unable to determine the effectiveness of a warning from the local controller because the amount of effective time available for the warning could have been nil.

2.3.4 Area Supervisor

The Safety Board recognizes that the area supervisor's responsibility was the general supervision of the tower personnel that included both oversight of their performance and associated administrative duties. An area supervisor is not expected or able to directly monitor the individual actions and communications of each of the controllers at all times, although he or she may do so when circumstances indicate that the redundancy of "a second set of eyes" or difficult decisions may be required. This occurs most frequently during periods of high workload or when an emergency is in progress.

At the time of the accident, the workload in terms of aircraft movements was relatively low and the supervisor was attending to administrative tasks at her desk. She was not plugged in to either the local or ground control frequencies. While in compliance with FAA policy and her job responsibilities, her decision to disinvolve herself from the actual control of traffic at this time can be questioned. The prevailing visibility was known to be marginal for the runway 3C/21C operation and she may have presumed that flightcrews would have some difficulty moving around the airport. Although the ground and local controllers in the tower at the time of the accident were all FPL personnel or were fully certified in their respective controller positions, their individual experience levels were low. The DTW air traffic environment and taxiway/runway layout was more complex than their previous FAA and military assignments. All the controllers, including the supervisor, stated that the visibility conditions they experienced on December 3 were the lowest in which they had ever controlled traffic. The Safety Board believes that these circumstances should have prompted the supervisor to provide more direct monitoring of the tower cab operations in the period prior to the accident.

The supervisor did become involved immediately after the ground controller announced that the DC-9 was "lost" and the Safety Board believes that her quick response to stop all traffic was appropriate. However, if she had been monitoring the situation as it developed, she might have detected the positional uncertainty of the DC-9 flightcrew and acted more promptly to stop the taxi operation, or at least have told the local controller to warn the B-727 of the potential collision threat. In addition, more direct attention might have prompted the supervisor to question the accuracy of the prevailing visibility reading.

The Safety Board has repeatedly expressed its concern about the lack of automated redundancies for tower controllers, such as currently exists for radar controllers. Similarly, the Safety Board is concerned that the current philosophy of operating with no specific human redundancy for

tower controllers will permit a single human error to occur, go undetected, and lead to another accident. Given the critical nature of the responsibilities of air traffic controllers, there is often no tolerance for any human error. Therefore, procedures or technological advances should be implemented to provide equivalent redundancy for tower controller tasks. For example, direct supervision of tower operations seems appropriate for certain operational conditions so that a second person will be aware of developing situations that need intervention. Similarly, procedures requiring the use of progressive taxi during low-visibility conditions could provide more control and awareness to ground controllers of aircraft locations on the airport. The implementation of procedural redundancies could involve general national guidelines for supervision, as well as site-specific guidelines and procedures for certain airports with unique operating environments. Therefore, the Safety Board believes that the FAA should immediately develop and implement procedures and policies to provide human redundancy of critical controller tasks, and should expedite the development and installation of redundant hardware systems.

2.4 B-727 Captain's Decision to Take Off

Considerable evidence suggests that the visibility at the departure end of runway 3C was much less than 1/4 mile. For example, a Mesaba Airlines' captain who was No. 2 for takeoff behind the B-727 testified that he was unable to see more than 100 feet while crossing runway 9/27. Moreover, they could barely see the first visual approach slope indicator light box 750 feet down the runway and about 600 feet from their position as they held at the departure end of runway 3C. Also, most significantly, the first officer on the B-727 announced that they did not have 1/4 mile visibility as they taxied onto the runway and applied takeoff power. The captain later stated that the first officer retracted that observation shortly thereafter, but the retraction was not recorded on the CVR.

The first officer's statement at 1345:08, "Definitely not a quarter mile but, ah, at least they're calling it," and a lack of response by the captain, indicates two things. First, a lack of CRM, in that the captain did not respond to the first officer's concern about the visibility in any manner, positively or negatively. Second, the last part of the first officer's statement indicates a reliance, at least in this pilot's mind, upon only the control tower for takeoff visibility information. In other words, the first officer appeared to believe that the takeoff was permissible as long as the control tower stated that the prevailing visibility was 1/4 mile.

If the captain of the B-727 had decided not to take off on runway 3C because of low visibility, his flight and others, including the DC-9, would have been directed to use one of the outer runways at DTW for departure. NWA's takeoff minimum visibility for those runways, because of their enhanced lighting and visibility measuring equipment, was 600 feet runway visual range.

The B-727 captain believed that since the ATIS stated that the visibility was 1/4 mile and he had "adequate visual references," he was legal in attempting the takeoff. His concept of adequate visual references

was the ability to maintain the runway centerline during the takeoff run, which he did during the collision with the DC-9 and during the aborted takeoff. He also stated that since he was not a trained weather observer, he could not be expected to question the ATIS information and had to accept the 1/4 mile ATIS observation as valid. The Safety Board believes it true that a pilot might have difficulty determining the visibility to within 300 or 400 feet. In this case, however, it was apparently obvious that the visibility was far less than 1,300 feet or 1/4 mile.

2.5 DTW Signage, Lighting and Markings

The Safety Board recognizes that maintenance of all signs, lights and pavement markings on an airport as large as DTW is a demanding task. However, some rather obvious shortcomings in this area were apparent. Although most of these shortcomings are not violations of any FARs, they reflect a disregard for the guidelines in several FAA advisory circulars concerning airport operations. The FAA was aware of some of these shortcomings and could have taken actions to correct them prior to the accident.

The investigation revealed several areas of faded or nearly invisible taxi lines on the airfield, especially near the area where the DC-9 was taxiing. These deficiencies may have been a factor in the DC-9 flightcrew's incorrect decision to turn left onto the Outer taxiway. However, photos taken after the accident showed that the yellow lines leading to Oscar 6 were clearly visible from the centerline of the Inner taxiway where it paralleled the edge of the ramp near the fire house. Thus, if the flightcrew had acquired the centerline of the Inner taxiway as it paralleled the edge of the ramp near the fire house, the fork between Oscar 6 and the easterly heading portion of the Outer taxiway would have been more evident to them.

The Safety Board believes that the repainting of the faded taxiway centerlines should be performed as soon as they are noted during daily airport inspections instead of during a set schedule for overall airport restriping.

Another confusing factor was the Oscar 6 sign located on the island between the Inner and Outer taxiways. Although the investigation determined that the size, coloration, and lighting of the airport signs in question met or exceeded regulatory requirements, the location and annotation of several signs observed by the DC-9 crew bear further discussion. For instance, the Oscar 6 sign at the intersection of Oscar 6 and the Outer taxiway misled the flightcrew into believing that they were on Oscar 6 when they were not. Adding an arrow and an OTR/arrow to this sign might clarify its meaning.

Along the Outer taxiway, there were no signs to indicate to the pilots that they were approaching the Oscar 4 taxiway. It is logical to assume that Oscar 4 would be the next available taxiway after Oscar 5, when taxiing east, but in this case, the turnoff to Xray taxiway is next. In fact, several investigators, some of whom were current airline pilots, were confused by the signage in this area when they observed it on a clear day

after the accident. The inspectors of the signage from the airport and the FAA are not airline pilots and, in some cases, are not pilots of any type of aircraft. The Safety Board believes that more user input should have been sought when the decision was made to place some signs at DTW. It recommends therefore that a survey be conducted of DTW signage for the purpose of developing signage that is more understandable to line pilots. Input from line pilots, rather than management or instructor pilots, should be a vital part of this survey.

Also, the two hold lines in the Oscar 4 area were parallel to runways instead of perpendicular to their respective taxiways. Flightcrews expect hold lines to be at right angles to taxiway centerlines and, in this accident, the DC-9 crew may have seen the yellow markings but could have failed to recognize them as hold lines because of the angle relative to the taxi path.

The absence of runway edge lights on runway 3C/21C in the Oscar 4/runway intersection area also probably contributed to the flightcrew's actions. If the lights had been imbedded in the pavement at intervals of 200 feet, as recommended by the AC, the DC-9 pilots would probably have noticed them before the runway incursion and stopped taxiing. The Safety Board notes that the single runway edge light that the captain eventually observed prompted him to taxi to the left of the runway centerline during the incursion.

Although it was not a direct factor in this accident, the Safety Board discovered that the centerline lights on 3C/21C were not annotated on the National Ocean Service or Jeppesen airport diagrams. This is an FAA responsibility and the FAA inspectors responsible for DTW should have ensured that the diagrams were accurate. These diagrams are used by pilots to predict what they will see when they taxi out for departure and takeoff. It is also important for pilots to be aware of the runway lighting configuration while they are conducting instrument approaches.

The lighting panel in the tower is an airport responsibility. The Safety Board believes that the tower controllers thought the centerline lights were on because the rheostat for the lights was at or near the step 5 (highest) setting. However, they were apparently off because of the poor layout of the panel and the deficient operation of the rheostat. This situation is significant because if the crew of the DC-9 had approached the runway with the centerline lights actually at step 5, the bright glare through the fog would have been a warning to them that they were about to transgress an active runway. At the very least, they would have known that something was wrong as soon as they reached the centerline of runway 3C.

Because of the discrepancies discovered during this investigation, the Safety Board is concerned that oversight by DTW managers and FAA Airport Safety and Certification Inspectors was lacking. These discrepancies should have been identified and corrected routinely after daily airport inspections by DTW personnel or by FAA inspectors during annual certification inspections. The Safety Board is concerned that the problem of complex

intersections, which can confuse pilots, exists at other airports and presents a situation that would require additional lighting and signage.

2.6 Survivability Issues

2.6.1 DC-9 Crewmember Actions

The Safety Board strongly supports the regulation that requires flight attendants to be seated during taxi, except when they are performing safety-related duties. About 6 minutes prior to the accident, the lead flight attendant stated that she informed the pilots that the cabin was ready for departure. She later got out of her jump seat to resecure some galley equipment and a passenger tray table. However, passengers reported that she was standing in the cockpit doorway just before the collision. The pilots stated that they were unaware of her presence during this time. If she had been seated at her duty station when the collision occurred, she would have been in a better position to aid in the subsequent evacuation. It is probable that one or more passengers reached the L-1 door area before the lead flight attendant, a situation that is unacceptable. The Safety Board issued two recommendations (A-87-94 and A-87-95) to the FAA in 1987 related to flight attendant seat belt discipline.

The physical evidence and survivor testimony does not support the lead flight attendant's claim that she opened the L-1 door. Damage to the door frame created a situation that required strength and proper body positioning to open the door. The flight attendant stated that she did so from a crouching position. It is more likely that the passenger in seat 6D unlocked and partially opened the door with assistance from another passenger. Footprints found on the L-1 slide pack cover were consistent with his statement that he pushed the door open with his feet while sitting on the door sill. Pushing on the slide pack cover, however, made the door more difficult to open completely. Pressure on the cover prevented the slide from being pulled from the door and thus prevented the door from opening fully and the slide from deploying. It could not be determined who opened the door completely.

The lead flight attendant's attempt and willingness to inflate the slide before the door was completely open are disturbing. If the slide had been inflated inside the airplane, both forward exits might have become blocked.

Neither of the two escape slides in the forward cabin were inflated during the evacuation. The Safety Board believes that the R-1 emergency slide would have deployed during the impact sequence as the R-1 door was ripped apart if the girt bar had been properly installed in the floor brackets. It could then have been inflated by the lead flight attendant or a passenger. Although the L-1 door initially required more than a normal effort to unlock and open past the deformed frame, the slide should have been manually inflated by the lead flight attendant or another crewmember. Four trained crewmembers (the first officer, the lead flight attendant and two off-duty flight attendants) did not inflate the slide manually during the evacuation. If one or both evacuation slides had been used, the evacuation

would have been more timely and the number and extent of serious evacuation injuries would most likely have been reduced.

The Safety Board is also concerned that none of the surviving crewmembers thought to activate the external tailcone release. All of the crewmembers, except one injured off-duty flight attendant, were physically capable of doing so. It is recognized that the ground fire under the empennage would probably have precluded any attempt by people other than fire fighters to pull the external release handle. However, the Safety Board believes that such a procedure under a similar scenario should be emphasized in both flight attendant and pilot training. The Safety Board is unable to determine if the internal tailcone jettison handle was broken before the accident or while the flight attendant and/or the passenger attempted to jettison the tailcone.

2.6.2 Flight Attendant Tailcone Training

The Safety Board believes that NWA flight attendants received inadequate training in the operation of the DC-9 tailcone. The DC-9 tailcone exit release handle simulator used for flight attendant training prior to the accident consisted of a platform to stand on, a pole rising obliquely, and a release handle mounted at the end of the pole. It was inadequate as a realistic training aid because:

The release handle was not installed in clips that would have represented the forces required to pull the handle free;

The training device was not installed in a realistic environment that represented a fully enclosed tailcone with low levels of ambient illumination;

A door or hatch was not used to gain entry to the handle simulator.

FAA Air Carrier Operations Bulletin (ACOB) 8-76-46, Crewmember Emergency Training, Use of Mockups, states, "For those exits where it is impractical for each individual to operate the exit or device, such as the DC-9 tailcone, a group demonstration will suffice provided it is supported by a realistic, detailed visual/pictorial presentation." The Safety Board believes that this guidance should be eliminated. Flight attendants should have hands-on experience with any exits that they may be required to operate during an emergency evacuation.

2.6.3 FAA Oversight of Flight Attendant Operations

The FAA's use of Cabin Safety Specialists for oversight of air carrier training programs is beneficial. However, testimony at the public hearing indicated that the FAA does not provide specialized training for cabin safety inspectors and that the inspectors must rely heavily on their previous flight attendant experience to guide them. The FAA should provide specialized training for cabin safety inspectors to ensure standardization of the approval process for training programs. In addition, cabin safety

inspectors and airline training departments should be provided guidance that will allow them to determine whether mockups are realistic, accurately reflecting the actual forces and other conditions encountered in operating exits in an emergency.

2.6.4 The B-727 Captain's Decision to Deplane

Following the collision, the B-727 captain made the difficult decision to keep his passengers onboard, rather than have them undergo an emergency evacuation down the escape slides. The Safety Board believes that this decision was reasonable, given the fact that the passengers would have been evacuated onto a runway at an undetermined location shrouded in fog among emergency response vehicles. In addition, the captain was told that the fuel leak in his right wing had slowed to a trickle and that foam had been applied to the entire right wing by the fire department. However, the fuel leak may have already stopped, and the liquid observed by the first officer could have been fire suppressant.

The Safety Board notes, however, that there were reasons to consider evacuating his passengers down the escape slides. Wing damage observable from the cockpit on the B-727 and the fact that all fire trucks had departed would have been good reasons to perform an emergency evacuation.

Although the decision to have passengers remain onboard initially is not faulted, the Safety Board believes that the captain should not have waited 15 to 17 minutes before deplaning his passengers in an orderly manner. After the last fire truck had departed and fire fighting activity in the immediate vicinity had ended, the passengers could have deplaned from the aft stairs and assembled in the grass, safely away from the damaged airplane and the runway surface. They would have been uncomfortable and wet from the rain, but they would have been removed from danger.

