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6. Abstract At 1619 e.s.t. April 4, 1977, a Southern Airways, Inc., DC-9, light 242, crashed in New Hope, Georgia. After losing both engines in flight, it ttempted an emergency landing on a highway. Of the 85 persons aboard Flight 242, were killed, 22 were seriously injured, and 1 was slightly injured. Eight persons the ground were killed and one person was seriously injured; one person died out 1 month later.

Flight 242 entered a severe thunderstorm between 17,000 feet and 14,000 feet r Rome, Georgia, en route from Huntsville to Atlanta. Both engines were damaged all thrust was lost. The engines could not be restarted and the flightcrew was ced to make an emergency landing.

The National Transportation Safety Board determines that the probable cause of s accident was the total and unique loss of thrust from both engines while the craft was penetrating an area of severe thunderstorms. The loss of thrust was ed by the ingestion of massive amounts of water and hail which in combination thrust lever movement induced severe stalling in and major damage to the engine essors.

Major contributing factors included the failure of the company's dispatching to provide the flightcrew with up-to-date severe weather information pertain- the aircraft's intended route of flight, the captain's reliance on airborne r radar for penetration of thunderstorm areas, and limitations in the Federal on Administration's air traffic control system which precluded the timely dis- tion of real-time hazardous weather information to the flightcrew.


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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: January 26, 1978

SOUTHERN AIRWAYS, INC.
DC-9-31, N1335U
NEW HOPE, GEORGIA
APRIL 4, 1977.

## SYNOPSIS

About 1619 e.s.t. on April 4, 1977, a Southern Airways, Inc., DC-9, operating as Southern Flight 242, crashed in New Hope, Georgia. After losing both engines in flight, Flight 242 attempted an emergency landing on State Spur Highway 92, which bisected New Hope. Of the 85 persons aboard Flight 242, 62 were killed, 22 were seriously injured, and 1 was slightly injured. One passenger died on June 5, 1977. Additionally, eight persons on the ground were killed and one person was seriously injured; the injured person died about 1 month after the accident. The aircraft was destroyed.

Flight 242 entered a severe thunderstorm during flight between 17,000 feet and 14,000 feet near Rome, Georgia, while en route from Huntsville, Alabama, to Atlanta, Georgia. Both engines were damaged and all thrust was lost. The engines could not be restarted, and the flightcrew was forced to make an emergency landing.

The National Transportation Safety Board determines that the probable cause of this accident was the total and unique loss of thrust from both engines while the aircraft was penetrating an area of severe thunderstorms. The loss of thrust was caused by the ingestion of massive amounts of water and hail which in combination with thrust lever movement induced severe stalling in and major damage to the engine compressors.

Major contributing factors included the failure of the company's dispatching system to provide the flightcrew with up-to-date severe weather information pertaining to the aircraft's intended route of flight, the captain's reliance on airborne weather radar for penetration of thunderstorm areas, and limitations in the Federal Aviation Administration's air traffic control system which precluded the timely dissemination of real-time hazardous weather information to the flightcrew.

## 1. FACTUAL INFORMATION

### 1.1 History of Flight

On April 4, 1977, Southern Airways, Inc., Flight 242, a DC-9-31, (N1335U) operated as a scheduled passenger flight from Muscle Shoals, Alabama, to Atlanta, Georgia, with an intermediate stop at Huntsville, Alabama. Flight 242 departed Muscle Shoals at 1521 1/ and landed at Huntsville about 1544.

About 1554, Flight 242 departed Huntsville on an instrument flight rules (IFR) flight plan for the Hartsfield-Atlanta International Airport; there were 81 passengers and 4 crewmembers aboard. The flight's route was direct to the Rome VOR 2/ and then a Rome runway 26 profile descent to Atlanta. Its estimated time en route was 25 min and its requested en route altitude was 17,000 ft 3/.

At 1554:35, Flight 242 established communications with Huntsville departure control and at 1554:39, the controller cleared the flight to climb to 17,000 ft. At 1555:14, the controller cleared the flight to proceed directly to the Rome VOR. According to the cockpit voice recorder (CVR), at 1555:58 the captain remarked, "Well the radar is full of it, take your pick." At 1556:00, the controller told Flight 242 that his radarscope was showing heavy precipitation and that the echos were about 5 nmi ahead of the flight. Flight 242 responded, "Okay... we're in the rain right now...it doesn't look much heavier than what we're in, does it?" At 1556:12, the controller said, "...I got weather cutting devices on which is cutting out the precip that you're in now... however, it's not a solid mass, it...appears to be a little bit heavier than what you're in right now." Flight 242 replied, "Okay, thank you."

At, 1556:37, the first officer, who was flying the airplane, said, "I can't read that, it just looks like rain, Bill. What do YOU think? There's a hole." The captain responded, "there's a hole right here. That's all I see." He added, "Then coming over, we had pretty good radar. I believe right straight ahead...there the next few miles is about the best way we can go."

At 1557:36, the controller said, "...you're in what appears to be about the heaviest part of it now, what are your flight conditions." Flight 242 replied, "...we're getting a little light turbulence and...I'd say moderate rain.." At 1557:47, the controller acknowledged Flight 242's report and told the flight to contact Memphis Center.

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1/ All times herein are eastern standard, based on the 24-hour clock.

2/ A very high frequency omnidirectional range navigational aid located about 72 nmi east-southeast of Huntsville and 46 nmi northwest of the Atlanta airport.

3/ All altitudes herein are mean sea level unless otherwise specified.

At 1558:10, Flight 242 established communications with Memphis Air Route Traffic Control Center (Memphis Center). At 1558:32, the captain said, "As long as it doesn't get any heavier we'll be all right." The first officer replied, "Yeah, this is good."

At 1558:26, the Memphis Center controller advised the flight that a SIGMET 4/ was current for the vicinity of Tennessee, southeastern Louisiana, Mississippi, northern and western Alabama, and adjacent coastal waters, and advised them to monitor VOR broadcasts within a 150-nmi radius of the SIGMET area. At 1558:45, the controller told Flight 242 to contact Atlanta Air Route Traffic Control Center (Atlanta Center). At 1559:00, the captain said, "Here we go...hold 'em cowboy."

At 1559:06, Flight 242 established communications with Atlanta Center (Sector 39) and stated that it was "out of eleven for seventeen." The controller replied, "...roger, expect Rome runway 26 profile descent." Flight 242 acknowledged the controller's transmission. Between 1559:18 and 1602:03, the Atlanta Center controller conversed with TWA Flight 584 about its deviations eastward around thunderstorms between Chattanooga, Tennessee, and Rome, Georgia. At 1600:30, the sound of rain was recorded on Flight 242's CVR. At 1602:57, the captain of Flight 242 said, "I think we'd better slow it up right here in this...." The first officer replied, "Got ya covered."

At 1603:01, an Atlanta Center controller (sector 40) contacted an Eastern Airlines flight, which had just crossed the storm area northwest of Rome, and asked, "How would you classify your ride through that line up there? You recommend anyone else come through it?" The flight answered that "it was not too comfortable but we didn't get into anything we would consider the least bit hazardous." At 1603, Flight 242 was told to contact Atlanta Center (sector 40). About 11 sec later, the sound of light rain was recorded on the CVR. At 1603:20, Flight 242 established communications with Atlanta Center on the new frequency and said, "...level at seventeen." At 1603:48, the captain said, "Looks heavy, nothing's going through that." Six secs later, he said, "See that." The first officer said, "That's a hole, isn't it?" The captain replied, "It's not showing a hole, see it?" At 1604:05, the sound of rain was recorded on the CVR, and 3 sec later the first officer asked, "Do you want to go around that right now?" At 1604:19, the captain said, "Hand fly it about 285 kts," and the first officer responded, "285."

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4/ Significant Meteorological Information--A weather advisory concerning weather significant to the safety of all aircraft. It includes tornadoes, lines of thunderstorms, embedded thunderstorms, large hail, severe and extreme turbulence, severe icing, and dust or sandstorms.

At 1604:30, the sounds of rain and hail were recorded, and 20 sec later Flight 242 reported to Atlanta Center that the flight was reducing speed. At 1605:53, the first officer said, "Which way do we go cross here or go out--I don't know how we get through there, Bill." The captain replied, "I know you're just gonna have to go out... ." The first officer said, "Yeah, right across that band." At 1606:01, the captain said, "All clear left approximately right now; I think we can cut across there now." At 1606:12, the first officer said, "All right, here we go."

Between 1604:42 and 1606:20, Atlanta Center was coordinating with TWA-584 about its route and altitude to intercept the Atlanta VOR 313° radial inbound. At 1606:30, the controller said, "I show weather up northwest of that position, north of Rome, just on the edge of it...maintain 15,000." TWA-584 replied, "Maintain 15,000, we paint pretty good weather at 1 or 2 o'clock."

At 1606:41, the first officer on Flight 242 said, "He's got to be right through that hole about now." About the same time, Atlanta Center cleared Flight 242 to descend to and maintain 14,000 ft. At 1606:46, the captain said, "Who's that?", and the first officer replied, "TWA." At 1606:53, the captain reported to Atlanta Center, "242 down to 14." About the same time, the sound of heavy hail or rain was recorded on the CVR. The sounds continued to 1607:57, at which time the CVR ceased to record for 36 sec; it began operation again at 1608:33, and the sound of rain continued for another 40 sec.

Between 1607:00 and about 1608:01, Atlanta Center made four transmissions to Flight 242; none was acknowledged. About 1608:34, Atlanta Center said, "Southern 242, Atlanta." At 1608:37, the first officer said, "Got it, got it back Bill, got it back." At 1608:42, Flight 242 told Atlanta Center to "standby." At 1608:49, Atlanta Center transmitted, "Roger, maintain 15,000 if you understand me, maintain 15,000, Southern 242." At 1608:55, Flight 242 replied, "We're trying to get it up there."