2.6.5 Fire Response and Fire Fighting

2.6.5.1 Initiation of Fire

The alignment and lateral displacement of the airplanes during the collision indicate that the No. 3 fuel tank on the B-727 was ruptured when the right wing struck the right engine of the DC-9. Also, an unknown amount of fuel probably was pumped onto the ground by the wing tank fuel pumps of the DC-9 in the seconds after the right engine was knocked off its pylon. These facts indicate two possible sources of fuel to feed the fire: the B-727's No. 3 fuel tank and the DC-9 fuel tank. The Safety Board was unable to conclusively determine the sources of the fuel that fed the fire. Also, the Safety Board was unable to determine the ignition source of the fire, although hot DC-9 engine parts or electrical short circuits on either airplane are possibilities.

2.6.5.2 Rescue Response and Fire Fighting Tactics

The low visibility and lack of immediate, accurate information available in the DTW tower resulted in the fire department being unaware of the location of the DC-9 for about 5 minutes after the collision. Under these circumstances, the response time to the DC-9 was reasonable.

After the fire trucks had arrived at the DC-9, fire fighting tactics were appropriate and effective considering the extent of the fire inside the cabin. When the fire fighters arrived, however, the tailcone was not immediately jettisoned, thereby denying the tailcone as an additional exit for survivors or as an entry point to attack the interior fire. Under certain emergency conditions, depending upon prevailing winds and the propagation of a fire, a DC-9 tailcone could provide considerable survival space for trapped persons. As a general rule, fire fighters should jettison tailcones as a high-priority task.

However, because of the number of variables involved, such as the amount of smoke, heat, and the exact arrival time of the ARFF forces, the Safety Board cannot conclude that an external deployment of the tailcone shortly after the arrival of ARFF vehicles would have saved the lives of the trapped individuals.

2.6.6 Tailcone Maintenance, Design and Operation

During the Safety Board's investigation, it was found that the upper left slider block/latch on the tailcone exit had been replaced and was misrigged during the replacement. The Safety Board believes that this misrigging occurred when the mechanic who changed the slider block/latch and the inspector who inspected the mechanic's work failed to ensure that the associated cabling was properly rigged in accordance with the DC-9 Maintenance Manual. The three mechanics who worked inside the tailcone and the general inspector who signed off on the final drop test of the tailcone stated that none of them had received specific training on the tailcone assembly either through on-the-job training or through NWA's DC-9 training school. Moreover, NWA's CITEXT cards did not always accurately reflect information contained in the DC-9 Maintenance Manual. Further, the DC-9 training program mainly addressed policies and procedures, and very little emphasis was placed on the technical aspects of the maintenance being performed.

The Safety Board believes that if the mechanics and the inspector had received specific training on the proper installation and rigging of the tailcone, and if the CITEXT cards had accurately reflected the DC-9 Maintenance Manual, the misrigging would not have occurred. The investigation found that the misrigging did not prevent the tailcone from jettisoning using the external release handle and would not have prevented the jettisoning of the tailcone if the interior handle had not been broken. Based on the two successful drop tests, conducted by the mechanics and observed by a general inspector, as well as their interview statements, the Safety Board believes that the interior tailcone release handle was not broken during the "C" check or subsequent stowing and that the handle was

safety wired prior to the accident. If the handle had been fractured, the two drop tests could not have been conducted and the handle could not have been reinstalled without considerable difficulty.

During the initial examination, the handle was in its housing and rotated 60°. Following the pull tests that failed to drop the tailcone, the handle drooped over the side of its housing by its cable and, when the lower right latch was returned to its fully closed position, the handle returned to the position in which it was originally found. The Safety Board believes that one of the two occupants found in the tailcone pulled and broke the handle. Unable to egress the smoked-filled environment, they collapsed. The male passenger was found in the vicinity of the lower right latch. The Safety Board believes that the male passenger probably stepped or collapsed onto the lower right latch returning it and the handle to the positions in which they were initially found.

The Safety Board believes that the design of the tailcone emergency release handle and its associated safety cable system was deficient in the following ways:

First, the steel ball fitting on the end of the locking cable could produce a dimple in the tailcone release handle shaft and a depression on the inside surface of the lock housing. Together, these damaged areas could increase the force needed to pull the handle from its support clips beyond that which a person could reasonably be expected to apply to the handle.

Second, the handle shaft was susceptible to fracture under relatively low bending loads, and the shaft remnant within the lock housing prevented release of the tailcone regardless of the amount of pull force applied to the handle. Bending loads could be applied by pulling the handle sideways instead of directly out of its support clips. Critical bending loads were well within the capability of a person to produce, especially if that person was in extremis. Although a handle could be inadvertently broken by bending loads during maintenance of the tailcone, it is unlikely that it could go unnoticed by mechanics.

During the extremely stressful conditions of an emergency evacuation, passengers and flight attendants cannot be expected to overcome built-in deficiencies such as these. Evacuees should be able to release the tailcone without having to align the handle in any specific way, and it should not be possible to fracture the handle, rendering the system unusable.

2.7 FAA NASIP Inspection

As a result of the Safety Board's investigation, the FAA conducted a National Aviation Safety Inspection Program (NASIP) inspection of NWA's Atlanta maintenance facility. Eleven out of the 62 findings of that inspection were considered class one and worthy of immediate corrective action. Notwithstanding the corrective action, the Safety Board believes

that if the FAA's surveillance had been adequate, these deficiencies would have been detected sooner. The Safety Board believes that the FAA could not maintain adequate surveillance of the NWA's DC-9 maintenance program because of the limited number of FAA inspectors assigned to the NWA certificate and the limited surveillance by FSDO 11 in Atlanta. The remote location of the CMO relative to the Atlanta maintenance base further exacerbated the lack of supervision and management oversight of the surveillance program.

The Safety Board believes that additional personnel at the NWA CMO would enhance the FAA's surveillance capabilities. Further, the adequacy of FAA surveillance of maintenance at NWA needs to be examined.

Concerning FAA NASIP policies, the Safety Board was disappointed to discover during its public hearing that unlike previously, personnel that comprise the inspection teams can now be the same people responsible for surveilling the organization receiving the inspection. Five of the seven NASIP team members inspecting the NWA Atlanta facility were from the Atlanta FSDO (the office delegated by the CMO to oversee many aspects of NWA maintenance in Atlanta) or from the CMO itself. This new policy defeats one of the most valuable purposes of a NASIP inspection--using outside evaluators to evaluate the FAA's own surveillance of an operator's procedures.

The Safety Board supports the NASIP-type special in-depth inspection program by the FAA to verify the adequacy of its routine surveillance program. However, the Safety Board believes that NASIP effectiveness could be significantly enhanced by two means. First, an assessment of local FAA surveillance effectiveness should be a formal goal of NASIP inspections so that NASIP findings can be used to correct the deficiencies of local inspectors, as well as those of the airline.

Second, the Safety Board believes that the correction and closeout of negative findings of a NASIP team should be reviewed and approved by the NASIP team leader, rather than just by the local inspectors under whose jurisdiction the negative findings existed. The Safety Board addressed this issue earlier in its report of the Aloha Airlines Inc., B-737-200, accident on April 28, 1988, when it recommended that the FAA:

Integrate the National Aviation Safety Inspection Program team leader in the closeout of the [NASIP] team findings.
(Class II, Priority Action) (A-89-65).

The FAA Administrator's reply to this recommendation, dated October 25, 1989, was not responsive because the FAA did not intend to include the NASIP team leaders in the evaluation of the closeout because such duties were not in its job function. Further, the FAA stated that it would follow implementation of corrective actions by means of an automated tracking system to record all NASIP followup actions. The Safety Board does not believe that this system is sufficient to provide the understanding of the intricacies of the problems that led to the original findings. Consequently, in a letter to the FAA, dated April 16, 1990, the Safety Board classified the status of A-89-65 as "Open--Unacceptable Action," pending further evaluation by the FAA.

The Safety Board believes that the detailed nature of NASIP inspections and the fact that deficiencies noted by the teams were permitted to occur, or the fact that they were overlooked by the local FAA office, indicate the need for the insight of the NASIP team leader in the closeout of the findings. Therefore, the Safety Board reiterates its concerns expressed in Safety Recommendation A-89-65 and urges the FAA to consider amending its policies for evaluating the closeout of NASIP findings.

2.8 Analysis of Other Corrective Actions

2.8.1 The FAA's Runway Incursion Prevention Plan

This accident, an earlier collision in Atlanta, and a later collision in Los Angeles, spurred the FAA into updating and finalizing its runway incursion prevention efforts, although work in this area was initiated several years ago.

The FAA's Runway Incursion Prevention Plan appears to be thorough and is now under a single manager. High technology systems such as the Airport Movement Area Safety System (AMASS), Advanced Airport Surface Detection Equipment (ASDE-3), and Airport Surface Traffic Automation (ASTA), when perfected, should enhance the safety of airport ground operations considerably. The concept of the formation of "demonstration airports" to exhibit and test new or different devices and surface marking methods is valid, and the selection of the four specific demonstration airports was done in an appropriate manner. The Safety Board is also aware of other new technologies, such as the satellite-based Global Positioning System, that could be included in future runway incursion prevention systems.

2.8.2 Detroit Metropolitan/Wayne County Airport

Since the accident, Detroit Metropolitan/Wayne County Airport personnel corrected a number of airfield discrepancies that were discovered during the Safety Board's investigation. The rheostat switches on the control tower airfield lighting panel were replaced with switches equipped with stops in accordance with AC 150/5345-3D. Reflective paint is now being used for all airfield markings, including taxiway centerlines and runway hold lines. All faded taxiway centerlines identified as faded during the investigation have been repainted, and a program to repaint markings when they are discovered faded is in effect. A purchase contract for a replacement taxiway hold position light was awarded and the light is being fabricated. Semiflush runway edge lights in the runway 3C/21C-9/27 intersection area are scheduled to be installed by September 1991. An experimental system of outlining taxiway centerline markings on concrete areas of the taxiways in black paint to improve contrast is in effect. Lastly, permanent removal of the Outer 4 taxiway between the Outer taxiway and the runways is also scheduled to occur in September 1991.

2.8.3 Northwest Airlines, Inc.

The new seven-item low-visibility taxi section that NWA is incorporating into its Flight Operations Manual is an excellent tool to inform its pilots of the dangers of aircraft movement in instrument weather conditions. All of the difficulties that the DC-9 crew encountered on December 3 are covered in this addition to the manual. The Safety Board recommends that the subject of low-visibility taxi problems become a recurring subject in all airline operations' manuals and pilot training forums.

Several of the items in this addition to the Flight Operations Manual relate to the concept of CRM. The preplanning of taxi routes, the admission of confusion, the criticality of communication within and outside the cockpit, are all basic tenets of good CRM. Unfortunately, NWA has been slow to offer formal CRM training to its line aircrews, compared with other large U.S. airlines. This situation is surprising because of NWA's early involvement in LOFT and CRM research many years ago. The newly established 1-day CRM course for line crewmembers is a small step in the right direction. However, in light of this accident, the Safety Board urges NWA to begin comprehensive line crewmember CRM training at the earliest possible time.

2.8.4 McDonnell Douglas Aircraft Company's Tailcone Service Bulletins

The Safety Board is pleased to note that McDonnell Douglas completed its DC-9 series tailcone system redesign effort in May 1991, about 6 months after the accident. Such a response time to a previously undiscovered design deficiency and aviation safety hazard is impressive. The interim measures devised by McDonnell Douglas to ensure the deployability of the tailcone in both series of airplanes are also appropriate reactions to the problem. The Safety Board believes that the redesign effort on the MD-80 series tailcone release system should be completed as soon as possible.

2.9 SIGMET Foxtrot 3 Ramifications

Although it was not germane to this accident, SIGMET Foxtrot 3, predicting severe turbulence below 8,000 feet in the DTW area, was not part of the ATIS broadcasts. Also, NWA's meteorologists did not provide this information, in the form of NWA turbulence plots, to the flights operating at DTW at the time of this accident.

SIGMET Foxtrot 3 extended the valid period of SIGMET Foxtrot 2 and, according to Cleveland Air Route Traffic Control Center logs, was received and verbally disseminated, in a timely manner, to those air traffic control facilities that did not have the equipment which would allow them to receive it directly from the Center's computer. However, Safety Board investigators were unable to determine whether the DTW tower had received SIGMET Foxtrot 3 as there is no FAA requirement that a copy of SIGMETs be retained by the receiving facility and DTW tower had no record of receipt. The DTW tower supervisor stated that she would usually record in the tower log that a SIGMET had been received and broadcast as part of an ATIS transmission. Even

though terminal radar approach control logs show that six SIGMETs were broadcast on December 3, 1990, they were not mentioned in the tower activity log for that day. Since the text of SIGMET Foxtrot 3 was similar to that of SIGMET Foxtrot 2, the tower supervisor could have overlooked it when it was received. The Manager of Meteorology for NWA stated that his forecasters monitored pilot reports in the area and that in this case they did not believe a warning for severe turbulence was necessary.

The Safety Board concludes that the methods of furnishing pilots with two sources of significant weather information (the FAA and the operator) were ineffective in this case.

2.10 Postaccident Drug Testing

The Safety Board was pleased to learn that drug testing performed by NWA covered more drugs than the FAA's program, and, especially that alcohol testing was included in the NWA program. The responsibility demonstrated by the management of this air carrier in its effort to examine whether or not drug use (including alcohol) was a factor in this accident is commendable.

In spite of exceeding federal postaccident drug testing requirements, NWA was still required to collect separate urine specimens for the five drug groups for the FAA program, which still does not include testing for alcohol.

FARs prohibit flight attendants from being under the influence of drugs, including alcohol, while on duty. The surviving on-duty flight attendants on both airplanes were not tested for drugs or alcohol. No evidence suggested that flight attendants associated with this accident were under the influence of drugs, including alcohol. However, flight attendant performance affects passenger safety, and the Safety Board believes that flight attendants should also be tested following an accident. The FAA should therefore require that each carrier have a plan to ensure that flight attendants are tested for drugs, including alcohol, under the same parameters as pilots, following an accident.

In contrast to NWA, the FAA took a narrow view when determining which controller to test, and decided to test only the ground controller. As a result, both the local controller, who was the last controller to communicate with the B-727 before the collision, and the area supervisor, who had overall responsibility for the tower operation, were not tested. Similarly, the FAA air traffic management made a decision following the runway collision at Hartsfield International Airport, Atlanta, Georgia, on January 18, 1990, to limit testing and did not test controllers who were later cited by the Safety Board as being causally related to the accident.

The Safety Board continues to believe that because a proper decision cannot be made within a reasonable period of time regarding whom to test immediately following an accident, specimens should be collected quickly from all those who are "reasonably associated with the circumstances of an

accident." The decision as to which specimens to send to the laboratory for analysis can be made after more investigative information is available.

The Safety Board raised the fundamental issue of requiring the collection, especially after accidents or incidents, of blood and urine and screening for a broader range of drugs, including alcohol and prescription drugs that impair, in Safety Recommendations I-89-4 through 12 in December 1989. These recommendations were addressed to the Secretary of Transportation. A response to these recommendations was received from the Secretary on August 3, 1990. The cover letter from the Secretary stated that his Special Assistant for Drug Enforcement and Program Compliance would enter into discussions with the Safety Board on the recommendations. Numerous discussions were held, and the Safety Board was led to believe that there was support in the Secretary's Office for these recommendations. However, the Special Assistant vacated the Secretary's Office in March 1991, and no apparent progress on these recommendations has been made. As a result, on May 31, 1991, the Safety Board wrote to the Secretary expressing its concern about the lack of progress and classified Safety Recommendations I-89-04 through -09, -11 and -12 as "Open--Unacceptable Response."

3. CONCLUSIONS

3.1 Findings

1. All flight crewmembers, flight attendants, and air traffic controllers were properly certificated to perform their duties.
2. Visibilities at the time and area of the collision varied, with the lowest estimated horizontal visibility near 100 feet. The official prevailing visibility, as determined by National Weather Service and Federal Aviation Administration personnel, was 1/4 mile.
3. The B-727 captain attempted a takeoff in runway visibility of less than 1/4 mile.
4. The runway centerline lights on runway 3C/21C were not illuminated at the time of the accident.
5. The placement of taxiway signs, the conspicuity of taxiway markings, and runway lighting were inadequate at DTW at the time of the accident.
6. The DC-9 flightcrew failed to follow their assigned routing in the taxiway Oscar-6 area.
7. The flightcrew contributed to their confusion by failing to taxi toward and intersect the centerline of the Inner taxiway where it paralleled the edge of the concrete as they left the

parking area. If they had done so, the centerline leading to Oscar-6 would have been more apparent to them.

8. The complex intersection of taxiway Oscar-4, and runways 09/27 and 3C/21C was a recognized danger area with a strong potential for runway incursions but was nevertheless inadequately marked.
9. The pilots of the DC-9 failed to consistently cross-check the airplane's heading with the headings of their taxi routing.
10. A reversal of command roles occurred during the accident sequence in which the first officer made most of the decisions regarding taxi activity and the captain tacitly relinquished his command role.
11. The first officer misled the captain concerning his familiarity with DTW and failed to follow the captain's direct instructions on three occasions prior to the runway incursion.
12. If the captain and first officer of the DC-9 had received thorough training in cockpit resource management, the command role reversal might not have occurred.
13. The captain of the DC-9 questioned his position a full 53 seconds before the collision; however, neither he nor the first officer advised the ground controller of their uncertainty at that time. If they had done so, the local controller might have taken action to prevent the B-727 takeoff.
14. The east ground controller missed several opportunities to take appropriate action to resolve confusion on the part of the DC-9 crew.
15. The east ground controller, after he realized that the DC-9 might have taxied onto an active runway, did not take timely action to correct the problem.
16. If Advanced Airport Surface Detection Equipment-3 had been installed in the tower and if the controllers had been trained in its use, the system might have prevented the runway incursion and subsequent collision by allowing the controllers to keep track of the DC-9.
17. The flightcrew of the DC-9 was not initially aware of their incursion onto the active runway because the runway 3C centerline lights were not on and the runway edge lighting was not continuous.

18. The lead flight attendant of the DC-9 was not in her assigned seat when the accident occurred, failed to properly secure the R-1 emergency evacuation slide girt bar into the floor brackets, and, along with other trained crewmembers, did not inflate the L-1 evacuation slide, thereby slowing the evacuation and increasing the number of injuries to the passengers.
19. The lead flight attendant failed to fully open the L-1 door, which may have covered the emergency evacuation slide's inflation handle.
20. The emergency response and fire fighting was timely and effective.
21. The DC-9 tailcone emergency release handle and the release handle lock housing contained a depression worn into the surface by the swaged steel ball on the release system safety cable.
22. During the DC-9's "C" check, the interior tailcone release handle was not broken and it was safety wired. No records were found indicating that the tailcone area had been entered after the "C" check and prior to the accident.
23. The flight attendant and a passenger died of asphyxia secondary to smoke inhalation in the tailcone. The interior tailcone release handle was broken when one of them attempted to jettison the tailcone.
24. Northwest Airlines' maintenance and inspection of the DC-9 tailcone exit system was inadequate.
25. The tailcone's lower right latch was returned to its fully closed position when the male passenger stepped or collapsed onto it, which caused the interior release handle to move to the position in which it was initially found.
26. Federal Aviation Administration surveillance of Northwest Airlines' Atlanta maintenance base was inadequate.
27. The Federal Aviation Administration failed to recognize important signage, lighting and marking discrepancies, which, if they had been identified and corrected, could have contributed to avoiding the accident.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was a lack of proper crew coordination, including a virtual reversal of roles by the DC-9 pilots, which led to their failure to stop taxiing their airplane and alert the ground controller of their positional uncertainty in a timely manner before and after intruding onto the active runway.

Contributing to the cause of the accident were (1) deficiencies in the air traffic control services provided by the Detroit tower, including failure of the ground controller to take timely action to alert the local controller to the possible runway incursion, inadequate visibility observations, failure to use progressive taxi instructions in low-visibility conditions, and issuance of inappropriate and confusing taxi instructions compounded by inadequate backup supervision for the level of experience of the staff on duty; (2) deficiencies in the surface markings, signage, and lighting at the airport and the failure of Federal Aviation Administration surveillance to detect or correct any of these deficiencies; and (3) failure of Northwest Airlines, Inc., to provide adequate cockpit resource management training to their line aircrews.

Contributing to the fatalities in the accident was the inoperability of the DC-9 internal tailcone release mechanism. Contributing to the number and severity of injuries was the failure of the crew of the DC-9 to properly execute the passenger evacuation.

4. RECOMMENDATIONS

As a result of this investigation, the National Transportation Safety Board makes the following recommendations:

--to the Federal Aviation Administration:

Improve standards for airport marking and lighting during low-visibility conditions, such as standards for more conspicuous marking and lighting; evaluation of unidirectional taxi lines for use on acute angle taxiways; and requirements for stopbars or position-hold lights at all taxiways that intersect active runways. (Class II, Priority Action) (A-91-54)

Identify, at all 14 CFR 139 certificated airports, complex intersections, where a potential for pilot confusion exists. Where needed, require additional lighting and signs. (Class II, Priority Action) (A-91-55)

Require that CFR 139 certificated airports use reflectorized paint for airport surface markings. (Class II, Priority Action) (A-91-56)

Require that CFR 139 certificated airports install semiflush runway edge lights in accordance with Advisory Circular 150/5340-24. (Class II, Priority Action) (A-91-57)

Include directions, in the forthcoming Advisory Circular for Surface Movement Control Guidance Systems, that 14 CFR 139 certificated airports, which operate at runway visual ranges of 1,200 feet or less, follow ICAO Annex 14 standards. (Class II, Priority Action) (A-91-58)

Include guidance in Advisory Circular 150/5220-4, Water Supply Systems for Aircraft Fire and Rescue Protection, that addresses the need for fire departments to be notified in a timely manner when hydrants and water supply systems used for fire fighting are inoperable. (Class II, Priority Action) (A-91-59)

Issue an Advisory Circular addressing acceptable methods for the design, construction, operation, and maintenance of mockups used for exit training during crewmember emergency training, and provide guidance to FAA inspectors to ensure that emergency equipment training devices accurately replicate the intended operational environment. (Class II, Priority Action) (A-91-60)

Require that air traffic control tower managers reemphasize the concept and use of progressive taxi/progressive ground movement instructions during low-visibility ground operations in local Operations Position Standards Handbooks. (Class II, Priority Action) (A-91-61)

Require that air traffic control tower managers emphasize to local controllers the need for positive determination of airplane departures in IFR conditions when direct visual observations of departing airplanes are not possible. (Class II, Priority Action) (A-91-62)

Develop and implement procedures for redundancy of critical controller tasks, and expedite the development and installation of hardware systems to supplement such redundancy. (Class II, Priority Action) (A-91-63)

Require that during National Aviation Safety Inspection Program (NASIP) inspections, the majority of the team members be from different FAA regions than FAA personnel being inspected. (Class II, Priority Action) (A-91-64)

Require that an assessment of local FAA surveillance effectiveness be a formal part of NASIP inspections, so that NASIP findings can be used to correct observed deficiencies of local inspectors as well as those of the airline. (Class II, Priority Action) (A-91-65)

Require that the subject of low-visibility taxi problems become a recurring subject in all airline operations manuals and pilot training forums. (Class II, Priority Action) (A-91-66)

--to Detroit Metropolitan/Wayne County Airport:

Install semiflush runway edge lights in accordance with Advisory Circular 150/5340-24. (Class II, Priority Action) (A-91-67)

Implement a program to provide for the prompt repainting of faded taxiway and runway markings when they are seen during daily airport inspections, rather than waiting for a set schedule for overall airport restriping. (Class II, Priority Action) (A-91-68)

--to Northwest Airlines, Inc.:

Immediately institute comprehensive line crewmember Cockpit Resource Management training as a part of Northwest Airlines' Line-Oriented Flight Training and coordinated crew training programs. (Class II, Priority Action) (A-91-69)

In addition, the Safety Board reiterates the following safety recommendations to the Federal Aviation Administration:

Integrate the NASIP team leader in the closeout of the team findings. (A-89-65)

The regulations concerning drug testing of U.S. Department of Transportation employees should provide testing requirements that include alcohol and drugs beyond the five drugs or classes specified in the Department of Health and Human Services (DHHS) guidelines and that are not limited to the cutoff thresholds specified in the DHHS guidelines. Provisions should be made to test for illicit and licit drugs as information becomes available during an accident investigation. (I-89-9)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

James L. Kolstad
Chairman

Susan Coughlin
Vice Chairman

Jim Burnett
Member

John K. Lauber
Member

Christopher A. Hart
Member

Jim Burnett, Member, filed the following concurring statement:

I concur with the final report but would have preferred to include as part of the final report two findings and one recommendation which were a part of the staff's draft report but which were not adopted by the full Board.

The two findings are:

13. The local controller, realizing that an aircraft might be on the active runway, failed to issue a safety alert or other advisory about this possibility to the flightcrew of the B-727.
18. The DC-9 tailcone was not jettisoned by the fire fighters; and the possible hazard, as well as the potential for fire ventilation, did not justify this lack of action.

The recommendation is:

- (9) Issue an Air Carrier Operations Bulletin (ACOB) addressing takeoffs in very low-visibility conditions on runways not equipped with runway visual range equipment. The ACOB should contain specific criteria to assist captains in making visibility decisions based on observations at the runway rather than depending on the Automatic Terminal Information Service or general tower data. (Class II, Priority Action)

/s/ Jim Burnett
Member

June 25, 1991

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The National Transportation Safety Board was notified of the accident around 1500 on December 3, 1990. An investigation team was dispatched from Washington, D.C., that evening and arrived at DTW shortly thereafter. Investigative groups were formed on the scene for operations, human performance, air traffic control, meteorology, structures/systems/maintenance records, and survival factors. Groups were later formed for aircraft performance and readout of the CVRs and FDRs in Washington, D.C. John Lauber was the Safety Board Member who accompanied the investigative team.

Parties to the investigation included Northwest Airlines, Inc., Boeing Commercial Airplanes, the McDonnell Douglas Aircraft Company, the Air Line Pilots Association, the Detroit Metropolitan/Willow Run Airports Authority, the International Brotherhood of Teamsters, the International Association of Machinists, and the Federal Aviation Administration.

2. Public Hearing

A public hearing on this accident was held in Detroit, Michigan, from March 18 through 23, 1991. Member Jim Burnett was the presiding officer of that hearing.

APPENDIX B

PERSONNEL INFORMATION

The DC-9 Captain

The captain, 52, was hired by Pacific Airlines, Inc. on August 1, 1966, as a first officer on the Fokker F-27. In accordance with several merger contracts, this date was also considered his date of employment with NWA. He progressed to captain, check airman, and senior check airman on this airplane as Pacific Airlines merged with Airwest, Inc., an airline that eventually became Hughes Airwest, Inc. He became a DC-9 captain on December 27, 1978, and flew in that capacity with Hughes Airwest and during the subsequent Hughes Airwest merger with Republic Airlines until February, 1984, when he was medically disqualified from flying because of kidney stones.

He was reissued a first-class medical certificate on October 11, 1990, with the limitation that the "Holder shall wear glasses that correct for distant vision, and possess glasses that correct for near vision." He held airline transport pilot certificate No. 1535822, with ratings for the DC-9, F-27, and airplane multiengine land, and commercial privileges for airplane single-engine land. He also held a noncurrent flight instructor certificate that was issued on March 30, 1967. He had accumulated about 23,000 total flying hours, 4,000 of which were in the DC-9.

The DC-9 First Officer

The first officer, 43, retired from the US Air Force (USAF) on October 31, 1989. His line assignments included copilot, aircraft commander and instructor pilot duties in the B-52 Stratofortress heavy bomber and instructor pilot duties in the T-38 Talon jet trainer.

The first officer was hired by NWA on May 25, 1990. He held airline transport pilot certificate No. 2058181 with ratings for the CE-500 (Cessna Citation) and airplane multiengine land, issued November 6, 1978. He also held flight engineer certificate No. 507560424, with a rating for turbojet-powered airplanes, issued on March 21, 1979. His FAA first-class medical certificate was issued on April 30, 1990, with no limitations. He estimated that he had accumulated about 4,685 total flying hours, 185 of which were in the DC-9.

The B-727 Captain

The captain of the B-727, 42, was hired by NWA on May 9, 1983 and held airline transport pilot certificate No. 2083104, with ratings for B-727, airplane multiengine land, and commercial privileges for the L-300 and airplane single-engine land, issued April 6, 1989. He completed his last proficiency check on October 27, 1990, and his last line check was completed on May 30, 1990. His FAA first-class medical certificate was issued on August 2, 1990, with no limitations. He also held a flight engineer

certificate. At the time of the accident, he estimated that he had approximately 10,400 total flying hours, 5,400 of which were in the B-727.

The B-727 First Officer and Second Officer

The first officer on the B-727, 37, was hired by NWA in September, 1985, and held airline transport pilot certificate No. 263063366. His FAA first-class medical certificate was issued on July 9, 1990, with no limitations. At the time of the accident he estimated that he had accumulated about 5,400 total flying hours, of which 2,350 were in the B-727.

The second officer on the B-727, 31, was hired by NWA in July, 1989. He held an airline transport pilot certificate and a flight engineer certificate (No. 134421621, issued on September 27, 1989) with a turbojet powered airplane rating. His FAA first-class medical certificate was issued February 20, 1989, with no limitations. At the time of the accident he had accumulated about 3,300 total flying hours, of which 900 hours were in the B-727.

The DC-9 Flight Attendants

The lead flight attendant on the DC-9 was hired by NWA on June 17, 1988 and received her last recurrent training on August 11, 1990. The second flight attendant was initially hired by North Central Airlines (an airline that also merged with Republic and then NWA) on March 15, 1968, and received her last recurrent training on February 27, 1990. Both of these individuals were qualified for flight attendant duty or had been previously qualified on Boeing 747-200/400, B-727, B-757, McDonnell Douglas DC-10, Airbus A-320, and Convair C-580 airplanes. Neither flight attendant on the DC-9 had received hands-on training in a DC-9 tailcone.