At 1609:15, Flight 242 reported to Atlanta Center, "Okay...we just got our windshield busted and...we'll try to get it back up to 15, we're 14." At 1609:36, the first officer said, "Left engine won't spool," and Flight 242 reported to Atlanta Center, "Our left engine just cut out." Atlanta Center replied, "...roger, and lost your transponder, squawk 5623." At 1609:43, the first officer said, "I'm squawking 5623, tell him I'm level 14."

At 1609:59, the captain said, "Autopilot off," and the first officer replied, "I got it, I'll hand fly it." At 1610:00, Atlanta Center cleared Flight 242 to descend to 13,000 ft. At 1610:04, the first officer said, "My... the other engine's going too...," and at

1610:05, Flight 242 reported to Atlanta Center, "...the other engine's going too." Atlanta Center replied, "...say again." Flight 242 said, "Standby, we lost both engines."

At 1610:14, the first officer said, "All right Bill, get us a vector to a clear area." At 1610:16, Flight 242 told Atlanta Center, "Get us a vector to a clear area Atlanta." Atlanta Center replied, "...continue present southeastbound heading, TWA's off to your left about 14 mi at 14,000 and says he's in the clear." Flight 242 replied, "Okay."

At 1610:27, Flight 242 asked Atlanta Center, "Want us to turn left?" The Center replied, "...contact approach control 126.9 and they'll try to get you straight into Dobbins." 5/ At 1610:36, the first officer said, "Give me--I'm familiar with Dobbins, tell them to give me vector to Dobbins if they're clear." At 1610:38, Flight 242 asked tlanta Center, "Give me, a, vector to Dobbins if they're clear." The enter replied, "...126.9, they'll give you a vector to Dobbins." At 610:45, Flight 242 replied, "269, Okay."

At 1610:50, the first officer said, "Ignition override, it's otta work...." At 1610:52, an Atlanta Approach Control transmission to ear Jet 999M was recorded on Flight 242's CVR; at 1610:56, the CVR eased operation for 2 min 4 sec. Between about 1611:17 and 1612:50, lanta Center made three transmissions to Flight 242. About 1612:00, lanta Approach Control made one transmission to Flight 242; 10 sec ter, TWA 584 called Flight 242. No responses were recorded.

At 1613:00, the CVR resumed operation, and at 1613:03 the ptain said, "There we go." The first officer responded, "Get us a ctor to Dobbins." At 1613:04, Flight 242 transmitted to Atlanta proach Control, "...Atlanta, you read Southern 242?" Approach Control plied, "Southern 242, Atlanta ...go ahead." Flight 242 said, "...we've stboth engines, how about giving us a vector to the nearest place, 're at 7,000 ft." At 1613:17, Approach Control replied, "Southern 2, roger, turn right heading 100°, will be vectors to Dobbins for a raight-in approach runway 11...your position is 15, correction 20 mi t of Dobbins at this time." Concurrent with this transmission, the stofficer said, "What's Dobbins' weather, Bill? How far is it? How is it?" Flight 242 transmitted, "Okay 140" heading and *20* mi."

At 1613:35, Atlanta Approach Control directed, "...make a ding of 120, Southern 242, right turn to 120°." Flight 242 replied, ay, right turn to 120 and.. .you got us our squawk, haven't you, on rgency." Concurrent with this transmission, the first officer said, clare an emergency, Bill." At 1613:45, Approach Control replied, I'm not receiving it but radar contact, your position is 20 mi west Dobbins." Flight 242 replied, "Okay."

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Dobbins Air Force Base is located about 33 nmi east-southeast of the Rome VOR.

At 1614:03, the first officer said, "Get those engines. ... " At 1614:24, Flight 242 transmitted to Approach Control, "All right, listen, we've lost both engines, and...I can't...tell you the implications of this...we...only got two engines, and how far is Dobbins now?" Approach Control replied, "...19 mi." Flight 242 transmitted, "Okay, we're out of...5,800, 200 kns." At 1614:45, Approach Control asked, "Southern 242, do you have one engine running now?" Flight 242 replied, "Negative, no engines."

At 1615:04, the captain said, "Just don't stall this thing out." The first officer replied, "no I won't." The captain said, "Get your wing flaps," and the sound of lever movement was recorded. At 1615:11, the first officer said, "Got it, got hydraulics, so we got." The captain replied, "We got hydraulics." At 1615:17, the first officer said "What's the Dobbins weather?" At 1615:18, Flight 242 asked Approach Control, "What's your Dobbins weather?" Approach Control said, "Standby." At 1615:46, Approach Control said, "Southern 242, Dobbins weather is 2,000 scattered, estimated 7,000 overcast, visibility 7 mi." Flight 242 replied, "Okay, we're down to 4,600 now." Approach Control responded, "Roger, and you're approximately...17 mi west of Dobbins at this time." At 1616:05, Flight 242 said, "I don't know whether we can make that or not."

At 1616:11, the first officer said, "...ask him if there is anything between here and Dobbins?" The captain said, "What?" and the first officer repeated his request. At 1616:25, Flight 242 asked Approach Control, "... is there any airport between our position and Dobbins?" Approach Control replied, "...no sir, closest airport is Dobbins." At 1616:34, Flight 242 said, "I doubt we're going to make it, but we're trying everything to get something started." Approach Control replied, "Roger, well there is Cartersville, you're approximately 10 mi south of Cartersville, 15 mi west of Dobbins."

At 1616:45, Flight 242 asked Approach Control, "Can you give us a vector to Cartersville?" Approach Control replied, "All right, turn left, heading of 360, be directly...direct vector to Cartersville." Flight 242 said, "360, roger." At 1616:53, Flight 242 asked Approach Control, "What's the runway heading?" Approach Control replied, "Standby." Flight 242 then asked, "And how long is it?" Approach Control replied, "Standby."

At 1617:08, the captain said, "...I'm picking out a clear field." The first officer replied, "Bill, you've got to find me a highway." The captain said, "Let's get the next clear open field." The first officer said, "No...." At 1617:35, the captain said, "See a highway over--no cars." The first officer said, "Right there, is that straight?" The captain replied, "No." The first officer said, "We'll have to take it."

At 1617:44, Approach Control transmitted, "Southern 242, the runway configuration... at Cartersville is...360 and running north and south and the elevation is 756 ft, and. ..trying to get the length now— it's 3,200 ft long." At 1618:02, Flight 242's last transmission to Approach Control was recorded: "...we're putting it on the highway, we're down to nothing." From 1618:36 to 1618:43, crash sounds were recorded on the CVR.

According to one of the passengers, a commercially licensed pilot who was seated on the left side of the airplane just forward of the left engine intake, the flight was routine until the aircraft encountered severe turbulence followed by very heavy precipitation, a lightning strike on the left wingtip, and hail. The hail increased in intensity and size; then the right engine quit and the left engine quit shortly thereafter. He thought the cabin lights went out shortly after the lightning strike, but before the hail began. Additionally, almost simultaneous with the turbulence, he noticed that the power was reduced on the engines. He estimated that the turbulence lasted from 1 to 2 min, the heavy precipitation lasted from 45 to 60 sec, and the hail lasted from 45 to 60 sec. The engines quit shortly after the hail ceased; just before the right engine quit, he heard loud popping sounds from an area ahead of the engine. Similarly, just before the left engine quit, he heard sounds of engine surging and loud popping. He also noticed that the inlet fairing in the center of the left engine was dented. After the engines quit, he heard sounds that he associated with attempts to start the auxilliary power unit (APU) followed by sounds of the unit in operatfpn.

The two flight attendants recalled details similar to those xpressed by the passenger.

About 1615, several witnesses in Rockmart, Georgia, saw Flight 2 flying over Rockmart in a westerly direction. The aircraft made a ft turn and flew back toward the east. They heard no engine sounds d saw nothing peculiar about the aircraft.

The aircraft crashed during daylight hours, at an elevation of 020 ft, and at latitude 33°57'45" and longitude 84°47'13".

2 Injuries to Persons

| uries | Crew | Passengers | Others |
|---|---|---|---|
| al | 2 | 60 | 8 |
| ious | 1 | 21 6/ | 1 6/ |
| or/none | 1 | 0 | 0 |

Two persons died about 1 month after the accident. However, they were not listed as fatalities because 14 CFR 830.2 defines a fatal injury as one which results in death within 7 days after the accident.

## 1.3 Damage to Aircraft

The aircraft was destroyed.

## 1.4 Other Damage

A combination grocery store-gasoline station was destroyed by fire. A truck and five automobiles were destroyed, and an automobile and a house were substantially damaged. Additionally, numerous trees, shrubs, lawns, utility poles, powerlines, mail boxes, highway signs, and fences were damaged.

## 1.5 Personnel Information

The four crewmembers on Flight 242 were qualified and certificated for the flight and had received the training required by current regulations. (See Appendix B.)

The crewmembers arrived in Muscle Shoals on April 3, 1977, about 2300. According to one of the flight attendants, they went directly to their motel. Since the restaurant in the motel and other restaurants in Muscle Shoals were closed, the crew had no dinner. The flight attendants arose at 0630 on April 4 and rode to the airport with the flightcrew. The flight attendants had a snack at the airport, but they did not see the flightcrew consume anything. They departed Muscle Shoals at 0747 and arrived in Atlanta at 0925. One of the flight attendants stated that the flightcrew had breakfast in Atlanta before leaving on a series of flights at 1051. The flight attendants stated that the pilots next had a snack on the ground at Huntsville about 1345 because they did not have sufficient time to eat a full meal between flights.

On April 3, the flightcrew had been on duty 6 hrs 2 min and had flown 3 hrs 3 min. They had been off duty 8 hrs 15 min before resuming duty on April 4. On April 4, they had flown 5 hrs 24 min and had been on duty about 9 hrs when the airplane crashed.

## 1.6 Aircraft Information

N1335U, a DC-9-31, was leased by Southern Airways, Inc., from the McDonnell Douglas Leasing Corporation. It was certificated, maintained, and equipped in accordance with current regulations and procedures. (See Appendix C.) The flight log contained no uncorrected discrepancies.