The off-duty flight attendant, who aided in the evacuation of the airplane, was hired by NWA on March 10, 1990. She had not received recurrent training because she had only been employed by the company for about 9 months at the time of the accident.

The B-727 Flight Attendants

All flight attendants on the B-727 were current in the airplane and received recurrent training during 1990.

The Area Supervisor

The area supervisor, 35, entered on duty with the FAA on July 25, 1982, and began working at DTW on November 10, 1985. She became a full-performance-level (FPL) controller and was certified in her current position in September 1990. Her last over-the-shoulder evaluation and last tape talk session occurred in October, 1990.

The Local Controller

The local controller, 25, entered on duty with the FAA and began working at DTW on June 5, 1988. He became an FPL controller and was certified as a local controller in June, 1989. His last over-the-shoulder evaluation was in September, 1990, and his last tape talk session was in October, 1990. He had no prior FAA assignments before DTW. However, he had 5 years of earlier military ATC experience with the US Army. He was medically qualified as a controller with no waivers or limitations and was not a pilot.

The East Ground Controller

The east ground controller, 26, entered on duty with the FAA on February 20, 1985, and began working at DTW on July 1, 1990. He was certified on the east ground control position on September 30, 1990, and was not an FPL controller. His last over-the-shoulder evaluation was in April, 1990, and his last tape talk session was in May, 1990. His only previous controller assignment was in the tower at Saginaw, Michigan. He was medically certified as a controller with no waivers or limitations. He was also a noncurrent private pilot with about 80 total hours of flying time.

The West Ground Controller

The west ground controller, 26, entered on duty with the FAA on April 29, 1986, and began working at DTW on May 7, 1989. He became an FPL controller on November 12, 1989. His last over-the-shoulder evaluation was on August 20, 1990, and his last tape talk session was on March 25, 1990.

The Tower Cab Observer

The tower cab observer, 32, entered on duty with the FAA on December 13, 1981, and began working at DTW on October 10, 1989. She became an FPL controller on April 13, 1990. Her last over-the-shoulder evaluation was on December 2, 1990, and her last tape talk was on November 14, 1990. Her other FAA assignments included the towers in Pontiac, and Flint, Michigan, and Indianapolis, Indiana. She was certified to take visibility observations on May 26, 1990.

APPENDIX C

AIRPLANE INFORMATION

The DC-9

N3313L, a DC-9-14 was acquired by NWA on August 1, 1986. It was operated exclusively by NWA until the accident, at which time it had a total of 62,253.2 operating hours and had undergone 88,255 cycles. It was equipped with two Pratt and Whitney JT8D-7 turbojet engines.

The B-727

N278US, a B-727-251-2A, was purchased by NWA from Boeing in November, 1975. It was operated exclusively by NWA until the accident, at which time it had a total of 37,710.2 operating hours and 27,933 cycles. It was equipped with three Pratt and Whitney JT8D-15A turbojet engines.

APPENDIX D

COCKPIT VOICE RECORDER TRANSCRIPTS

TRANSCRIPT OF A FAIRCHILD MODEL A-100A COCKPIT VOICE RECORDER S/N 10371
 REMOVED FROM A NORTHWEST AIRLINES INC. BOEING 727, N278US WHICH WAS INVOLVED
 IN A TAXIING/TAKEOFF ACCIDENT ON DECEMBER 3, 1990 AT THE DETROIT
 METROPOLITAN/WAYNE COUNTY INTERNATIONAL AIRPORT, ROMULUS, MICHIGAN

CAM	Cockpit area microphone voice or sound source
RDO	Radio transmission from accident aircraft
INT	Cockpit flight/ground intercom voice or sound source
PA	Aircraft Public Address source
-1	Voice identified as Captain
-2	Voice identified as First Officer
-3	Voice identified as Second Officer
-4	Voice identified as Northwest Mechanic
-5	Voice identified as Northwest Gate Agent
-6	Voice identified as Female Flight Attendant
-7	Voice identified as Ground Crew Chief
-?	Voice unidentified
GND	Detroit Ground Controller
TWR	Detroit Local Controller (Tower)
RAMP	Northwest Ramp Controller
NW1482	Northwest flight fourteen eighty two
NW234	Northwest flight two thirty four
M3165	Mesaba flight thirty one sixty five
SW494	Southwest flight four ninety four
M2	Maintenance Vehicle number two (snow plow)
C70	Detroit Airport Car seven zero
*	Unintelligible word
@	Nonpertinent word

#	Expletive deleted
%	Break in continuity
()	Questionable text
(())	Editorial insertion
-	Pause

NOTE: All times are expressed in Eastern Standard Time.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1341:51
 CAM-1 takeoff check.

1341:52
 CAM-3 roger.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1341:45
 GND Mesaba thirty one sixty five at ah
 Oscar six ah disregard -

1341:51
 GND - Northwest fourteen eighty two when
 you get to ah fox and x-ray follow a
 Mesaba Fokker that'll be approaching
 from your right side

1341:58
 NW1482 okay fourteen eighty two

1342:02
 GND Northwest two ninety nine what's
 your position now

1342:05
 RDO-2 okay we just turned down onto x-ray
 two ninety nine.

1342:09
 GND two ninety nine roger tower one one
 eight point four

1342:12
 RDO-2 roger.

1342:14
 C70 Metro ground car seven zero

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1342:16
 ((flight switched to tower frequency))

1342:30
 CAM-2 let's see runway heading is thirty four
 degrees, ten thousand feet, max power, runway
 heading to eleven hundred before any turns.

1342:39
 CAM-1 okay.

1342:50
 CAM-1 are they ready in the back I didn't get an all
 clear?

1342:53
 CAM-3 I haven't I haven't heard anything I'll talk
 to them in a second.

1342:58
 CAM-3 okay all set to go back there?

1342:59
 CAM-? *.

1343:00
 CAM-3 okay.

1343:03
 CAM-3 panel items complete allowable takeoff weight
 checked. probe heat?

1343:05
 CAM-2 on, lights out.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1343:06

CAM-3 EPR?

1343:07

CAM-2 set, and ah lets see corrected is what minus ah there you go *, checked set and corrected.

1343:19

CAM-3 * instruments?

1343:21

CAM-1 I got ah zero zero and ah one ninety normal flags.

1343:24

CAM-2 same.

1343:26

CAM-3 mark bug? one forty six takeoff.

1343:27

CAM-1 one forty six takeoff numbers checked and set.

1343:31

CAM-2 takeoff numbers checked set.

1343:33

CAM-3 flaps?

1343:34

CAM-2 fifteen fifteen blue.

1343:35

CAM-3 trim?

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1343:29

TWR callin' tower say again id

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1343:37
 CAM-2 zero, zero, five point nine.

1343:41
 CAM-3 controls?

1343:45
 CAM-2 controls?

1343:47
 CAM-1 free and normal.

1343:48
 CAM-3 shoulder harnesses?

1343:49
 CAM-1 on.

1343:50
 CAM-2 on.

1343:51
 CAM-3 on. APU light out, pressurization set, final
 items to go.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1343:36
 TWR Northwest ah five thirty ah you
 probably know three right's the only
 landing runway the RVR touchdown one
 thousand feet midpoint eight hundred
 and ah rollout also one thousand
 breaking action is good how ever

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1343:56
 CAM-1 tell him we're ready to go.

1343:57
 CAM-2 okay.

1344:01
 PA-3 good afternoon ladies and gentlemen from the
 front cockpit welcome aboard flight two ninety
 nine to Memphis. we're currently number one for
 departure. we should be airborne fairly shortly.
 flight attendants please be seated.

1344:19
 CAM ((sound of snap))

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1343:51
 TWR ah is that what you need for the
 approach is ah thousand

1343:57
 TWR ah okay it's been eight hundred at
 the midpoint there for about ah gees
 for a good twenty minutes it hasn't
 moved up or down

1344:08
 RDO-2 tower Northwest two ninety nine's
 ready on the center.

1344:15
 TWR Northwest two ninety nine Metro
 tower runway three center wind one
 one zero at eight clear for takeoff
 turn right heading zero four zero

INTRA-COCKPIT
TIME &
SOURCE CONTENT

Northwest

1344:24
 CAM ((sound of five snaps))

1344:26
 CAM-3 final items. anti-skid?

1344:27
 CAM-1 on.

1344:28
 CAM-3 ignition continuous. start levers?

1344:29
 CAM-2 forward and latched.

1344:33
 CAM-3 flight attendants are notified, boost pumps are
 all on, fuel heat is off. transponder?

1344:37
 CAM-2 code set on.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1344:21
 RDO-2 right to zero four zero, cleared for
 takeoff runway three center,
 two ninety nine.

1344:28
 C70 Metro tower car seven zero

1344:32
 TWR car seven zero tower

1344:34
 C70 I'm at the de- departure end of
 three right request clearance to
 inspect three right

INTRA-COCKPITTIME &
SOURCE CONTENT

1344:39

CAM-3 CSD cooler's ground off. takeoff check complete.

1344:59

CAM-2 boy this is dog # * now.

1345:00

CAM-1 yup.

AIR-GROUND COMMUNICATIONTIME &
SOURCE CONTENT

1344:38

TWR car seven zero you're at the
departure end of three right drive
on three right

1344:41

C70 seven zero driving on three right

1344:44

TWR Northwest two thirty four Metro
tower verify that you are at the
approach end of three center

1344:48

NW234 at the approach end of three center
Northwest two thirty four roger

96

1344:51

TWR okay Northwest two thirty four
runway three center taxi into
position and hold wind one one zero
at eight

1344:56

NW234 position and hold three center
Northwest two thirty four

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1345:03
CAM ((sound of increasing engine noise))

1345:08
CAM-2 definitely not a quarter mile but ah at least
 they're callin' it.

1345:28
CAM-2 eighty knots.

1345:39
CAM-? oh.

CAM-? oh *.

1345:40
CAM ((sound of crash))

1345:43
CAM-1 abort.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1345:18
M3165 Metro tower Mesaba thirty one sixty
 five I believe we're number two at
 the center

1345:48
RDO-2 Northwest two ninety nine aborting
 three center.

1345:51
TWR Northwest two ninety nine roger
 report clearing the runway do you
 have any problem

INTRA-COCKPIT
TIME &
SOURCE CONTENT

right

his

1346:05
 PA-6 -ladies and gentleman please remain seated.

1346:07
 PA-6 ladies and gentleman please remain seated.

1346:11
 CAM-3 * evacuate?

1346:12
 CAM-2 ah do you want to * *?

1346:14
 CAM-1 I don't think we'll need to if there's no fire.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1345:54
 RDO-2 affirmative there's an aircraft on the runway and we struck his ah wing.

1345:59
 TWR alright ah we're going to notify the crash trucks you say you impacted right wing

1346:03
 RDO-2 affirmative and we're stopped on the ah upwind end of three center.

1346:07
 TWR okay sir the ah emergency vehicles are on the runway now just remain this frequency let me know if ah you need any assistance

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1346:16
 CAM-3 * there's no fire or anything right?

1346:17
 CAM-(*) no. no.

1346:18
 CAM-3 okay everybody stay seated back there for now.

1346:24
 CAM-2 ah great.

1346:25
 PA-6 ladies and gentleman stay seated.

1346:31
 CAM-2 shall we ah?

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1346:14
 RDO-2 Northwest two ninety nine roger.

1346:21
 UNK-? ops

1346:26
 TWR car seven zero you on the frequency

1346:29
 C70 that's affirmative

1346:31
 TWR did you copy what happened on the frequency there

INTRA-COCKPITTIME &
SOURCE CONTENT

1346:34

CAM-3 we were cleared for takeoff weren't we?

1346:36

CAM-1 yeah and they even cleared the guy behind us
into position and hold.

1346:45

CAM-3 we're alright.

1346:47

CAM-3 how are they *?

1346:48

CAM-1 is is is there ah is there ah any anything
going on, stick your head out that window and
look at that wing.

1346:54

CAM-2 I can't see any *.

AIR-GROUND COMMUNICATIONTIME &
SOURCE CONTENT

1346:33

C70 okay where's the aircraft that
struck ah one on center

1346:37

TWR I assume he's on the last ah last
third of runway three center there
toward the departure end

1346:41

C70 on the way -

INTRA-COCKPIT

<u>TIME &</u>	
<u>SOURCE</u>	<u>CONTENT</u>

1346:56

CAM-3 want to get the people off the airplane?

1346:57

CAM-1 check the wing I think it's mi--

1346:57.5

((end of recording))

AIR-GROUND COMMUNICATION

<u>TIME &</u>	
<u>SOURCE</u>	<u>CONTENT</u>

TRANSCRIPT OF A FAIRCHILD MODEL A-100 COCKPIT VOICE RECORDER S/N 2619 REMOVED FROM A NORTHWEST AIRLINES INC. MCDONNELL DOUGLAS DC-9, N3313L WHICH WAS INVOLVED IN A TAXIING/TAKEOFF ACCIDENT ON DECEMBER 3, 1990 AT THE DETROIT METROPOLITAN/WAYNE COUNTY INTERNATIONAL AIRPORT, ROMULUS, MICHIGAN

CAM	Cockpit area microphone voice or sound source
RDO	Radio transmission from accident aircraft
INT	Cockpit flight/ground intercom voice or sound source
UNK	Unknown voice or source
-1	Voice identified as Captain
-2	Voice identified as First Officer
-3	Voice identified as Female Jump Seat Passenger
-4	Voice identified as Female Flight Attendant
-5	Voice identified as Northwest Gate Agent
-6	Voice identified as Ground Crew Chief
-?	Voice unidentified
GND	Detroit Ground Controller
TWR	Detroit Local Controller (Tower)
RAMP	Northwest Ramp Controller
NW299	Northwest flight two ninety nine
NW234	Northwest flight two thirty four
NW1495	Northwest flight fourteen ninety five
NW783	Northwest flight seven eighty three
NW1146	Northwest flight eleven forty six
NW1402	Northwest flight fourteen zero two
M3165	Mesaba flight thirty one sixty five
SW494	Southwest flight four ninety four
M2	Maintenance Vehicle number two (snow plow)

C70 Detroit Airport Car seven zero

* Unintelligible word

@ Nonpertinent word

Expletive deleted

% Break in continuity

() Questionable text

(()) Editorial insertion

- Pause

NOTE: All times are expressed in Eastern Standard Time.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1315:02
 Start of recording
 Start of transcript

1315:03
 CAM-2 I don't recall them changin' that since I looked.

1315:07
 CAM-1 we we use to use we use to use the speed command
 bars all the time then they said after that
 accident they said no.

1315:12
 CAM-2 the speed command is that little little thingie
 on the right.

1315:16
 CAM-1 yeah but I'm talkin' about the bars.

1315:20
 CAM-2 sorry about that.