The aircraft was equipped with two Pratt and Whitney model JT8D-7A engines. The last routine inspection on the engines had been performed on March 10, 1977. The engine operating time since the last heavy maintenance was 2,336.2 hrs on the left engine and 878.7 hrs on the right engine. N1335U was equipped with a Bendix model RDR-1E weather radar system. The weight and balance sheet for departure from Huntsville showed that the aircraft had 14,300 lbs of jet-fuel aboard at that time.

1.7 Meteorological Information

Forecast Conditions

On April 4, 1977, the National Weather Service's (NWS) 1600 surface weather chart showed a deep low pressure system centered over the southern tip of Lake Michigan, an occluded front that extended from the low pressure center to southwestern Indiana, and a cold front that extended from there to south-central Louisiana and into the Gulf of Mexico. A warm front was positioned along a line from southwestern Indiana to western North Carolina and then eastward to the Atlantic Ocean. A squall line extended northeastward from near Meridian, Mississippi, through northern Alabama and northwestern Georgia to near Knoxville, Tennessee.

The area forecast issued by the NWS forecast office in New Orleans at 0740 and valid from 0800 on April 4 to 0200 on April 5 was, in part, as follows:

> Alabama, northwest Florida, and adjacent coastal waters--ahead of cold front extending from near Fayetteville, Arkansas, to Beaumont,, Texas, and moving east to Paducah, Kentucky, and Layfayette, Louisiana, by 1400: Ceilings 1,000 to 2,000 ft broken to overcast, layered clouds to 15,000 ft; visibilities 3 to 5 mi in haze. Ceilings and visibilities occasionally below 1,000 ft and 3 mi in moderate rainshowers and fog. Scattered thunderstorms with tops to 35,000 ft; a few severe thunderstorms, 7/ especially near the cold front. Tops of severe thunderstorms at 55,000 ft, locally moderate to severe mixed icing in thunderstorms or buildups above the freezing level, which was generally at 12,000 ft to 14,000 ft but lower behind the cold front.

The area forecast issued by the NWS forecast office in Miami 0740 and valid from 0800 on April 4 to 0200 on April 5 was, in part, follows:

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7/ Wind gusts of 50 kns or greater or hail 3/4 inch or greater in diameter.

Northern one third of Georgia--Conditions improving after 0900 and becoming generally 2,000 to 3,000 ft broken, variable scattered with a chance of ceilings and visibilities locally at or below 1,000 ft and 3 mi in moderate rainshowers and thunderstorms with moderate rainshowers. Moderate icing in towering cumulus and cumulonimbus tops above freezing level, which was near 13,000 ft in northern Georgia.

At 1120, the NWS forecast office in New Orleans issued SIGMET Charlie 6, which was valid from 1120 to 1520. The pertinent part of the SIGMET covered Alabama west of a line from near Boothville, Louisiana, to Bristol, Tennessee. Scattered thunderstorms were forecast, occasionally in lines; possibly a few would be severe with occasional tops to above 40,000 ft.

At 1520, the New Orleans office issued SIGMET Charlie 7, which was valid from 1520 to 1920. The pertinent portion of this SIGMET covered northern and western Alabama, east of a line from Lafayette, Louisiana, to Dyersburg, Tennessee, and northwest of a line from Mobile, Alabama, to Columbus, Georgia. Scattered to numerous thunderstorms, occasionally in lines were forecast; "a few will be severe, possibly a tornado, with occasional tops to above 45,000 ft."

At 1400, the NWS forecast office at Miami issued SIGMET Bravo 2, which was valid from 1400 to 1800. The SIGMET area covered Georgia north of a line between Atlanta and Athens. It forecast embedded thunderstorms developing, possibly a few severe with hail and strong gusts, occasionally forming in northeast-southwest lines. Activity was moving from southwest to northeast.

On April 4, the National Severe Storms Forecast Center, (NSSFC), Kansas City, Missouri, issued tornado watches Nos. 55 and 56, which were pertinent to Flight 242's area of operation.

No. 55 was issued at 1150 and was effective from 1200 to 1800 for an area 70 statue mi on each side of a line from 20 statue mi east of Huntsville, Alabama, to 60 statue mi south of Jackson, Mississippi. This watch called for tornados and a few severe thunderstorms with hail up to 3 in. in diameter at the surface and aloft, extreme turbulence, surface wind gusts to 70 kns, and a few cumulonimbus with maximum tops to 58,000 ft. Also, a line of thunderstorms from southwest Mississippi to northern Alabama was to continue to intensify while a small-scale low center moved northeastward from southern Mississippi.

No. 56 was issued at 1317 and was valid from 1400 to 2000 for an area 70 statute mi on each side of a line from 50 statute mi southwest of Chattanooga, Tennessee, to 30 statute mi northeast of Hickory, North Carolina. Conditions similar to those described in No. 55 were forecast. Additionally, No. 55 was continued in effect.

Actual Conditions

The surface weather observations at the following times and locations were, in part:

Rome, Georgia

1459 - Sky--1,400 ft scattered, ceiling estimated 3,000 ft broken, 5,000 ft overcast; visibility--5 mi, thunderstorm, light rainshowers; temperature--70°F; wind--210° at 4 kns; remarks--one thunderstorm northeast, moving northeast, and thunderstorm southwest, moving northeast and occasional thunder.

1600 - Sky--1,800 ft scattered, ceiling estimated 5,000 ft overcast; visibility--7 mi, thunderstorm, light rainshowers; wind--210° at 9 kns; remarks--continuous thunder southwest through northwest and pressure failing rapidly.

1610 - Special - Sky--ceiling estimated 500 ft obscuration; visibility--3/4 mi, severe thunderstorm, heavy rainshowers; wind--320° at 28 kns, gusts 50 kns; remarks--dark west quadrants frequent lightning in clouds, and frequent thunder.

According to the rainfall recorder at the Rome Airport, about .20 ins. of rain fell between 1605 and 1615.

Huntsville, Alabama

1553 - Special - Sky--ceiling estimated 800 ft broken, 3,000 ft overcast; visibility--4 mi, thunderstorm, moderate rainshowers; wind--260° at 19 kns, gusts 25 kns; remarks--thunderstorm overhead moving northeast.

At 1534, the NWS's weather station at Athens, Georgia, reported area of very strong radar echoes which contained thunderstorms with y heavy rainshowers. The area was approximated by a line from near xville, Tennessee, east-southeastward to Ashville, North Carolina, n southeastward to near Birmingham, Alabama, then northward to a nt about 35 nmi north-northeast of Huntsville, Alabama, and then back near Knoxville. Four-tenths of the area was covered by the echoes ch were moving east-northeastward at 55 kns. The maximum top of ectable moisture was 46,000 ft at a point about 35 nmi northwest of Rome VOR.

At 1535, the NWS station at Atlanta reported a similar area of thunderstorms as that reported by the Athens station at 1534, except the area extended farther to the west. Five-tenths of the area was covered with intense echoes and three-tenths was covered by weak echoes. Additionally, Atlanta reported a possible line-echo-wave pattern 8/ centered along a line beginning about 86 nmi west of Atlanta to a point 86 nmi northwest of Atlanta. The station reported indications of hail in most of the cells in this line and most cell tops above 40,000 ft.

At 1601, the Athens station made a special radar report. The station reported cells of intense echoes containing thunderstorms with intense rainshowers. The center of one group of cells was 15 nmi west of the Rome VOR; the maximum top of detectable moisture was 51,000 ft and the group was 10 nmi in diameter. The cells were moving east-northeastward at 55 kns.

At 1632, the Athens station made another special radar report of cells of extreme intensity containing thunderstorms with extreme rain showers. The center of the cells was about 13 nmi north-northeast of the Rome VOR. The maximum top of detectable moisture was 45,000 ft and the cells were moving east-northeastward at 56 kns.

From 1531 to 1601, the NWS radar at Old Hickory, Tennessee, showed a group of heavy echoes west of Rome and an almost continuous area of light precipitation between Huntsville and this group of heavy echoes.

The above radar observations were transmitted via the NWS's radar report and warning coordination system (RAWARC) circuits to the NSSFC at Kansas City, Missouri. This information was not generally available in the above narrative form to aviation users unless they subscribed to the RAWARC service. Similar information was available to the aviation users by means of the Weather Bureau radar remote system (WBRR); the users of this system could obtain a facsimile of the radar display from selected NWS radars by telephoning the appropriate NWS office. The facsimile was transmitted via the telephone line to the user's receiver in about 3 min, which provided the user with a current picture of the weather radar display. Southern Airways did not subscrib to the RAWARC service but did have a WBRR receiver.

The NSSFC compiled data from the RAWARC circuits into maps of the United States showing severe weather areas. Facsimiles of these maps were periodically transmitted to subscribers via the National

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8/ A configuration of radar echoes in which a line of echoes has been subjected to an acceleration along one portion or a deceleration along that portion immediately adjacent, or both, with a resulting sinusoidal mesoscale wave pattern in the line.

Facsimile Network Circuit (NAFAX). Also, the NSSFC issued tornado watches and severe thunderstorm watches over the RAWARC circuits to NWS offices throughout the United States and to the Weather Message Switching Center (WMSC) at the FAA's National Communications Center in Kansas City. According to Southern Airways' flight dispatch personnel, the company's NAFAX receiver was inoperative most of the late morning and early afternoon on April 4, and they had received none of the severe weather maps.

The tornado watches, severe thunderstorm watches, SIGMETS, aviation terminal observations, and aviation area forecasts are available to aviation users through the WMSC. Southern Airways' flight dispatch personnel had access to this information. Atlanta Center also received all of this information except tornado watches and severe thunderstorm watches. The information was further processed by Center personnel, as necessary, and distributed to the controllers.

The following severe weather conditions were reported in, various locations and at various times in eastern Alabama and western Georgia:

| | | |
|---|---|---|
| 1300 | - | Tornado about 22 mi southeast of Gadsden, [9] Alabama. |
| 1315 | - | Tornado about 37 mi north of Gadsden, Alabama. |
| 1405 | - | Tornado about 14 mi south-southeast of Gadsden, Alabama. |
| 1418 | - | Tornado about 15 mi north-northeast of Anniston, [10] Alabama. |
| 1430 | - | Tornado about 20 mi south of Huntsville, [11] Alabama. |
| 1530 | - | Possible tornado about 4 mi east-northeast of Gadsden, Alabama. |
| 1532 | - | Severe thunderstorm at Gadsden, Alabama. |
| 1600 | - | Tornado moved from southwest to northeast about 3 mi northwest of the Rome VOR. |
| 1612 | - | Large hail in western part of Rome, Georgia. |

The NWS observer on duty at the Richard B. Russell Airport [12] Rome, Georgia, stated that about 1400 the NWS forecast office at Atlanta issued a tornado watch for the Rome area. About the same time, the observer heard thunder and saw cloud-to-cloud lightning to the west. About 30 min later, a brief but very heavy rainshower passed over the airport. At 1459, the observer reported thunderstorms to the northeast and southwest; about 1530, she heard continuous thunder from the southwest and northwest quadrants and saw "boiling" cumulonimbus clouds to the

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[9] About 45 mi west-southwest of Rome, Georgia.
[10] About 48 mi southwest of Rome, Georgia.
[11] About 72 mi west-northwest of Rome, Georgia.
[12] About 11 mi north of the Rome VOR.

southwest. She called the Atlanta office and the Atlanta forecaster told her that they had observed intense radar echoes and several hook echoes west of Rome. The forecaster told her to issue a tornado warning for the Rome area. She issued the tornado warning; later she learned that a tornado had passed through the southern suburbs of Rome and just north of the Rome VOR about 1600.

According to Southern Airways' flight dispatchers, before Flight 242 departed Muscle Shoals, the captain was provided with copies of tornado watches 55 and 56, SIGMETS Charlie 6 and Bravo 2, and the 1400 aviation weather reports for selected terminals along its intended route. Those terminals were: Atlanta, Georgia, Birmingham, Alabama, Columbia, South Carolina, Chattanooga, Tennessee, Columbus, Georgia, Greenville-Spartanburg, South Carolina, Huntsville, Alabama, and Montgomery, Alabama. According to the station agent at Huntsville, the flightcrew was provided with the 1500 terminal reports for the selected terminals listed above; no other weather information was given to, or requested by, the flightcrew. One of the flight attendants stated that both pilots remained in the cockpit during the stop at Huntsville. The central flight dispatch facility at Atlanta did not communicate with the flightcrew of Flight 242 while on the ground at Huntsville or while en route to Atlanta.

One of the lead dispatchers testified that about 1545 he telephoned the NWS office at Athens to obtain a facsimile of the weather that was under surveillance by that office's radar. He was interested in potentially severe weather that might affect the Atlanta terminal area. However, the telephone was busy, and he was not able to get the information. To his knowledge, no one in the dispatch office called the Atlanta NWS office or any other NWS office to discuss weather radar observations or other information on the severe weather conditions northwest of Atlanta.

According to a postaccident analysis by the NWS, the storm system that moved across northeast Alabama and northwestern Georgia on the afternoon of April 4 was one of the most severe systems in the United States in the past 3 years. Also, it was one of the fastest moving systems on record. About 20 tornadoes and 30 severe thunderstorms were included in the system.

## 1.8 Aids to Navigation

The Rome VOR, which operates on 115.4 MHz, is located about 46 mi northwest of the Hartsfield-Atlanta International Airport. No discrepancies were reported before the accident, and postaccident flight checks disclosed normal operation.

The Atlanta Center is equipped with an ARSR-1E radar, an ATC BI-4 radar beacon system, and National Airspace System (NAS) Stage-A automation. The Atlanta Approach Control is equipped with an ASR-7 radar, an ATC BI-4 radar beacon system, and ARTS III automation. **No** discrepancies were reported with any of these systems.

**1.9** Communications

Between 1607:00 and 1608:01, Atlanta Center made four transmissions to Flight 242 **on** 121.35 MHz. None of these transmissions were acknowledged by Flight 242, although three of the transmissions were recorded **on** its CVR.

From 1610:46 to 1613:04, Flight 242 did not communicate with either Atlanta Center or Atlanta Approach Control. Between 1610:49 and 1610:56, two transmissions, one from Atlanta Approach Control and one from Eastern Air Lines Flight 683, were recorded on Flight 242's CVR; from 1610:56 to 1613:04, no transmissions from Atlanta Center, Atlanta Approach Control, or any other facility or aircraft were recorded. Atlanta Approach Control frequency 126.9 MHz and Atlanta Center frequencies 135.05 MHz and 121.35 MHz were checked and were certified to have been operating properly.

**1.10** Aerodrome and Ground Facilities

The following facilities were potentially available to Flight 242 for its emergency landing:

Dobbins Air Force Base, near Marietta, Georgia, is about 17 mi north-northwest of the Hartsfield-Atlanta International Airport. It has one concrete runway, 11–29, which is 10,000 ft long and 300 ft wide. Dobbins is equipped with both approach surveillance and precision approach radars. The airport elevation is 1,068 ft. Complete crash-fire-rescue facilities were located on the air base.

Cartersville Airport is located about 4 mi southwest of Cartersville, Georgia. It has one asphalt runway, 18–36, which is 3,200 ft long and 60 ft wide. The airport elevation is 756 ft. The airport was not equipped with crash-fire-rescue facilities.

Cornelius Moore Airport is about 5 mi east of Cedartown, Georgia, and about 5 mi west-northwest of Rockmart, Georgia. It has one asphalt runway, 10–28, which is 4,000 ft long and 75 ft wide. The airport elevation is 973 ft. The airport was not equipped with crash-fire-rescue facilities.

**1.11** Flight Recorders

N1335U was equipped with a Sundstrand Data Control model FA-542 flight data recorder (FDR), serial **No.** 4159. The FDR case was damaged mechanically, but it showed no evidence of exposure to fire, heat, or smoke. The foil recording medium was not damaged, and all traces were clear and active.

The FDR traces indicated two instances of electrical power interruption. From the time the aircraft was moved on the ground at Huntsville until the first power loss, 15 min 7.7 sec elapsed. After electrical power was restored, the FDR operated for 2 min 24 sec before the power was lost again. After the second resumption of electrical power, the FDR operated for 5 min 40.2 sec until the crash.

N1335U was equipped with a Collins Radio model 642 C-1 cockpit voice recorder, serial No. 581. The CVR case was damaged by fire, but the recording tape was intact and unharmed. The recording was of fair to good quality. (See Appendix D.)

A plot for Flight 242's probable ground track from Huntsville was derived from FDR data and NAS Stage-A D-log data from the Atlanta Center. Pertinent comments from the CVR transcript and the air traffic control transcripts were added to the plot. Additionally, the precipitation conditions in the Rome area as identified at 1608 by the NWS's WSR-57 weather radar at Athens, Georgia, were scaled and positioned on the plot. (See Appendix E.) The range of the radar was set at 125 mi; therefore, no weather west of a 125-mi radius of the Athens' radar was plotted. The radar's antenna was at 1° tilt above the horizon and the radar beam width was 2°. Therefore, the precipitation conditions for the Rope area shown on the plot were those between 6,500 ft and 20,500 ft. The precipitation conditions are labeled on the plot in terms of the standard NWS radar-identified intensity levels of precipitation as follows:

| Level | Precipitation category | Rainfall rate (in./hr.) |
|---|---|---|
| 1 | Light | Less than 0.1 |
| 2 | Moderate | 0.1 to 0.5 |
| 3 | Heavy | 0.5 to 1.0 |
| 4 | Very heavy | 1.01 to 2.0 |
| 5 | Intense | 2.01 to 5.0 |
| 6 | Extreme | greater than 5.0 |

From 1602:26 to 1618:16, the D-log data showed 44 secondary radar returns for codes 5623 and 7700, the discrete codes that identified Flight 242 in the air traffic control radar beacon system. During this period, the returns were interrupted twice--once at 1607:50, which lasted for 1 min 57 sec, and again at 1607:11, which lasted for 6 min 34 sec. To complete the track during these interruptions, primary radar returns for which coordinates fell within a reasonable range of Flight 242's probable ground track were used. The first portion of the plot was established from FDR data and pertinent meteorological information. This portion of the plot was then adjusted for alignment with the D-log data plots.

The probable ground track established by the radar data is believed to be accurate within ± 1 mi. The weather radar plot of the precipitation areas west of the Rome VOR is believed accurate within the same tolerance. However, since the precipitation areas were established by the strongest radar returns between 6,500 ft and 20,500 ft, the conditions that existed at Flight 242's flight level may not have been precisely those shown on the plot. Nevertheless, the Safety Board believes that the precipitation areas shown represent a reasonable approximation of the conditions that existed between 17,000 and 14,000 ft. Additionally, a comparison of photographs of the Athens radar display taken from 1604 to 1608 disclosed only slight differences in the boundaries of the precipitation areas from those shown on the plot.

## 1.12 Wreckage and Impact Information

The aircraft's outboard left wing section first contacted two trees near State Spur Highway 92 south-southwest of the community of New Hope. About 0.8 mi farther north-northeast, the left wing again contacted a tree alongside the highway within the community of New Hope. The left and right wings continued to strike trees and utility poles on both sides of the highway, and 570 ft after striking the first tree in New Hope, the aircraft's left main gear contacted the highway to the left of the centerline. Almost simultaneously, the outer structure of the left wing struck an embankment, and the aircraft veered to the left and off the highway. The aircraft traveled another 1,260 ft before it came to rest. As it traveled, the aircraft struck road signs, utility poles, fences, trees, shrubs, gasoline pumps at a gas station-store, five automobiles, and a truck. The total wreckage area was about 1,900 ft long and 295 ft wide; the area was oriented on a magnetic heading of about 025°.