1315:47
 CAM-2 okay check the Vee bar mode, altitude hold, * selector
 press reset pitch up pitch command knob fifteen up
 for a thirty, forty, and fifty ten up for a ten. Okay
 it should be ten on this one because this is a ten.

1316:06
 CAM-2 okay then you turn the mode selector to off then your
 check is done; if you want to takeoff with it on you can.

1316:12
 CAM-1 huh because they had us leave this in zero and this off
 for takeoff.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1316:27
CAM-1 but I always use it you know when it was Republic we
always used the speed command bars on takeoff.

1316:32
CAM-2 as far as I know those are only heading and pitch.

1316:36
CAM-1 yeah pitch yes.

1316:38
CAM-2 the speed command capability we don't use any more
that's that little --

1316:41
CAM-1 yeah but I'm talkin' about the speed command bars.
You know that little yellow thing here.

1316:44
CAM-2 now are you gunna?

1316:46
CAM-1 what?

1316:48
CAM-2 will you delay now for this icing check here if
they get all the people loaded?

1316:51
CAM-1 yeah yeah cause I want ah I want the tail checked.

1316:56
CAM-2 ow I don't see.

INTRA-COCKPIT	
TIME & SOURCE	CONTENT

AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT

1317:06

CAM-2 too bad I don't have a big tall ladder out here.
I would just walk out and do it myself.

1317:09

CAM-1 yeah well like I said I stood up there in the window
and looked. I didn't see anything but I thought well
we better get that thing checked. You never know. You
see this hasn't been flyin' it's been in a hanger
I guess.

1317:16

CAM-3 excuse me my name is my name is @ I'm a jump seat rider.

1317:18

CAM-1 oh hi @ I'm Bill, Jim.

1317:20

CAM-2 are you gunna ride up here or?

1317:22

CAM-3 no, if that's okay can I take a passenger seat in
the back? We're suppose to actually ask you so.

1317:27

CAM-1 sure I don't care do you care?

1317:28

CAM-3 okay.

1317:30

CAM-2 no, it's up to you but most Captains I say fly
fly first class.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1317:32
CAM-1 what ever you want to do is fine.

1317:35
CAM-3 okay thanks a lot.

1317:42
CAM-4 okay.

1317:43
CAM-2 hi.

1317:44
CAM-4 we done yet?

1317:46
CAM-1 oh no not yet. I don't know if we are going to
get delayed or not, but I wanted them to check
that tail for ice. Oh here he comes here yeah.

1317:51
CAM-2 yeah here he comes.

1317:52
CAM-1 yeah okay.

1317:53
CAM-4 oh we're still got another fifteen minutes, right?

1317:55
CAM-1 yeah we're in good shape. No actually got twenty.
So thirty five we leave right?

1317:58
CAM-4 yeah oh yeah your mines a little -

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

CAM-2 excuse me, I'm gunna slide my seat back.

1317:59

CAM-4 huh no.

1318:00

CAM-2 hay we told that girl she could ride in first
class. Is that okay?

1318:02

CAM-4 yeah sure is.

1318:03

CAM-2 you know I got chewed out by a lead flight
attendant one day for just presuming that.

1318:07

CAM-4 you probably will.

1318:09

CAM-2 I was on a DC-10 late night flight, there
was nobody in the whole airplane but me.

1318:10

CAM-4 yeah.

1318:20

CAM-4 um yeah normally it will be that way.
usually anybody non-rev I usually put
them in first -

1318:25

CAM-1 I haven't got a uniform yet. I got blue
pants on here.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1318:28
CAM-2 do you have do you have a coat?

1318:29
CAM-1 I got my old Republic coat.

1318:30
CAM-2 the top you mean the suit coat?

1318:33
CAM-1 yeah yeah the top coat yeah

1318:36
CAM-2 you know those things are # expensive.

1318:38
CAM-1 well not only that but there a long time
gettin' 'em. Ah six weeks they said. I went
and checked the other day they said it will
be a at least a couple of more weeks after
that, so we're lookin' at eight weeks now
before you get your uniform.

1318:47
CAM-2 we're going to Greater Pittsburgh right?

1318:50
CAM-1 ah.

1318:52
CAM-2 PIT?

1318:53
CAM-1 PIT yeah.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1318:59
CAM-1 you're askin' difficult questions there *.

1319:03
CAM-1 that's like yesterday I went to Columbus or
the day before yesterday, and ah # was that
Columbus Ohio or Columbus Georgia?

1319:17
CAM-2 which way were the winds blowin' at PIT?

1319:20
CAM-1 ah see I gave you the weather. I think
they're out of the south as I recall.

1319:33
CAM-2 it's five miles rain fog * *. Five miles and
fog oh one one zero at fourteen.

1319:47
CAM-1 okay it is windy.

1319:55
CAM-2 oh you probably aren't up to date on
flight attendant jokes either then are you?

1319:57
CAM-1 no.

1319:59
CAM-2 oh man.

1320:00
CAM-1 and I'm I'm so far behind.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1320:02
 CAM-1 did our other gal ever come?

1320:06
 CAM-1 did our other gal ever come?

1320:08
 CAM-2 no.

1320:09
 CAM-4 I think I replaced her.

1320:11
 CAM-1 oh is that right?

1320:12
 CAM-4 yeah.

1320:12
 CAM-4 they went, oh well you're off the trip. No
 just kidding.

((one minute and thirty seconds of non-pertinent cockpit conversation
 between the flight attendant and the cockpit crew removed))

1321:46
 CAM-2 now you're suppose to get a final weather.
 was that it?

1321:49
 CAM-1 no that's the one I brought up from the -

CAM-2 okay.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1321:50
 CAM-1 they're suppose to send me out a new one.

1321:52
 CAM-2 I already got a final MGL right here.

1321:53
 CAM-1 okay.

1321:55
 CAM-2 and the load thing, we get over that.

1321:56
 CAM-1 okay.

1321:57
 CAM-2 it's sittin' there ready to go.

1321:58
 CAM-1 alright.

1322:00
 CAM-2 and in fact, they the MGL we're suppose to use
 this as opposed to the weight book because they
 say that this computer is far more current than
 that book could ever be.

1322:10
 CAM-1 okay.

1322:11
 CAM-2 which you know I tend to believe.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1322:12

CAM-1 yeah right.

((one minute and eight seconds of non-pertinent conversation between the flight crew removed))

1323:22

CAM-2 well I wonder if he is going to tell us on
interphone or somethin'. you got him toggled off.

1323:28

CAM-1 yeah he said ah I asked him to. I don't know
if he going to come up here.

1323:32

CAM-2 we push at thirty five?

1323:33

CAM-1 yeah.

1323:34

CAM-2 I'll go out and look.

1323:35

CAM-1 oh okay thank you.

1324:21

CAM-1 hay ah -- I got a question *. - I got a question.

1324:29

CAM-1 if the loads are light can we go with two girls
or do we have to have three?

1324:31

CAM-4 yeah.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1324:32
CAM-1 no, I'm serious.

1324:33
CAM-4 no we only need two.

1324:34
CAM-1 is that right?

1324:35
CAM-4 for this flight for this plane.

1324:36
CAM-1 okay.

CAM-4 hum.

1324:38
CAM-1 depends on the load.

1324:40
CAM-4 well eh if it's over we can still go with two.

1324:42
CAM-1 oh is that right?

1324:44
CAM-4 then we just get paid more for a short crew.

1324:45
CAM-1 oh I see.

1325:05
CAM-2 I forgot to ask you. Are you high minimums
by any chance?

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1325:07
CAM-1 no. no.

1325:09
CAM-2 tail's clear.

1325:10
CAM-1 okay thank you, talk to the guy?

1325:12
CAM-2 yeah the guy that was up in the -

1325:16
CAM-1 okay, thank you.

1325:17
CAM-2 nothin' up there but water.

1325:18
CAM-1 sounds good.

1325:20
CAM-2 visibility's really goin' down though.

1325:22
CAM-1 is it? yeah.

1325:28
CAM-1 I had a buddy ah come out of. I think it was
Seattle. He had that tail deiced. Boy he # near
lost the airplane.

1325:30
CAM-2 oh cause of ice on it?

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1325:32

CAM-1 yeah it was after takeoff and ah everything
 looked pretty clear but everything that they
 you know they deiced it they didn't get it
 down in the cracks or somethin' and ah got
 that wobble thing going you know.

1325:43

CAM-2 see that's one thing that I miss I've always
 flown with a ejection seat. Used it twice.

1325:47

CAM-1 yeah I bet that was - how was - that scary
 when ya punched out?

1325:52

CAM-2 I got shot down once over in Southeast Asia and ah -

1325:55

CAM-1 oh is that right?

1325:56

CAM-2 I didn't have time to get scared.

1325:57

CAM-1 yeah.

INTRA-COCKPIT	
TIME & SOURCE	CONTENT

AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT

1325:58

CAM-2 and then ah, when I was flyin' T-38s one time, I had a fire, an engine fire. That was a that was a simple procedure in that airplane because ah if they if the fire was confirmed, bold face was: throttle throttle(s) closed, engine fire shutoff switch pull, if fire is confirmed eject. And you could confirm it you know with rough EGT high, or high EGT, or fire lights, and in my case the tower controller said ah - my call sign that day was DAY-21 "DAY-21 you are on fire, eject." So my decision was made. Bam I -

1326:32

CAM-1 was this right after takeoff or somethin'?

1326:33

CAM-2 right on takeoff yeah.

1326:35

CAM-1 wow.

1326:36

CAM-2 after a touch and go.

1326:37

CAM-1 wow.

1326:38

CAM-2 it turned out what had happened was that we sucked a bird up in there and that blew the engine up and then ah somehow a fuel line got cut.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1326:47

CAM-1 you know that this tee tail is pretty critical
with ice.

1326:59

CAM-2 I've flown three line checks with three different
captains. you know they were gettin' their line checks.
I've been exposed I've had a had a urine test since
I've been on the line.

1327:09

CAM-1 yeah I talked to a guy the other day. he's had two
drug tests I guess in about two weeks.

1327:13

CAM-2 yeah, both of mine well, the one I got from ah

1327:16

CAM-1 what do they do? just take you off the airplane and -

1327:18

CAM-2 no when you come off the airplane they'll say are
you Captain Joe Blow -

1327:20

CAM-1 yeah.

1327:21

CAM-2 and you say yeah and he said ah we need ah a
drug test. and over at Minni they take you down
under the green concourse.

1327:26

CAM-1 uh huh.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1327:27
 CAM-2 and you wait around until you can make your deposit.

1327:30
 CAM-1 huh.

1327:31
 CAM-2 and in my case it was I was -

1327:32
 CAM-1 did they take the whole crew off?

1327:33
 CAM-2 no just the pilot and co-pilot.

1327:34
 CAM-1 is that right?

1327:35
 CAM-2 yeah my case it was a ah ah they were lookin'
 for another guy and they didn't know what to
 do cause I had just been called out for a sick
 guy. and then they finally decided well any port
 in the storm and they said come on you'll do.

1327:49
 CAM-1 yeah. yeah.

1327:51
 CAM-1 now was that for drugs or booze or is it both?

1327:52
 CAM-2 no it's drugs.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1327:53

CAM-1 drugs.

1327:54

CAM-4 they were suppose to have female --

1327:59

CAM-1 well I think that doctor that ah I went
 through over here at Minneapolis I think he
 thought maybe I was a boozier because he must
 have asked me three times when I quit drinkin'.
 and I said I don't drink. and yet he'd be writing
 something we'd be talking about something and
 he'd say when did you quit.

1328:10

CAM-2 was this a shrink?

1328:11

CAM-1 no this was that doctor @.

1328:13

CAM-2 @?

1328:15

CAM-1 @ yeah he's the company doctor.

1328:16

CAM-2 he's the guy that gave me my interview physical.

1328:17

CAM-1 yeah nice ol' guy.

1328:18

CAM-2 yeah but boy he was tough.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1328:20
CAM-2 yeah we had a extensive shrink thingie.

1328:22
CAM-1 oh is that right?

1328:23
CAM-2 yeah yeah asked ah they asked us a lot about
drinking but so does every other airline.

1328:27
CAM-1 yeah.

1328:28
CAM-2 I interviewed with Delta, American, Alaska,
and Northwest. and I got hired by all of them
but Alaska which is the one I really wanted
to work for.

1328:35
CAM-1 is that right?

1328:37
CAM-2 Northwest was my number two choice
obviously or I wouldn't be here.

1328:41
CAM-1 I think that American looks pretty good.

1328:44
CAM-2 yeah it's just that their pay was so low and
ah I think I was kind of concerned you know
they hired like two thousand guys you know
in the immediate two years in front of me and -

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1328:54
CAM-1 how long were you in the service?

1328:56
CAM-2 twenty years.

1328:57
CAM-1 twenty years?

1328:58
CAM-2 yeah I retired as a Lt. Colonel.

1328:59
CAM-1 ah super.

1329:00
CAM-2 twenty years.

1329:03
CAM-2 actually twenty years and twenty days.

1329:05
CAM-1 I tell you my brother in law he ah he was a
Colonel and ah he's doin' real well now. he ah
works for ah well, I don't remember who it is,
but he does consulting and he's there in DC
and ah makin' a lot of money.

1329:24
CAM-1 do you know @@? does that ring a bell? yeah he
was a B-52 pilot. I use to fly with him. I don't
even know where he's at now. so how long you
been hired?

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1329:31

CAM-2 I started in May.

1329:33

CAM-1 yeah this this year.

1329:35

CAM-2 yeah I got the new ba-. you probably got one of these too.

1329:36

CAM-1 yeah I got one.

1329:37

CAM-2 yeah everybody looks at those they say ah new hire.

1329:39

CAM-1 yeah.

((one minute and thirty six seconds of non-pertinent cockpit conversation
between the flight crew removed))

1331:16

CAM-2 It says we weigh for takeoff seventy seven two,
so the closest one of these that's this one.

1331:23

CAM-1 okay.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1331:25
 CAM-2 one twenty four, one thirty three, one forty
 six, and one seventy nine.

1331:36
 CAM-2 and normally you would be lookin' at say partial
 thrust but we have what they call contaminated
 runways today so we can't do that.

1331:40
 CAM-1 right.

1331:42
 CAM-2 so it'd be ah full power.

1331:45
 CAM-1 yeah.

1331:47
 CAM-1 thanks. I like I like I like your finger
 nails. that's neat.

1331:51
 CAM-5 thank you. thank you.

1331:53
 CAM-2 what do you have little Northwests on 'em?

1331:55
 CAM-5 em no I was lookin' for some though.

1331:58
 CAM-2 MGL is final-

1332:01
 CAM-5 bye.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1332:04
 CAM-2 for flight ninety one eighty lets see ninety
 one eighty one ship number flight fourteen
 eighty two three December forty one degrees
 is the last **.

1332:12
 CAM-2 are you ready to push?

1332:13
 CAM-1 yeah guess so.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1332:16
 RDO-2 hello ramp ah Northwest fourteen
 eighty two at charlie eighteen to
 push.

1332:20
 RAMP - eighty two charlie eighteen go to
 ground for the push, we show you
 out.