The aircraft fuselage broke into five major sections: (1) The nose section rearward to fuselage station (FS) 148, (2) FS 148 to FS 275, which contained the cockpit bulkhead, forward passenger door, service door, and four cabin windows, (3) FS 275 to FS 579, which contained 12 cabin windows, (4) FS 579 to FS 870, which contained the wing center section, and (5) FS 870 to FS 1,090, which included the engine pylons, APU, and the aft pressure bulkhead. Additionally, the empennage section had separated at FS 1,090.

The first section came to rest inverted, and the captain's and first officer's seats were outside the cockpit. The windshield sections separated from the cockpit structure. Although the center windshields were intact, the outer panes were shattered and the inner panes were cracked. Both clear-view side windows were intact but scratched. The other windows were intact but had been damaged by impact. Fire did not damage this section.

In the second section, the flight attendant's seat, which was outside the structure and bulkhead, was in good condition. The passenger and service doors were jammed. Several passenger seats were outside the section, and all the seats showed evidence of compression buckling to the right. The galleys and coat closets were damaged but were generally in place; their contents were scattered about the section. There was no fire damage to this section.

The third section was inverted and most of the passenger seats separated from their tracks. Many of the seats were scattered around the section. There was no fire damage.

The fourth section was damaged substantially by fire; all of the passenger seats and the cabin floor were consumed by fire. Both wings had separated from the wing center section.

The fifth section was upright and was damaged substantially by fire. The top of this section was separated and was lying on the ground about 20 ft away from the main portion of the section. Most of the passenger seats had separated from their tracks and were scattered around the section. Some of the seats were substantially damaged by fire.

The landing gears were extended and the spoilers were retracted. The wing trailing edge flaps were at 50° extension and the leading edge flaps were fully extended. All flight control surfaces were accounted for. All fractures observed were typical of those caused by overloads. The leading edges of the wing slats, the vertical stabilizer, and the horizontal stabilizer contained numerous indentations which varied from 1/16-in. to 1/4-in. deep. The indentations were typical of those caused by in-flight hailstone strikes.

Both engines remained near the fifth section of the fuselage but the left engine pylon was separated from the fuselage structure. The right engine and its pylon remained attached to the fuselage but the pylon was bent downward. The cowls on both engines had small, smooth dents in the leading edges. All engine and inlet anti-icing valves were in the closed position.

The fan blades on both engines were generally in good condition and were undamaged. The fronts of both inlet fairings were dented, the right one more severely than the left. The accessory sections were intact and the constant speed drive units were connected. The accessory drive shaft port in the accessory gearbox of the right engine was fractured. Otherwise, the gearboxes were in good condition.

The low-pressure compressors on both engines were damaged heavily aft of the third stage rotor, and the high-pressure compressors had extreme damage in all stages. The main damage in both low-pressure compressors consisted of bent and broken trailing edges of the fifth-stage stator vanes and bent and broken blades in the sixth-stage rotors. The main damage in the high pressure compressors consisted of bent and broken rotor blades in all stages--7 through 13--and bent or broken stator vanes in all stages. Many of the rotor blades in the lower stages were bent forward, and most of the blades in the higher stages were either broken or missing. Numerous blade roots from the 9th and 10th stages were lodged among the stator vanes in the last three stages of the high-pressure compressors. All fragments were battered severely.

The combustion sections of both engines were generally in good condition. Quantities of fine metal particles were in the diffuser areas and in some of the combustors in the left engine. The fuel nozzles and manifolds in both engines were in good condition. The combustion case drain valves contained metal chips. Melted aluminum covered external portions of the turbine case on the right engine.

Many blades and vanes were broken from the first three turbines on the left engine, and all turbines had been overheated. All blades in the four turbines in the right engine were burned and broken, and the last three stages of nozzle guide vanes were melted. Several sections of the first stage nozzle guide vanes were melted and burned.

The outer race of the left engine's No. 1 main bearing was displaced forward about 1/2 in. Otherwise, all bearings and seals were in good condition with no evidence of electrical arcing. The right engine's main bearings were generally in good condition with no evidence of electrical arcing; there was evidence of heat discoloration on the rollers and races of the No. 6 bearing.

The fuel controls and fuel pumps were tested. The control for the left engine was within prescribed tolerances; the control for the right engine provided a slightly high fuel flow throughout the engine acceleration schedule. The fuel pumps, pressure ratio bleed controls, pressurizing valves, and drain valves on both engines functioned properly. All ignition exciters and plugs were tested: all components functioned properly except the left igniter plug on the left engine. The plug was bent and, when tested, it discharged internally.

The APU doors were open and the actuator was in the "run" position. The APU compressor, turning pipes, and combustors contained large quantities of dirt.

The constant speed drive units and a.c. generators from both engines were tested. Both units and both generators functioned within prescribed tolerances. Both aircraft batteries were fully charged, and all major electrical power relays were operable. The emergency electric power switch was in the "off" position and tests on the switch verified that the switch was off.

The weather radar radome had separated from the fuselage and had broken into pieces. Consequently, the status of the radome before impact could not be determined.

The No. 1 transponder switch was "on" and code 7700 was selected. The mode selector switch was on "A" and the altitude reporting switch was "on."

The No. 1 COMM/NAV panel was set as follows:

NAV--On - 116.9 MHz (Atlanta VOR)
COMM--On - 126.85 MHz (Southern flight dispatch)
DME--Missing

The No. 2 COMM/NAV panel was set as follows:

NAV--On - 116.85 MHz
COMM--On - 126.9 MHz (Atlanta Approach Control)
DME--On

The audio control panel was set as follows:

Microphone selector buttons--not depressed
VHF No. 1 and No. 2 switches--On
VOR No. 1 and No. 2 switches--On
Range/voice switch--Both
Normal/emergency switch--EMER

The controls on the weather radar control panel were in the following positions:

Gain control--Auto
Mode switch--broken
Stabilizer switch--On
Antenna tilt--broken
Range selector--80 mi
Trace control--45° clockwise from minimum
Brightness control--Full bright

The engine ignition switch was tested; it functioned correctly and was in the "override" position.

## 1.13 Medical and Pathological Information

Post mortem examinations of the flightcrew and passengers were made to determine injuries and to aid in identification. Toxicological examinations of the flightcrew revealed no ethyl alcohol. The tests for drugs were inconclusive because the specimens tested were either unsuitable or insufficient for analysis. The tests for hemoglobin (%), carboxyhemoglobin (gm %), and hydrogen cyanide ug/ml disclosed the following respective levels in the captain and first officer: 14.1 and 8, 0.4 and 5.8, and 0 and 0. Both flightcrew members died of extensive trauma; they were not burned and there was no evidence that they had inhaled smoke.

Twenty passengers died of burns and smoke inhalation; their blood contained various levels of carbon monoxide saturation, the highest level of which was 38 percent. Autopsies revealed no significant injuries although some injuries could have been obscured by the severe burns.

Thirty-one passengers died of extensive traumatic injuries. Most of these injuries consisted of crushing of the upper torso and head. There was no evidence of soot or smoke inhalation in these passengers.

Nine passengers sustained trauma combined with burning or smoke inhalation. In addition to the traumatic injuries, these passengers displayed evidence of smoke inhalation and increased levels of carbon monoxide in the blood. Also, the levels of hydrogen cyanide found in blood samples varied; the highest level was 5.5 ug/ml.

The surviving passengers sustained a variety of serious injuries. Many were burned about the head, face, hands, and lower legs. Three passengers had fractured spines. Arm, hand, and leg fractures were common and most passengers had numerous abrasions and contusions.

Both flight attendants had sprained necks and both had contusions and abrasions of the legs. One flight attendant also had contusions and abrasions on both hands.

## 1.14 Fire

Volunteer firemen who witnessed the crash of N1335U from a nearby fire station in New Hope responded immediately to the crash scene with two firetrucks. The firemen's first efforts were directed toward a fire in a combination grocery store-gasoline station and scattered fires among the automobiles. The fire in the store was apparently ignited by short-circuited powerlines and was fed by gasoline from the damaged pumps. One firetruck was used to fight this fire while the other truck was used to fight the fire in the mid and aft sections of the aircraft. There was no fire in the fuselage sections forward of the wings.

About 1646, firemen from the Cobb County Fire Department arrived and assisted the New Hope volunteers in extinguishing the fires. Additionally, volunteer firemen from the Hiram and Union volunteer fire departments assisted in the firefighting and rescue activities. The fires were extinguished in about 30 min.

## 1.15 Survival Aspects

According to the CVR, at 1607:22 and shortly after the aircraft entered the heavy hail and rain, the aft flight attendant announced on the cabin address system that the passengers should keep their seatbelts securely fastened. At 1608:38, the aft flight attendant made another announcement concerning the stowage of luggage and instructed the passengers about what to do in the event of an emergency landing.

Several minutes later, when the aft flight attendant was certain that both engines were inoperative, the flight attendants began to brief the passengers on emergency crash landing and evacuation procedure they demonstrated how to open the exits, and how to assume the brace position on receipt of the flightcrew-activated chime signal, or on command from the flight attendants. Additionally, they instructed the passengers to remove sharp objects from clothing and stow the objects, to check that luggage was stowed securely, and to remove their shoes to prevent damage to the evacuation slides during evacuation.

After the briefings, the forward flight attendant opened the cockpit door to tell the flightcrew that the passengers were prepared for an emergency landing. The first officer immediately told her to sit down, and she returned to the cabin. She noticed that the windshield was shattered., At 1616:28, the forward attendant called the aft attendant on the interphone and told her about the situation in the cockpit and they discussed their preparations for an emergency landing and evacuation.

Shortly thereafter, the aft flight attendant saw trees outside the cabin window and she yelled to the passengers, "grab your ankles!'' The forward flight attendant repeated the command, and according to both attendants, the passengers responded as instructed. There were no signals from the flightcrew that landing was imminent. According to the flight attendants, they received no information from the flightcrew about what had happened after the aircraft entered the heavy hail, or how the flightcrew planned to land the aircraft.

After the aircraft stopped, both flight attendants freed themselves without assistance. The forward flight attendant was hanging upside down in her seat, restrained by her seatbelt (the seat had no shoulder harness). After releasing her seatbelt she fell onto debris inside what she thought was the galley area. When she was unable to open the main cabin door, she climbed through an opening in the fuselage and jumped to the ground. She ran to a nearby house to get help. There she saw some of the passengers.

The aft attendant recalled that the aircraft struck the ground about six times before it came to rest. A fireball erupted after the first or second impact and traveled rearward along the ceiling of the cabin. The fireball extended downward from the ceiling to the tops of the passenger seats. She saw passengers on fire before the aircraft stopped, but was unable to recall where these passengers were located. After protecting her hand with her apron because the release lever was hot, she released her seatbelt and stood up. A wall of fire was in front of her, and smoke caused her to cough repeatedly. After trying unsuccessfully to open the rear bulkhead door, she turned and moved forward because the flames had diminished, and walked out of the cabin onto the ground. She then began to pull passengers from the wreckage until an explosion forced her away.

One passenger covered his head with a leather jacket and wedged a pillow between his face and the seatback in front of him just before impact. After the aircraft stopped, he removed the jacket; his head was burned by melted plastic which dripped from the ceiling. He moved forward and exited the aircraft through a hole in the fuselage.

Six of the surviving passengers were seated in the section of the cabin forward of the wings' leading edge. Of these passengers, four were ejected from the aircraft, two of which were ejected with their seats. None of the four were burned although they sustained extensive musco skeletal trauma. The remaining two passengers were seated in the row nearest the wings' leading edge; they received extensive second-degree burns. One of them said that fire and smoke were around him after the aircraft stopped, and one said that fire erupted during the impacts. Their seats and seatbelts remained intact.

Five of the eight survivors who were seated in the portion of the cabin aft of the wings' leading edge and just forward of the engine intakes said that fire erupted inside the cabin before the aircraft stopped. Almost all of these passengers said that smoke, fire, debris, and bodies hampered their escape. The eight survivors said their seats remained intact. The passengers near the overwing exits opened the right exit but closed it because of fire. The eight passengers were burned severely; three sustained musco skeletal trauma.

Four of the five survivors in the aft section of the aircraft were ejected with their seats during the impacts. The condition of the fifth survivor's seat could not be determined. All of these survivors were burned seriously and three sustained musco skeletal trauma.

The two survivors from the last row of seats reported that their seats remained intact and that fire was all around them wheh the aircraft stopped. Both passengers were seriously burned and one sustained rib fractures and lacerations.

Five hospitals were notified of the accident--the first was notified about 1620 and the last, about 1810. All of these hospitals implemented emergency plans and were prepared to care for the survivors. The first survivor arrived at Paulding Memorial Hospital in Dallas about 1630.

An FAA-designated medical examiner and a nurse arrived at the accident scene about 1634; they were the first medically qualified persons on the scene. The medical examiner began triage and coordinated the transportation of survivors to hospitals.

The accident was partially survivable because some sections of the aircraft remained comparatively intact while others were demolished.

The forward fuselage section (from the leading edge of the wing forward) was completely destroyed by impact forces. The forward flight attendant survived because she was in an area of this section that shielded her from numerous impacts with trees and other objects. Most of the survivors from this section were ejected during its fragmentation and destruction, but were seriously injured. Therefore, their survival was fortuitous rather than a consequence of design.

The accident was survivable for those passengers who were seated aft of the wings' leading edges, except for those who were injured too severely to escape unaided. A number of these passengers probably died in their seats from burns and smoke inhalation. For the most part, the survivors' seats and seatbelts in this section remained intact, and about half the survivors were ejected from the wreckage. The ejected passengers were probably burned before they were ejected. The remaining survivors were not incapacitated and, therefore, were able to escape unaided although they were burned in the process. Consequently, certain areas of the aft cabin were survivable in spite of the fire there, because these areas were not damaged as badly as the forward part of the fuselage.

The feet of a number of the survivors were cut and some were also burned because they had no shoes for protection. In accordance with standard evacuation procedures, the flight attendants had briefed the passengers to remove their shoes to prevent damage to evacuation slides. Because of the lack of information from the flightcrew, the flight attendants had no way of knowing the circumstances associated with the landing and, therefore, had no reason to deviate from standard procedures.

Although the flightcrew was preoccupied with trying to restart the engines and with selecting suitable landing areas, the Safety Board concludes that a few words from the flightcrew to the flight attendants about the type of landing expected might have enabled the attendants to better prepare the passengers. Had pillows and blankets been distributed and had shoes been worn, some of the passengers' injuries probably would have been less severe and more passengers probably would have been able to escape from the wreckage. (See Appendix F, "Summary of Passenger and Flight Attendant Observations.")

## 1.16 Tests and Research

At the request of the Safety Board, the engine manufacturer conducted a test program to investigate the effects of ingestion of large amounts of water on the operation of the JT8D-7 engine. The program included water ingestion tests, compressor rig tests, and spin pit tests of-individual compressor disk and blade assemblies. Concurrently, all JT8D compressor tests, development data, and service experience were reviewed.

Since the conditions encountered by N1335U could not be precisely determined, particularly the water concentrations encountered, no attempt was made to simulate or duplicate the engine inlet conditions, and the tests were conducted at sea level static conditions with various fixed throttle positions between flight idle and takeoff thrust. Additionally, because of a water flow limit in the test facility of 125 gal/min, the water-to-air ratios varied from 18 percent at idle thrust to 4.1 percent at takeoff thrust.

At flight idle thrust, and with ingestion rates exceeding about 14 percent (by weight) water-to-air ratio, the high pressure rotor RPM decelerated to below generator cut-out speed. Rotor speed decayed as long as water was ingested. When water ingestion was terminated, the rotor speed recovered to the set speed, and it was stable. The engines did not surge or flameout during any of the ingestion testing. At lower ingestion rates and higher power settings, engine operation remained stable. The tests also showed that water did not collect in the air bleed cavities or compressor cases during ingestion and that the compressor rotors were not damaged during ingestion tests.

The compressor rig spin pit and tests were designed to determine whether liquid water trapped in the bleed cavities could hit the compressor blades and cause damage similar to that sustained by N1335U's engines. Water jets were directed at the rotating compressor blades and rotors until the blades failed. All failures were high frequency fatigue type failures and occurred in the airfoil near the platform. The blades in N1335U's engines failed from overload bending at random points on the airfoil. In addition, in N1335U's engines, many blade roots were torn from the disk slots; none of the blades was torn from the slots during the rig tests.

The compressor damage 'in N1335U's engines was compared to previous JT8D compressor damage from known causes. The damage was found to be nearly identical to high-pressure compressor damage caused by material which originated forward of this compressor. Static load testing of low-pressure compressor blades showed that the fourth-, fifth-, and sixth-stage blades could deflect sufficiently to contact the upstream vanes. However, testing and calculations showed that water ingestion ratios of about 300 percent water-to-air were required to produce water deep enough to deflect the blade tips to the extent that they would contact upstream vanes.

A review of JT8D compressor developmental history and an analysis of JT8D compressor test data showed that during water ingestion, the high-pressure compressor's sensitivity to stalls and surges is significantly increased. Calculations showed that, when water is ingested in large quantities, surging in the higher stages of the compressor could cause upstream overpressures and correspondingly high aerodynamic forces in excess of any experienced during the developmental and service history of the engine. These calculations also showed that the aerodynamic forces generated could be high enough in the sixth-stage of the compressor to deflect the blades and cause them to clash with the upstream stator vanes.

On April 29, 1977, the Douglas Aircraft Company, with Pratt and Whitney Aircraft's concurrence, issued an alert service bulletin to all DC-9 operators. This bulletin cited the circumstances of Flight 242's accident and suggested as an interim measure that thunderstorm/monsoon conditions be avoided. In the event avoidance was not possible, override ignition and engine ice protection should be activiated before penetrating these conditions, and engine thrust should be maintained at, or above, 80 percent $N_2$ until the aircraft is clear of the abnormal precipitation.

On November 8, 1977, the Douglas Aircraft Company issued a letter, with Pratt and Whitney's concurrence, to all DC-9 operators which canceled the above procedures and recommended that operators avoid severe storm systems, but if encounters could not be avoided, the following procedures be used:

"1. Follow the DC-9 FAA approved airplane flight manual procedure for severe turbulence.

"2. Do not make thrust changes in extremely heavy precipitation unless airspeed variations occur. If thrust changes are necessary, move thrust levers very slowly. Avoid changing thrust lever direction until engines have stabilized at a selected setting.

"3. Engine ice protection as required.

"4. If installed, engine sync and autothrottle systems off."

## 1.17 Additional Information

### 1.17.1 Aircraft Performance Data

The aircraft manufacturer provided information on the glide ratio of a 88,400-lb, cleanly configured DC-9-30 series aircraft with engines inoperative. Under the atmospheric conditions that existed on the day of the accident and at the indicated airspeed at which the maximum lift/drag ratio is achieved, the aircraft could glide about 34 mi in wings-level flight while descending from 14,000 ft to about 1,300 ft; this distance was calculated without considering the effects of winds. The time of descent would have been about 9 min 30 sec. Under the same conditions, while descending from 7,000 ft to about 1,300 ft, the aircraft could glide about 12 mi in wings-level flight. FDR and ATC radar data showed that N1335U flew about 32.5 mi as it descended from 14,000 ft to about 1,300 ft.