1332:24
 RDO-2 okay.

1332:28
 RDO-2 Metro ground, Northwest fourteen
 eighty two, charlie eighteen push.

1332:48
 INT-6 good afternoon flight deck this is
 line maintenance. ready for push
 back?

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1332:59
 CAM-2 push is approved.

1333:00
 CAM-1 read final items on start check.

1333:02
 CAM-2 flight attendant advisory?

1333:03
 CAM-1 is off.

1333:04
 CAM-2 ignition?

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1332:52
 RDO-2 ground fourteen eighty two at
 charlie eighteen push.

1332:53
 INT-1 okay stand by please we'll give them
 a call.

1332:53
 GND Northwest fourteen eighty two
 charlie eighteen push approved

1332:58
 RDO-2 fourteen eighty two roger.

1333:02
 M3165 Metro ground Mesaba thirty one sixty
 five at G concourse

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1333:06
 CAM-1 is on.

 CAM-2 seatbelt sign?

 CAM-1 is on.

 1333:07
 CAM-2 door lights?

 CAM-1 are out.

1333:08
 CAM-2 beacon?

1333:09
 CAM-1 is on.

1333:11
 CAM-2 aux pumps on. checklist complete.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1333:07
 GND Mesaba thirty one sixty five Metro
 ground taxi to runway three center
 turn left on the inner and you're
 gunna follow traffic that's pushed
 back out of fox eleven gate a
 Northwest seven twenty seven

1333:12
 INT-1 alright brakes are off, the pressure
 is up, door lights are out.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1333:25
 CAM-1 okay Jim startin' the right side.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1333:18
 INT-6 and we're cleared to push?

1333:18
 M3165 but we're not ready to taxi out
 we're just gettin' ready to start we
 were just wonderin' if there's gunna
 be any delays well obviously there
 are with the fog

1333:20
 INT-1 cleared to push, yes sir.

1333:23
 INT-6 c. r to start.

1333:24
 INT-1 okay here we go.

1333:25
 GND ,
 yeah there are gunna be some delays
 but right now if you get out early
 you aren't gunna have any wait at
 the runway

1333:31
 M3165 all right

1333:33
 SW494 Southwest four ninety four holdin'
 short of wolf and charlie twelve

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1333:42
 CAM-2 let's see, charlie eighteen's going to push
 us right on to the ramp.

1333:47
 CAM-2 look at the vis out there now.

1333:49
 CAM-1 hum.

1333:58
 ((sound of power interruption to the CVR))

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1333:36
 GND Southwest four ninety four turn
 right on the outer taxiway oscar
 seven to the gate report pullin'
 into the gate

1333:40
 SW494 roger

1333:44
 M2 ground maintenance two

1333:48
 GND maintenance two ground

1333:49
 M2 ah maintenance two I'm plowing snow
 on ah runway nine two seven between
 Yankee and center if you could keep
 aircraft off it

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1333:59
 GND okay you might want to monitor
 ground on one one niner point four
 five I'm not workin' that particular
 piece of ground today -- and
 nineteen forty five -

1334:01
 INT-6 there is a snow plow off your right
 rear approximately about four
 o'clock.

1334:07
 RDO-2 roger.

1334:08
 INT-2 roger.

1334:11
 M2 ah thank you

1334:13
 NW299 Northwest two ninety nine taxi

1334:20
 GND Northwest two ninety nine taxi to
 runway three center make a right
 turn out of parking hold short of
 oscar seven for now

1334:27
 NW299 right turn hold short of oscar seven
 goin' to three center Northwest two
 ninety nine

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1334:38
 ((sound of power interruption to the CVR))

1334:57
 CAM-2 okay.

1335:57
 CAM ((start of unintelligible cabin briefing))

1335:07
 CAM-2 that's the fire station right there when
 you divide over to east west ground.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1334:49
 INT-6 brakes set please.

1334:52
 INT-1 okay brakes are set, you're cleared
 to disconnect.

1335:11
 INT-6 pin pulled, tow bar clear, you have
 nose wheel steering, your wheel well
 lights are out, stand by for the
 wave off, good day.

1335:16
 INT-1 good day now.

1335:27
 RDO-2 ground, Northwest fourteen eighty
 two taxi.

INTRA-COCKPIT

<u>TIME & SOURCE</u>	<u>CONTENT</u>
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1335:49 CAM-2	did you get all that?
1335:51 CAM-1	yeah but I'm gunna -
1335:52 CAM-2	just kind a wind around here and oscar six is gunna be just just right around the corner here.
1335:58 CAM-1	okay.
1335:59 CAM-2	engine anti-ice?
1336:00 CAM-1	it's on.
1336:01 CAM-2	ah annunciator?
1336:03 CAM-1	is checked.

AIR-GROUND COMMUNICATION

<u>TIME & SOURCE</u>	<u>CONTENT</u>
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1335:31 GND	fourteen eighty two right turn out of parking taxi runway three center exit ramp at oscar six contact ground now one one niner point four five
1335:40 RDO-2	three center exit the ramp at oscar six one one nine four five, ah Northwest fourteen eighty two.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1336:04
CAM-2 hydraulic's checked on. wave off?

1336:05
CAM-1 is received.

1336:08
CAM-1 okay Jim you just watch and make sure I go
the right way.

1336:18
CAM-2 we are doing flaps twenty takeoff(?.?)

1336:21
CAM-1 okay.

1336:25
CAM-2 just kind a stay on the ramp here.

1336:28
CAM-1 okay.

1336:32
CAM-1 until the yellow line I guess huh?

1336:33
CAM-1 that fog is pretty bad here.

1336:38
CAM-2 I'll be broken hearted if we don't get back.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1336:39
NW299 ground Northwest two ninety nine is
abeam oscar nine

INTRA-COCKPITTIME &
SOURCE CONTENT

1337:02
CAM-2 hay it looks like it's goin' zero zero
 out there.

AIR-GROUND COMMUNICATIONTIME &
SOURCE CONTENT

1336:49
GND Northwest two ninety nine Metro
 ground roger taxi via inner oscar
 six and fox and ah report crossing
 runway niner two seven

1336:58
NW299 inner oscar six fox and we'll report
 crossing nine two seven Northwest
 two ninety nine

1337:05
GND fourteen eighty two ground are you
 on

1337:07
RDO-2 yes go ahead.

1337:08
GND what's your position

1337:09
RDO-2 right by the fire station.

1337:11
GND roger Northwest fourteen eighty two
 taxi inner oscar six fox report
 making the ah right turn on x-ray

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1337:17
RDO-2 inner oscar six to foxtrot, report
x-ray.

1337:25
CAM-2 # oscar six. oh that probably this across
that runway -

1337:32
CAM-? (before/report) X (.)

1337:37
CAM-2 guess we turn left here.

1337:39
CAM-1 left turn or right turn?

1337:41
CAM-2 yeah well this is the inner here. we're still
goin' for oscar.

1337:46
CAM-1 so a left turn.

1337:48
CAM-2 near as I can tell. man I can't see # out here.

1337:50
CAM-1 yeah.

1337:52
CAM-1 man this is -

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1337:53
 CAM-2 that's still the inner though that way.

1337:56
 CAM-1 okay.

1337:57
 CAM-2 go that way.

1337:58
 CAM-1 okay.

1338:09
 CAM-2 okay there's oscar six right here.

1338:12
 CAM-1 okay so what do we do here?

1338:13
 CAM-2 go we take oscar six to foxtrot.

1338:16
 CAM-1 right turn right here?

1338:18
 CAM-2 yeah right out there.

1338:29
 CAM-1 I'm gunna turn these lights on.

1338:33
 CAM-? * there's the yellow line * follow *

1338:47
 CAM-1 you go right around the corner?

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1338:49
CAM-2 yeah this is oscar six.

1338:50
CAM-1 yeah what runway we goin' to?

1338:52
CAM-2 three center.

1338:56
CAM-1 we gotta be below minimums *.

1338:59
CAM-2 oh yeah I think they'll tell us.

1339:02
CAM-2 six hundred feet now we can see six
hundred feet. think so?

1339:16
CAM-1 naw I don't think we got six hundred feet *.

1339:22
CAM-1 well anyway flaps twenty and takeoff check
when you get time.

1339:25
CAM-2 electric power's checked. anti-skid?

1339:27
CAM-4 (ready)*

1339:29
CAM-1 okay it's armed.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1339:30
 CAM-2 APU is off, air-conditioning supply switches
 are auto, ignition is off. fuel heat?

1339:34
 CAM-1 it's ah I'm gunna give it a shot lets see here.

1339:40
 CAM-1 I'm gunna give it a shot any way.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1339:37
 GND fourteen eighty two what's your
 position now

1339:40
 RDO-2 ah we're approaching the parallel
 runway on oscar six.

1339:48
 GND you approaching oscar six and runway
 niner two seven

1339:52
 RDO-2 ah we're headed eastbound on oscar
 six here.

1340:01
 GND Northwest fourteen eight two report
 crossing runway niner two seven on
 fox

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1340:14
 CAM-2 we are, just keep goin' straight.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1340:06
 RDO-2 okay I think we might have missed
 oscar six. see a sign here that
 says ah the arrows to oscar five.
 think we're on foxtrot now.

1340:16
 GND Northwest fourteen eighty two ah you
 just approach oscar five and you
 are you on the outer

1340:23
 RDO-2 yeah that's right.

1340:25
 GND Northwest fourteen eighty two
 continue to oscar four then turn
 right on x-ray

1340:31
 RDO-2 okay oscar four then right on x-ray
 roger.

1340:34
 NW299 Northwest two ninety nine just
 cleared nine two seven on fox

1340:39
 GND two ninety nine roger

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1340:41
GND Northwest fourteen eighty two report
ah report approaching x-ray and fox

1340:46
RDO-2 wilco.

1340:49
M3165 Mesaba thirty one sixty five is on
the • by the fire hall on the inner
I should say

1340:52
GND Mesaba three one sixty five Metro
ground taxi the inner oscar fox and
x-ray report crossing runway niner
two seven

1340:59
M3165 oscar six fox to the center we'll
report crossing niner two seven
Mesaba thirty one sixty five

1341:05
GND Northwest fourteen eighty two at
oscar four make the right turn on x-
ray and then report crossing nine
two seven

1341:11
RDO-2 roger at ah oscar four make the
right turn onto x-ray.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1341:17
 CAM-1 this is nine two seven huh?

1341:19
 CAM-2 that says x-ray right there.

1341:24
 CAM-1 so what's he want us to do here?

1341:25
 CAM-2 you can make the right turn he said and report
 crossing two seven and then I'll ask him.

1341:31
 CAM-2 there's oscar four. this is x-ray.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1341:16
 NW234 and ero ground Northwest two
 th our just wanted to verify our
 our outing

1341:20
 GND Northwest two thirty ground taxi via
 the inner oscar six fox and x-ray
 say your position now

1341:28
 NW234 inner oscar six fox and x-ray
 Northwest two thirty four comin' up
 on two seven

1341:34
 GND Northwest two thirty four roger

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1341:46
 CAM-1 okay.

1342:00
 CAM-1 this this a right turn here Jim?

1342:01
 CAM-2 that's the runway.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1341:37
 RDO-2 and ground ah fourteen eighty two
 did you say we were cleared to cross
 two seven and nine.

1341:40
 GND Northwest fourteen eighty two
 affirmative cross nine two seven

1341:43
 RDO-2 roger.

1341:45
 GND Mesaba thirty one sixty five at ah
 oscar six ah disregard -

1341:51
 GND - Northwest fourteen eighty two when
 you get to ah fox and x-ray follow a
 Mesaba Fokker that'll be approaching
 from your right side

1341:58
 RDO-2 okay, fourteen eighty two.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1342:02
 CAM-1 okay, we're goin' right over here then (.)

1342:03
 CAM-2 yeah that way.

1342:24
 CAM-2 well wait a minute. oh # this uh ah

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1342:02
 GND Northwest two ninety nine what's
 your position now

1342:05
 NW299 okay we just turned down onto x-ray
 two ninety nine

1342:09
 GND two ninety nine roger tower one one
 eight point four

1342:12
 NW299 roger

1342:14
 C70 Metro ground car seven zero

1342:16
 GND car seven zero ground

1342:18
 C70 I'm at outer four and the ah ramp
 request clearance to the ah
 departure end of three right to
 inspect three right

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1342:32
CAM-2 I think we're on ah x-ray here now.

1342:35
CAM-1 give him a call and tell him that ah.

1342:37
CAM-2 yeah this is nine. we're we're facing one six
zero yeah. cleared to cross it.

1342:42
CAM-1 we're cleared to cross?

1342:44
CAM-2 yeah we're cleared to cross.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1342:27
GND car seven zero hold short of runway
three center on taxi way victor

1342:32
C70 roger hold short of center seven
zero

1342:39
GND seven zero cross three center at
victor report clear

1342:43
C70 seven zero cross seven zero

1342:46
NW1495 Northwest fourteen ninety five's
with ya comin' up on the fire house

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1342:50
 CAM-1 when I cross this which way do I go? right?

1342:51
 CAM-2 yeah.

1342:56
 CAM-1 this this is the active runway here isn't it?

1342:59
 CAM-2 this is should be nine and two seven.

1343:04
 CAM-2 it is.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1342:50
 GND Northwest fourteen ninety five
 ground taxi via the inner oscar six
 fox and x-ray report crossing runway
 niner two seven

1342:59
 NW1495 fourteen ninety five we'll do it

1343:01
 M3165 Mesaba thirty one sixty five's
 across nine two seven

1343:05
 GND Mesaba thirty one sixty five roger
 they'll be a DC-9 approaching from
 your left on ah x-ray he'll follow
 you

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1343:07
 CAM-2 yeah this is nine two seven.

1343:08
 CAM-1 okay.

1343:14
 CAM-1 follow this. # we're cleared to cross
 this thing. you sure?

1343:18
 CAM-2 that's what he said yeah.

1343:20
 CAM-2 but this taxi light takes us --

1343:22
 CAM-2 is there a taxiway over there?

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1343:11
 M3165 thirty one sixty five

1343:14
 C70 seven zero's cleared of the center

1343:16
 GND roger car seven zero

1343:19
 NW783 and ah ground Northwest seven eighty
 three's with ya comin' up on Yankee
 seven

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1343:24
 CAM ((sound similar to parking brake being set))

1343:24
 CAM-1 naw I don't see one.

1343:35
 CAM-1 give him a call and tell him that
 ah we can't see nothin' out here.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1343:24
 GND Northwest seven eighty three ground
 do you have the DC-9 in front of you
 in sight

1343:27
 NW783 sure do

1343:28
 GND okay follow to three center via
 it will be inner oscar six fox
 and x-ray

1343:33
 NW783 inner oscar six fox x-ray roger

1343:36
 GND ((Unintelligable))- x-ray and fox

1343:45
 GND Northwest fourteen eighty two ground
 say your position

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1344:07
 CAM ((sound similar to parking brake release))

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1343:48
 RDO-2 ah believe we're at the intersection
 of ah x-ray and ah nine two seven.