### 1.17.2 Southern Airways, Inc., Operating Procedures

According to Southern Airways' DC-9 Operating Manual, the emergency procedure for complete a.c. electrical power failure was as follows:

"1. EMER PWR switch .............................. ON
Note: If EMER POWER is not avail, pull BATT DIR BUS feed CB reset handle.
2. THNDSTRM' LIGHT switch........................ ON
3. BATT switch ............................ (CHECK) ON
4. CABIN PRESS controller.. .................... MANUAL
5. CABIN TEMP switches.......; ................ MANUAL
6. AC BUS X-TIE switch ........................ OPEN
7. GALLEY PWR switch.. ........................ OFF
8. LEFT GEN (or APU GEN). ............ RESET/ON (NORM)
9. RIGHT GEN (or APU GEN). ............ RESET/ON (NORM)"

If engine generator operation is NOT normal:

"Position L and R GEN switches to OFF
Attempt APU airstart using windmill RPM....
Start APU. APU PWR AVAIL light should be ON
Note: After start, it may be necessary to place APU GEN switch to RESET
Place the selector to APU VOLT/FREQ position. Voltage and frequency should indicate in the normal range.
Place the APU L BUS switch to ON. The L APU power in use light should come on. Place the APU R BUS switch to ON. The R APU power in use light should come ON....

10. YAW DAMPER ................................... ON"

The emergency power switch, when placed in the "on" position, selects the battery as the source of emergency a.c. and d.c. power. Power to the d.c. emergency bus is supplied through the battery-direct bus, and single phase a.c. power is supplied to the emergency bus by the emergency inverter, which is powered by the battery-direct bus. When the emergency power switch is "off", no power is available to the emergency d.c. bus.

When the aircraft's batteries are used as the only source of electrical power, much of the aircraft's electrical equipment, including the FDR and CVR, becomes inoperative. The following is a partial list of essential equipment that will operate:.

a. With the battery switch ON:

1. APU control, and
2. standby attitude indicator,

b. With emergency power switch ON, and the battery switch ON:

1. No. 1 VHF COMM radio,
2. no. 1 VHF NAV radio,
3. captain's horizon display,
4. captain's turn and slip indicator,
5. captain's course-heading indicator, and
6. first officer's compass

When the APU generator is the only source of electrical power, power is available to all electrical buses, and, subject to generator load limitations, all electrical equipment will operate.

Southern Airways' DC-9 operating procedures required that engine ignition be placed "on" whenever adverse flight conditions, such as icing, water, or turbulence, were encountered. Additionally, engine anti-icing heat was to be used in flight anytime the ram air temperature was 6" C or less and moisture was visible.

Southern Airways' Operating Manual provided that:

"1. Flights shall not intentionally be conducted through thunderstorms or clear air turbulence. If, in the opinion of the Captain and Flight Superintendent, flight conditions warrant such actions the flight should be delayed on the ground until the turbulent conditions have passed.

"2. Take-offs and landings shall not be made during wind shifts, thunderstorms, frontal passage or other weather phenome which may affect the performance and safety of the aircraft.

"During periods of icing, hail, thunderstorms, turbulence or any other potentially hazardous meteorological conditions, a flight may deviate from the approved route to the extent necessary to circumnavigate such conditions. However, during deviations, flight shall be conducted at an altitude that will provide at least minimum terrain clearance and within a reasonable distance of the prescribed route. If this is not practical, the flight will be held on the ground until the conditions creating the potential hazard have subsided."

The Operating Manual provided that if severe turbulence is encountered above 10,000 ft the indicated airspeed should be reduced to 285 kns or 0.79 Mach, whichever is lower, and that below 10,000 ft the indicated airspeed should be reduced to 250 kns.

1.17.3 Aircraft Weather Radar

N1335U was equipped with a Bendix model RDR-1E weather radar system. The system operated on X-band frequency at a 3.2 cm wavelength. The system could display targets at three range selections--30 mi, 80 mi, and 180 mi. The system was designed to display weather in two modes--normal and contour. In the normal mode, precipitation is displayed as luminescent areas on the dark background of the cockpit display indicator. In the contour mode, the areas of heavy precipitation are electronically eliminated to produce a dark hole (contour hole) surrounded by the luminescent areas of lighter precipitation. According to the manufacturer, in the contour mode, areas of precipitation that exceed a reflectivity factor of $\log Z^{4.1}$ (which is equivalent to a rainfall rate of 0.5 to 1.0 in. per hour) would appear as contour holes. According to the manufacturer's operating manual for pilots which was used by Southern Airways as a flightcrew training guide, contour holes should definitely be avoided by at least 10 mi. Additionally, any weather displayed beyond a range of 75 mi indicates areas of significant rainfall, regardless of the presence or absence of contour holes, and should be avoided. The manual recommended that flights detour around weather as soon as possible and that the pilot avoid late detours around a particular target at close range.

The manufacturer's manual addressed attenuation effects as follows:

"Venturing into contour holes results in an unnecessary degree of turbulence. Also severe rainfall within the antenna near field (100 feet) disperses the beam with a consequent reduction of radar range performance. Radome icing reduces system range performance. In severe cases, all targets disappear, an indistinct haze may appear at the indicator origin."

**No** other references were made to the effects of attenuation by rain or water vapor.

The theoretical effects of attenuation by rainfall and water vapor between the radar antenna and the target have been calculated to be quite high for X-band radar as compared to radar operating at lower frequencies and longer wavelengths. 13/ Additionally, empirical evidence 14/ exists that radio magnetic waves of the X-band frequency are significantly more susceptible to attenuation by rainfall than are the waves of longer length and lower frequency. According to Medhurst, there were indications that the measured amounts of attenuation substantially exceeded the theoretical amounts, and he believed that further measurements were needed to clarify the discrepancies.

According to a Southern Airways first officer who rode with the flightcrew in the cockpit of N1335U on an earlier flight, which departed Atlanta about 1353 and arrived in Huntsville about 1439 on April 4, the airborne radar was operating properly. At 19,000 ft, flight was clear of clouds briefly before the descent into Huntsville. The descent was made in instrument conditions, and the flight encountered hail and moderate to heavy rain during the descent and approach. The first officer stated that none of these conditions presented a contour indication on the radar; he could not explain why.

## 1.17.4 Air Traffic Control and Severe Weather Avoidance

On June 18, 1976, the FAA issued Advisory Circular (AC) 90-12B on the subject of severe weather avoidance. (See Appendix G.) In October 1976, Southern Airways published, verbatim, paragraphs 4 and 5 of AC 90-12B in its newsletter for Southern pilots.

According to the Chief, En Route Radar Branch, Airway Facilities Service of the FAA, paragraph 4 of AC 90-12B is not correct because it states, "For this function, light precipitation has been classified as a precipitation fall of less than 5 but more than 1 inch per hour. Heavy precipitation is classified as 5 or more inches per hour." In actuality, light precipitation equals a fall rate of 1 in. or less per hour and for these purposes, heavy precipitation is more than 1 in. per hour.

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13/ Skolnik, Merrill L.: Radar Handbook, Chapter 24, McGraw-Hill Book Company, New York, 1970.

14/ Medhurst, R.G.: Rainfall Attenuation of Centimetre Waves: Comparison of Theory and Measurement, IEEE Transactions, Vol AP-13, pp. 550-564, July 1965.

# 2. ANALYSIS AND CONCLUSIONS

## 2.1 Analysis

The pilots were certificated properly and were qualified for the flight. They had received the off-duty time required by regulation. There was no direct evidence, that medical or physiological factors might have affected the flightcrews performance.

The aircraft was certificated, equipped, and maintained in accordance with regulations and approved procedures. Before encountering the precipitation and hail which immediately preceded the loss of power from the engines, there was no evidence of a failure or a malfunction of the aircraft's structure, powerplants, or flight controls. Moreover, except for the possibility that the aircraft's weather radar system may not have been functioning effectively, there was no evidence that any of the aircraft's other systems had failed or malfunctioned.

From an evaluation of all the evidence, the Safety Board concludes that the causal factors related to this accident are associated with the severe weather conditions that Flight 242 encountered near Rome, Georgia, the extent of the flightcrew's knowledge of those conditions before the encounter, and the information about those conditions provided to the flightcrew. After the severe weather conditions were encountered and thrust from the engines was completely and permanently lost, an accident most orobablv was inevitable.

### 2.1.1 Engine Failures and Flightcrew Reactions

The engine tests, the review of JT8D compressor research data, and passenger and flight attendant testimony produced a viable theory of how N1335U's engines were damaged so severely.

Clearly, based on passenger and flight attendant testimony, radar weather reports, and the CVR, the aircraft flew in rain most of the time after it departed Huntsville and flew in heavy rain and hail for about 2 1/2 min immediately before thrust was lost completely from the engines. Although the intensity of the rain and hail is not known, the Safety Board concludes that the intensity was sufficient to cause the rotational speed of the engines to decrease below that required for operation of the engine-driven generators. This is supported by the 36-sec loss of normal electrical power which began at 1607:57 while the aircraft was in heavy rain and hail. Furthermore, the Safety Board concludes that engine rotational speed was lost shortly after the thrust levers were retarded to low settings--probably flight idle--in preparation for the descent from 17,000 to 14,000 ft. Passenger testimony supports this conclusion. Also, the engine tests proved that rotational speed will be lost at low thrust settings if water is ingested at a rate greater than 14 percent water-to-air ratio.

The engines did not lose combustion during the first loss of rotational speed because they surged and stalled, which could only have occurred if the compressors were being driven. Also, engine tests showed that, despite the loss of rotational speed caused by water ingestion, combustion was not lost. Therefore, the Safety Board concludes that neither the presence of, nor the absence of, engine ignition during the first loss of rotational speed was a factor in the ultimate loss of thrust.

Engine rotation speed increased on at least one engine about 36 sec after the first loss of normal electrical power because the CVR, FDR, and communication radios returned to normal operation. Although the recovery of rotational speed to generator operating speed or above could have been related to reduced water ingestion, as demonstrated in the engine tests, the Safety Board believes that recovery was more likely related to thrust lever advancement--a pilot's normal reaction to a loss of engine RPM. Additionally, the flight was attempting to climb, which normally would require higher thrust settings.