1343:58
 GND x-ray and nine two seven okay are
 you ah southbound

1344:01
 RDO-2 yeah we're holdin' short of nine two
 seven here right now.

1344:05
 GND cross nine two seven Northwest
 fourteen eighty two -

1344:06
 RDO-2 okay.

1344:08
 GND -`* x-ray to three center

1344:13
 NW1495 Northwest fourteen ninety five is
 just past the nine two seven

1344:16
 GND Northwest fourteen ninety five roger

INTRA-COCKPIT
TIME &
SOURCE CONTENT

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1344:23
 CAM-1 now what runway is this?

1344:30
 CAM-1 this is a runway.

1344:32
 CAM-2 yeah turn left over there.

1344:33
 CAM-2 naw that's a runway too.

1344:35
 CAM-1 well tell him we're out here. we're stuck.

1344:17
 GND Northwest fourteen eighty two did
 you copy

1344:19
 RDO-2 yes.

1344:22
 M3165 Mesaba thirty one sixty five's
 turning off of fox onto x-ray

1344:26
 GND Mesaba thirty one sixty five roger
 tower on one one eight point four

1344:29
 M3165 roger

1344:33
 NW1146 Northwest eleven forty six in front
 of the fire house

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1344:40
 CAM-2 that's zero nine.

((transmission by Captain on some unknown frequency or interphone))

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1344:37
 GND Northwest eleven forty six Metro
 ground taxi via inner oscar six fox
 x-ray report crossing runway niner
 two seven

1344:45
 NW1146 inner oscar six fox x-ray eleven
 forty six

1344:47
 UNK-1 hay ground fourteen eighty two.
 we're out here we're stu we can't
 see any thing out here.

1344:55
 UNK-1 ah ground fourteen eighty two.

1344:58
 GND Northwest fourteen eighty two just
 to verify you are proceeding
 southbound on x-ray now and you are
 across nine two seven

1345:02
 RDO-1 ah we're not sure it's so foggy out
 here we're completely stuck here.

1345:05
 GND okay ah are you on a ru- taxiway or
 a runway -

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1345:14
 CAM-2 we're on runway two one center.

1345:20
 CAM-? * (#)

1345:31
 CAM-2 yes we are.

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1345:07
 RDO-1 we're on a runway we're right by ah
 zero four.

1345:12
 GND yeah Northwest fourteen eighty two
 roger are you clear of runway three
 center

1345:17
 RDO-1 yeah it looks like we're on two one
 center here.

1345:23
 NW1402 Metro ground Northwest fourteen oh
 two to push off of delta fourteen

1345:27
 GND Northwest fourteen eight two y'say
 you are on two one center

1345:29
 RDO-1 I believe we are we're not sure.

INTRA-COCKPIT
TIME &
SOURCE CONTENT

1345:38

CAM-? oh #.

1345:39

CAM-? oh #.

CAM-? oh.

CAM ((sound of impact))

1345:40

((end of recording))

AIR-GROUND COMMUNICATION
TIME &
SOURCE CONTENT

1345:33

GND Northwest fourteen eighty two roger
 if you are on two one center exit
 that runway immediately sir

The flight crew from each of the accident aircraft were invited to review the CVR group's transcript of their respective CVR recording for accuracy. Their suggested corrections and additions to the group's transcript are as follows:

DC-9 TRANSCRIPT

Page 20:

Statement at 1329:35 sixth word changed from "BA" to badge.

Page 31:

Statement at 1337:02 source changed from CAM-2 to CAM-1

Page 32:

Statement at 1337:25 should read: " # oscar six fox is probably this across that runway "

Statement at 1337:32 source changed from CAM-? to CAM-1.

Page 33:

Statement at 1338:33 should read: "CAM-1 I'm going to stay on the yellow line"

Page 40:

Statement at 1342:24 delete "uh ah" and replace with "is really bad"

Page 46:

Statement at 1344:30 the first officer thought it should be changed to CAM-2 but the Captain said it should remain CAM-1.

B-727 TRANSCRIPT

Page 2:

Statement at 1317:03 change source from CAM-1 to CAM-2

Statement at 1317:04 change source from CAM-2 to CAM-1

Page 3:

Statement at 1317:27 change source from CAM-2 to CAM-3

Page 4:

Statement at 1318:01 change source from CAM-2 to CAM-1

Statement at 1318:21 change source from CAM-2 to CAM-1

Statement at 1318:24 change source from CAM-? to CAM-3

Page 5:

Statement at 1319:12 delete * from beginning of statement.

Statement at 1319:27 change source from CAM-1 to CAM-2 and change the word "you" to "I".

Page 7

Statement at 1320:57 changed to read " uh huh"

Statement at 1321:26 change source from CAM-1 to CAM-2

Statement at 1321:27 change source from CAM-3 to CAM-1

Page 8:

Statement at 1321:38 change source from CAM-3 to CAM-1 and delete the name "Bill" and replace it with a "*"
 Statement at 1321:47 change source from CAM-3 to CAM-1

Page 9:

Statement at 1322:25 delete the first "yeah"
 Statement at 1322:48 change the word "make" to "may"

Page 11:

Statement at 1323:40 change the word "should" to "could" in the eight line

Page 13:

Statement at 1325:19 remove the name "Bob" and replace it with a "*"
 Statement at 1326:26 change the source from CAM-2 to CAM-1
 Statement at 1326:34 change the source from CAM-2 to CAM-1

Page 14:

Statement at 1327:25 change the source from CAM-3 to CAM-1
 Statement at 1327:33 change the source from CAM-3 to CAM-1
 Statement at 1327:34 change the source from CAM-1 to CAM-2
 Statement at 1327:35 change the source from CAM-2 to CAM-1
 Statement at 1328:18 change the source from CAM-2 to CAM-3
 Statement at 1328:24 change the source from CAM-2 to CAM-3
 Statement at 1328:27 change the source from CAM-2 to CAM-3

Page 15:

Statement at 1328:36 change source from CAM-2 to CAM-3

Page 16:

Statement at 1329:38 change source from CAM-2 to CAM-3
 Statement at 1329:55 change the source from CAM-2 to CAM-1

Page 19:

Statement at 1331:58 change the source from CAM-2 to CAM-1
 Statement at 1332:01 change the source from CAM-1 to CAM-2
 Statement at 1332:04 change the source from CAM-2 to CAM

Page 22:

Statement at 1333:16 and the word "two" after "oil pressure"

Page 25:

Statement at 1334:32 change the source from CAM-? to CAM-1
 Statement at 1334:33 change the source from CAM-1 to CAM-2 and change the word "left" to "right"

Page 26:

Statement at 1334:53 changed to read " on down there by C concourse"

Page 28:

Statement at 1336:20 change source from CAM-3 to CAM-1
Statement at 1336:22 delete the word "yeah" and add new statement of "CAM-2 yeah"

Page 30:

Statement at 1337:18 change source from CAM-3 to CAM-2
Change ATIS reception from 2nd officers radio to 1st officers radio

Page 31:

Statement at 1338:05 change source from CAM-3 to CAM-2
Statement at 1338:06 change source from CAM-? to CAM-1
Statement at 1338:10 change source from CAM-3 to CAM-2
Statement at 1338:22 change source from CAM-3 to CAM-2
Statement at 1338:35 change source from CAM-3 to CAM-2

Page 32:

Statement at 1338:50 change source from CAM-3 to CAM-2
Statement at 1338:55 change source from CAM-3 to CAM-2
Statement at 1339:11 change source from CAM-1 to CAM-3
Statement at 1339:13 change source from CAM-2 to CAM-1
Statement at 1339:14 change source from CAM-3 to CAM-2
Statement at 1339:21 change source from CAM-2 to CAM-3
Statement at 1339:26 change source from CAM-2 to CAM-3
Statement at 1339:27 change source from CAM-3 to CAM-2

Page 33:

Statement at 1339:34 change source from CAM-1 to CAM-2

Page 34:

Statement at 1340:22 change source from CAM-1 to CAM-2

Page 35:

Statement at 1340:56 delete the word "for"

Page 39:

Statement at 1342:30 change the source from CAM-2 to CAM-1 and end CAM-1 statement after word "power". Add CAM-2 as source for the remainder of the statement beginning with the word "runway"

Page 40:

At time 1343:07 remove "ah there you go" from the CAM-2 statement and insert "CAM-1 ah there you go" after the original statement.

Page 42:

Identify the snap sound at 1344:19 as parking brake release.

Page 43:

Identify the 5 snap sounds at 1344:24 as anti-skid, 2 landing lights, 2 turn off lights, and 1 strobe.
Statement at 1344:26 add "CAM-1 final items" prior to "CAM-3 anti-skid"

Page 44:

Statement at 1344:59 change source from CAM-2 to CAM-3

Page 45:

Statement at 1345:39 change source from CAM-? to CAM-1

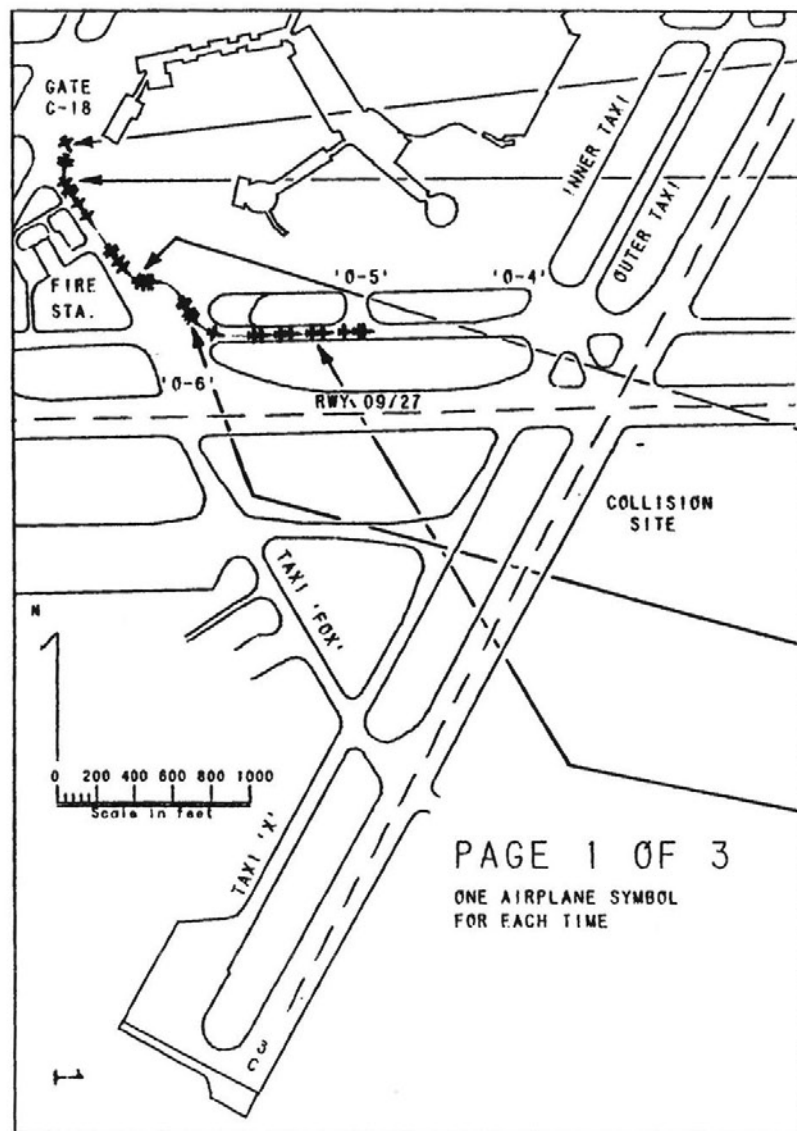
Statement at 1345:43 change source from CAM-1 to CAM-2

Page 48:

Statement at 1346:36 change source from CAM-1 to CAM-2

AIRPLANE PERFORMANCE STUDY

Dialogue from Cockpit Voice Recorder

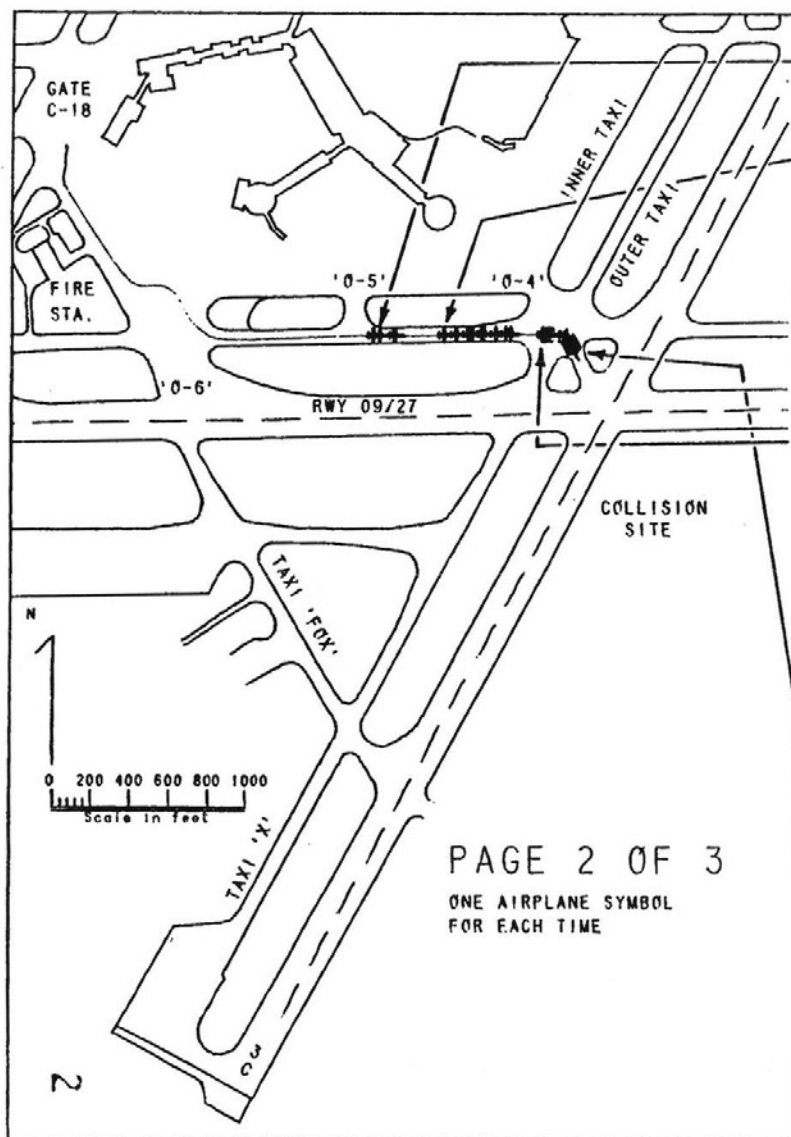


SELECTED DIALOGUE FROM COCKPIT VOICE RECORDING:

1335:31 GND FOURTEEN EIGHTY TWO RIGHT TURN OUT OF PARKING TAXI
RUNWAY THREE CENTER EXIT RAMP AT OSCAR SIX CONTACT
GROUND NOW ONE ONE NINER POINT FOUR FIVE
1336:33 CAM-1 THAT FOG IS PRETTY BAD HERE.
39 NW299 GROUND NORTHWEST TWO NINETY NINE IS ABEAM OSCAR NINE
1337:02 CAM-2 HEY IT LOOKS LIKE IT'S GOIN' ZERO ZERO OUT THERE.
08 GND WHAT'S YOUR POSITION
09 RDO-2 RIGHT BY THE FIRE STATION.
11 GND ROGER NORTHWEST FOURTEEN EIGHTY TWO TAXI INNER OSCAR
SIX FOX REPORT MAKING THE AH RIGHT TURN ON X-RAY
17 RDO-2 INNER OSCAR SIX TO FOXTROT, REPORT XRAY.
25 CAM-2 * OSCAR SIX, OH THAT PROBABLY THIS ACROSS THAT RUNWAY-
46 CAM-1 SO A LEFT TURN.
48 CAM-2 NEAR AS I CAN TELL. MAN I CAN'T SEE * OUT HERE.
53 CAM-2 THAT'S STILL THE INNER THOUGH THAT WAY.
57 CAM-2 GO THAT WAY.
1338:09 CAM-2 OKAY THERE'S OSCAR SIX RIGHT HERE.
12 CAM-1 OKAY SO WHAT DO WE DO HERE?
13 CAM-2 GO WE TAKE OSCAR SIX TO FOXTROT.
16 CAM-1 RIGHT TURN RIGHT HERE?
18 CAM-2 YEAH RIGHT OUT THERE.
47 CAM-1 YOU GO RIGHT AROUND THE CORNER?
49 CAM-2 YEAH THIS IS OSCAR SIX.
56 CAM-1 WE GOTTA BE BELOW MINIMUMS *.
59 CAM-2 OH YEAH I THINK THEY'LL TELL US.
1339:02 CAM-2 SIX HUNDRED FEET NOW WE CAN SEE SIX HUNDRED FEET.
THINK SO?
16 CAM-1 NAW I DON'T THINK WE GOT SIX HUNDRED FEET *.
37 GND FOURTEEN EIGHTY TWO WHAT'S YOUR POSITION NOW
40 RDO-2 AH WE'RE APPROACHING THE PARALLEL RUNWAY ON OSCAR SIX.
48 GND YOU APPROACHING OSCAR SIX AND RUNWAY NINER TWO SEVEN
52 RDO-2 AH WE'RE HEADED EASTBOUND ON OSCAR SIX HERE.
1340:01 GND NORTHWEST FOURTEEN EIGHTY TWO REPORT
CROSSING RUNWAY NINER TWO SEVEN ON FOX
06 RDO-2 OKAY I THINK WE MIGHT HAVE MISSED OSCAR SIX. SEE A
SIGN HERE THAT SAYS AH THE ARROWS TO OSCAR FIVE.
16 GND THINK WE'RE ON FOXTROT NOW.
23 RDO-2 NORTHWEST FOURTEEN EIGHTY TWO AH YOU JUST APPROACH
OSCAR FIVE AND YOU ARE YOU ON THE OUTER
25 GND YEAH THAT'S RIGHT.
NORTHWEST FOURTEEN EIGHTY TWO CONTINUE TO OSCAR FOUR
THEN TURN RIGHT ON X-RAY

CAM1,2 - DIALOGUE BETWEEN 1482'S CAPTAIN (1), FIRST OFFICER (2)
RDO1,2 - FLIGHT 1482'S RADIO TRANSMISSIONS
GND - GROUND CONTROLLERS, NW299 - NORTHWEST FLIGHT 299

Dialogue from Cockpit Voice Recorder

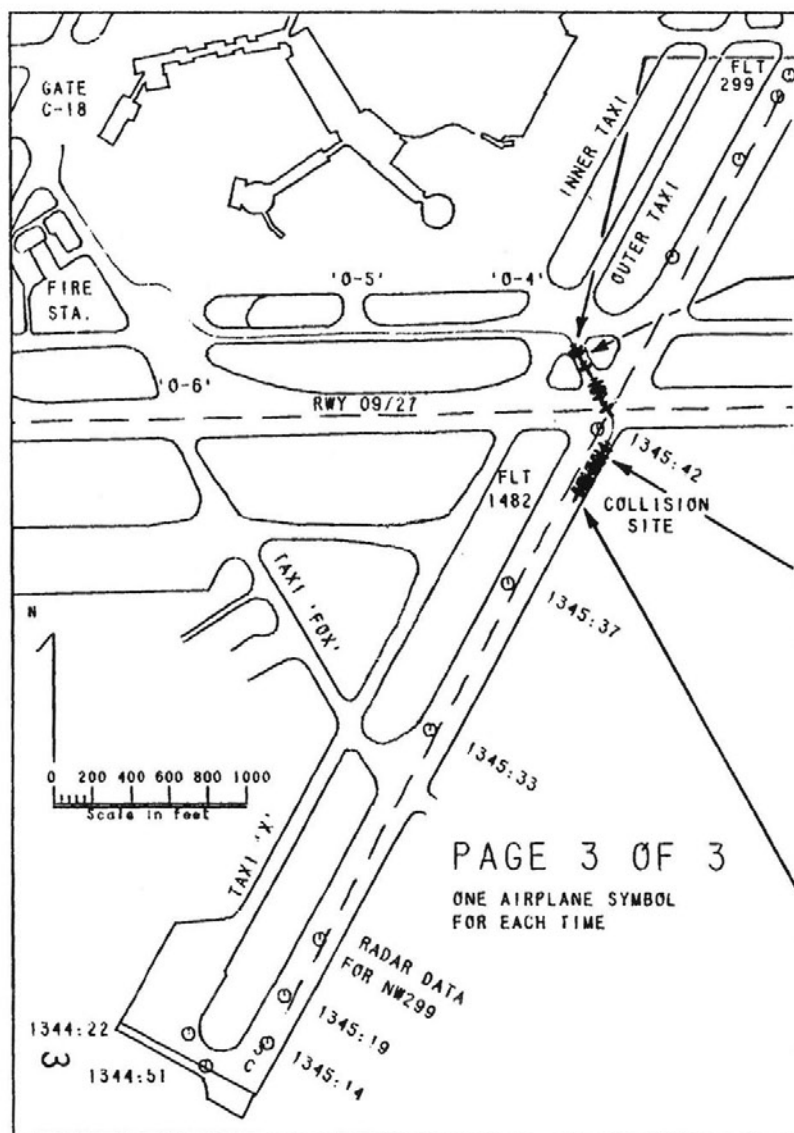


SELECTED DIALOGUE FROM COCKPIT VOICE RECORDING:

1340:31 RDO-2 OKAY OSCAR FOUR THEN RIGHT ON X-RAY ROGER.
 :34 NW299 NORTHWEST TWO NINETY NINE JUST CLEARED NINE TWO SEVEN ON FOX
 :41 GND NORTHWEST FOURTEEN EIGHTY TWO REPORT AH REPORT
 APPROACHING X-RAY AND FOX
 1341:05 GND NORTHWEST FOURTEEN EIGHTY TWO AT OSCAR FOUR MAKE THE
 RIGHT TURN ON X-RAY AND THEN REPORT CROSSING NINE TWO SEVEN
 :11 RDO-2 ROGER AT AH OSCAR FOUR MAKE THE RIGHT TURN ONTO X-RAY.
 :17 CAM-1 THIS IS NINE TWO SEVEN HUH?
 :19 CAM-2 THAT SAYS X-RAY RIGHT THERE.
 :24 CAM-1 SO WHAT'S HE WANT US TO DO HERE?
 :25 CAM-2 YOU CAN MAKE THE RIGHT TURN HE SAID AND REPORT
 CROSSING TWO SEVEN AND THEN I'LL ASK HIM.
 :31 CAM-2 THERE'S OSCAR FOUR. THIS IS X-RAY.
 :37 RDO-2 AND GROUND AH FOURTEEN EIGHTY TWO DID YOU SAY WE
 WERE CLEARED TO CROSS TWO SEVEN AND NINE.
 :40 GND NORTHWEST FOURTEEN EIGHTY TWO AFFIRMATIVE CROSS NINE TWO SEVEN
 1342:00 CAM-1 THIS THIS A RIGHT TURN HERE JIM?
 :01 CAM-2 THAT'S THE RUNWAY.
 :02 CAM-1 OKAY, WE'RE GOIN' RIGHT OVER HERE THEN (..?)
 :03 CAM-2 YEAH THAT WAY.
 :05 NW299 OKAY WE JUST TURNED DOWN ONTO X-RAY TWO NINETY NINE
 :09 GND TWO NINETY NINE ROGER TOWER ONE ONE EIGHT POINT FOUR
 :24 CAM-2 WELL WAIT A MINUTE. OH * THIS UH AH
 :32 CAM-2 I THINK WE'RE ON AH X-RAY HERE NOW.
 :35 CAM-1 GIVE HIM A CALL AND TELL HIM THAT AH.
 :37 CAM-2 YEAH THIS IS NINE. WE'RE WE'RE FACING ONE SIX
 ZERO YEAH. CLEARED TO CROSS IT.
 :42 CAM-1 WE'RE CLEARED TO CROSS?
 :44 CAM-2 YEAH WE'RE CLEARED TO CROSS.
 :50 CAM-1 WHEN I CROSS THIS WHICH WAY DO I GO? RIGHT?
 :51 CAM-2 YEAH.
 :56 CAM-1 THIS THIS IS THE ACTIVE RUNWAY HERE ISN'T IT?
 :59 CAM-2 THIS IS SHOULD BE NINE AND TWO SEVEN.
 1343:04 CAM-2 IT IS.
 :07 CAM-2 YEAH THIS IS NINE TWO SEVEN.
 :14 CAM-1 FOLLOW THIS. * WE'RE CLEARED TO CROSS THIS THING. YOU SURE?
 :18 CAM-2 THAT'S WHAT HE SAID YEAH.
 :20 CAM-2 BUT THIS TAXI LIGHT TAKES US --

CAM1,2 - DIALOGUE BETWEEN 1482'S CAPTAIN (1), FIRST OFFICER (2)
 RDO1,2 - FLIGHT 1482'S RADIO TRANSMISSIONS
 GND - GROUND CONTROLLERS, NW299 - NORTHWEST FLIGHT 299

Dialogue from Cockpit Voice Recorder



SELECTED DIALOGUE FROM COCKPIT VOICE RECORDING:

1343:22 CAM-2 IS THERE A TAXIWAY OVER THERE?
 :24 CAM ((SOUND SIMILAR TO PARKING BRAKE BEING SET))
 :24 CAM-1 NAW I DON'T SEE ONE.
 :35 CAM-1 GIVE HIM A CALL AND TELL HIM THAT
 AH WE CAN'T SEE NOTHIN' OUT HERE.
 :45 GND NORTHWEST FOURTEEN EIGHTY TWO GROUND SAY YOUR POSITION
 :48 RDO-2 AH BELIEVE WE'RE AT THE INTERSECTION OF AH
 X-RAY AND AH NINE TWO SEVEN.
 :58 GND X-RAY AND NINE TWO SEVEN OKAY ARE YOU AH SOUTHBOUND
 1344:01 RDO-2 YEAH WE'RE HOLDIN' SHORT OF NINE TWO SEVEN HERE RIGHT NOW.
 :05 GND CROSS NINE TWO SEVEN NORTHWEST FOURTEEN EIGHTY TWO -
 :07 CAM ((SOUND SIMILAR TO PARKING BRAKE RELEASE))
 :15 (ON OTHER FREQUENCY, NW 299 IS CLEARED TO TAKEOFF ON RUNWAY 3C)
 :23 CAM-1 NOW WHAT RUNWAY IS THIS?
 :30 CAM-1 THIS IS A RUNWAY.
 :32 CAM-2 YEAH TURN LEFT OVER THERE.
 :33 CAM-2 NAW THAT'S A RUNWAY TOO.
 :35 CAM-1 WELL TELL HIM WE'RE OUT HERE. WE'RE STUCK.
 :40 CAM-2 THAT'S ZERO NINE.
 :58 GND NORTHWEST FOURTEEN EIGHTY TWO JUST TO VERIFY YOU
 ARE PROCEEDING SOUTHBOUND ON X-RAY NOW AND YOU ARE
 ACROSS NINE TWO SEVEN
 1345:02 RDO-1 AH WE'RE NOT SURE IT'S SO FOGGY OUT
 HERE WE'RE COMPLETELY STUCK HERE.
 :05 GND OKAY AH ARE YOU ON A RU- TAXIWAY OR A RUNWAY -
 :07 RDO-1 WE'RE ON A RUNWAY WE'RE RIGHT BY AH ZERO FOUR.
 :12 GND YEAH NORTHWEST FOURTEEN EIGHTY TWO ROGER ARE
 YOU CLEAR OF RUNWAY THREE CENTER
 :14 CAM-2 WE'RE ON RUNWAY TWO ONE CENTER.
 :17 RDO-1 YEAH IT LOOKS LIKE WE'RE ON TWO ONE CENTER HERE
 :23 NW1402 METRO GROUND NORTHWEST FOURTEEN OH
 TWO TO PUSH OFF OF DELTA FOURTEEN
 :27 GND NORTHWEST FOURTEEN EIGHT TWO Y'SAY
 YOU ARE ON TWO ONE CENTER
 :29 RDO-1 I BELIEVE WE ARE WE'RE NOT SURE.
 :31 CAM-2 YES WE ARE.
 :33 GND NORTHWEST FOURTEEN EIGHTY TWO ROGER IF YOU ARE ON
 TWO ONE CENTER EXIT THAT RUNWAY IMMEDIATELY SIR
 :38 CAM-2 OH #.
 CAM ((SOUND OF IMPACT))
 :40 ((END OF RECORDING, NW299 AND NW1482 COLLIDE))

CAM1,2 - DIALOGUE BETWEEN 1482'S CAPTAIN (1), FIRST OFFICER (2)
 RDO1,2 - FLIGHT 1482'S RADIO TRANSMISSIONS
 GND - GROUND CONTROLLERS, NW299 - NORTHWEST FLIGHT 299

APPENDIX F

RUNWAY INCURSION RECOMMENDATION SUMMARY

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 six safety recommendations to the Federal Aviation Administration (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 -43) 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 safely 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 three 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 two 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--Unacceptable 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 an 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 an 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 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-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.

On June 12, 1991, as a result of the investigation of a January 18, 1990, collision of an Eastern Airlines Boeing 727-225A and an Epps Air Service Beechcraft King Air A100, while the Eastern 727 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 the Eastern 727, the Safety Board issued five safety recommendations related to ground control of airplanes. These safety recommendations are listed below with the current status assignments:

A-91-27 Open--Await Response

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.

A-91-28 Open--Await Response

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.

A-91-29 Open--Await Response

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 III).

A-91-30 Open--Await Response

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.

A-91-31 Open--Await Response

Incorporate into the training syllabus at the Federal Aviation Administration's Academy at Oklahoma City, Oklahoma, materials which stress 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.

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