Passenger and flight attendant testimony verifies that both engines surged and stalled while the aircraft was in heavy rain just before the engines quit. The engine tests and the analysis of JT8D compressor developmental data indicate that at low rotational speeds ingestion of large quantities of water is likely to cause surging in the aft stages of the high-pressure compressors which could produce overpressu in the low-pressure compressors sufficient to cause blades to deflect and clash against the vanes in these compressors. Moreover, throttle advancement under these conditions is likely to aggravate the surging and stalling. Consequently, the Safety Board concludes that after rotational speed was first lost, the throttles more advanced, and surging and stalling occurred which caused blades in the low-pressure compressors to clash against the vanes. This conclusion is supported by the physical damage to the engines. The damage to both low-pressure compressors indicates that the sixth-stage blades deflected forward, clashed with the fifth-stage stator vanes, and broke pieces from the blades and vanes. Pieces of vanes and blades were then ingested into the high-pressure compressors, causing extreme damage to these compressors. The Safety Board further concludes that the lack of typical foreign object damage, including hail damage from known encounters, to the fan blades and the blades in the forward stages of the low-pressure compressors clearly indicates that hail ingestion was not responsible for the compressor damage.

If the thrust levers remained at relatively high thrust setting after the compressors were damaged, high fuel flow in conjunction with reduced compressor efficiency would cause overtemperatures in the turbine sections of the engines. The damage to the turbine sections of both engines clearly indicates overtemperatures before the engines quit.

Finally, the internal physical damage to the engines clearly indicates that, following the damage to the compressors and turbines, the engines were no longer capable of producing thrust. After the engines ceased to function, about 1610:56, normal electrical power again was interrupted. This interruption lasted about 2 min 4 sec, and the power undoubtedly was restored by the operation of the APU generator because the CVR and FDR again began to function. Also, passenger testimony, CVR comments, and the condition of the APU after the crash indicated that the APU was operating before the crash.

Although the flightcrew might have been able to land N1335U on shighway or airport without major damage or injury, the probability of completing such a landing was extremely low. Even under ideal meteorological conditions, this type of landing is difficult and requires knowledge of glide ratios for various aircraft configurations and airspeeds, and requires continuous judgments about altitude versus angle of bank, airspeed, rate of descent, distance to touchdown, and aircraft configuration. With no thrust available, there is no way to correct misjudgments. Consequently, instruction and practice are required to develop these skills, and Southern's flightcrews never received, nor were they required to receive, any instruction and practice in emergency landings with all engines inoperative. Moreover, the approved operating manuals contained no guidance or procedures on the subject. The FAA does not require this kind of training or guidance from any certificated air carrier because the probability that a transport category turbojet aircraft will lose permanently all thrust is extremely low. This low probability has been confirmed by service history--there is no other recorded instance of a transport category turbojet aircraft experiencing a similar emergency.

Although the Safety Board concludes that, after complete failure of the engines, an accident was most probably inevitable, we believe that had the flight continued toward Dobbins Air Force Base, the flightcrew's chances of successfully landing the aircraft on the 10,000-ft runway at Dobbins would have been significantly greater than their chances with any other available option.

Because the CVR was inoperative, the Safety Board was unable to determine precisely why the flightcrew turned the aircraft about 180" back toward the west-northwest instead of continuing toward Dobbins. Under the circumstances, the only electrical power available to energize flight instruments (except the standby attitude indicator), one communications radio, and one navigation radio would have been from the aircraft's batteries through activation of the emergency power switch. Possibly shortly after the loss of the engines, the aircraft entered visual flight conditions and the pilots, busy trying to start the engines and the APU, chose to remain in visual conditions which dictated that they make a 180° turn. This theory is consistent with the first officer's first request "...get us a vector to a clear area." They may, therefore, have failed to turn on the emergency power, which would explain the loss of communications with air traffic control because the communications radio would have remained inoperative until the APU generator began to function.

On the other hand, Southern's communications procedures specified that the No. 1 communications radio would be used for company communications and the No. 2 radio would be used for air traffic control communications. If the flightcrew adhered to this procedure, they may not have realized that the No. 2 radio was inoperative even with emergency power selected. After the crash, the No. 1 radio was on company frequency and the No. 2 radio was on Atlanta Approach Controls' frequency. However, if emergency power was selected, the captain's flight instruments would have been operative, and they should have been able to continue southeastward toward Dobbins in instrument flight conditions despite the lack of radio communications. Therefore, the Safety Board concludes that the flightcrew probably did not select emergency power, but instead turned the aircraft back toward the west-northwest in an effort to remain in visual flight conditions while they attempted to start the engines and the APU.

The option of attempting a landing at Cornelius Moore Airport might have been available to the flightcrew had they known or been told of the airport's location when the aircraft was over Rockmart, Georgia. However, the flightcrew apparently was not aware of the aircraft's position at that time because the first officer said, "Get us a vector to Dobbins," and the captain responded with a request for "...a vector to the nearest place...." Atlanta Approach Control was not able to provide assistance because the airport was outside of Atlanta Approach Control's airspace and, therefore, was not shown on the controllers' video map displays.

It is not known what the flightcrew's reaction might have been had they known or been informed of the location of Cornelius Moore Airport. However, because of the weather conditions there, the lack of crash-fire-rescue facilities, the short runway, and the aforementioned difficulties associated with making an emergency landing with both engines inoperative, it is impossible to assess the outcome of an attempted emergency landing at Cornelius Moore Airport.

Standard operating procedures and practices dictate that a captain take control of the aircraft in an emergency situation. It could not be determined why the captain did not take over control at least in the final stages of the emergency landing. His total flying experience and DC-9 experience were far superior to that of the first officer. It can be theorized that his greater familiarity with the DC-9 and its systems made it logical that he devote his attention to attempts to restart the engines and all related emergency procedures in order to insure the controllability of the aircraft. The captain may also have considered the first officer's familiarity with Dobbins AFB and its approaches a reason to let him handle the aircraft.

## 2.1.2. Acquisition, Dissemination, and Interpretation of Weather Information

Southern Airways' Operating Manual contained procedures for the avoidance of thunderstorms, including the options of delaying flights on the ground or deviating as necessary while en route to avoid thunderstorms. Consequently, Southern clearly did not intend that its flightcrews fly through thunderstorms to reach their destinations. It is equally clear that Flight 242 flew through a severe thunderstorm near Rome, Georgia. Therefore, the Safety Board sought to determine why the flightcrew of Flight 242 entered thunderstorms that were extremely hazardous.

In Muscle Shoals, the flightcrew had received weather information through Southern's flight dispatch system. However, the most pertinent information they received was tornado watches Nos. 55 and 56 and SIGMET's Charlie 6 and Bravo 2, all of which were forecasts of conditions that were expected to materialize in northern Alabama and northern Georgia sometime between 1120 and 2000 on April 4. During the stop at Huntsville, both pilots remained in the cockpit. The only additional information given to them by flight dispatch was the 1500 terminal weather observations for selected terminals. Consequently, the information was of little value with regard to the actual flight conditions that might be expected on the return flight to Atlanta, and the flightcrew, having just 2 hrs before flown the route on which they were to fly to Atlanta, probably relied more on their knowledge of actual conditions than on a forecast or warning of conditions that might materialize.

In any event, when Flight 242 departed Huntsville, the flightcrew apparently had little meaningful weather information to alter their impressions of conditions that existed 2 hrs earlier between Huntsville and Atlanta. Moreover, despite the requirements of 14 CFR 91.5 15/ and 14 CFR 121.601(b) 16/ there is no evidence that either the flightcrew or flight dispatch personnel made any significant attempt to seek information on the current conditions along Flight 242's route between Huntsville and Atlanta, including information from the 1459 weather report from Rome which identified thunderstorms to the northeast and the southwest of Rome. We conclude, therefore, that both flight dispatch and the flightcrew placed significant reliance on the latter's personal knowledge of conditions along the route. Additionally, we conclude that both parties relied heavily on the use of the aircraft's weather radar to provide en route weather-avoidance information.

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15/ "Each pilot in command shall, before beginning a flight, familiarize himself with all available information concerning that flight. This information must include: (a) For flight under IFR...weather reports and forecasts...."

16/ "During a flight, the aircraft dispatcher shall provide the pilot in command any additional available information of meteorological conditions...that may affect the safety of the flight."

About the same time Flight 242 departed Huntsville, the NWS reported a thunderstorm with moderate rainshowers over the airport. After takeoff, the Huntsville departure controller provided Flight 242 with radar weather advisories. Flightcrew comments on the CVR indicate that they were receiving similar information, although not clearly, on the aircraft's radar display. Since the range of the departure control radar was about 40 mi, it is clear that departure controller's comments and the flightcrew's comments were about a different area of weather than the area which the flight later entered near Rome. The only other known information provided to Flight 242 while en route to Atlanta was the Memphis Center controller's advisory which pertained to SIGMET Charlie 7. There was no evidence that the flightcrew received the full text of this SIGMET.

As Flight 242 proceeded toward Atlanta in instrument flight conditions, the flightcrew had no visual indication of the towering thunderstorm near Rome. However, the flightcrew obviously was receiving radar returns from the storms near Rome because at 1603:48, when the flight was about 35 mi west-northwest of the Rome VOR and about 20 mi west of the weather that, according to the probable ground track and weather radar plot, should have provided a contour indication, the captain said, "Looks heavy, nothing's going through that." It is not clear why the captain changed his initial assessment of rhe weather as reflected in this statement. The aircraft continued on about the same heading for slightly more than 1 min following that comment, and then began a right turn. During that period, the flightcrew discussed a possible hole. Given the high intensity precipitation levels of the storm and the comparatively short distance between the aircraft and the higher intensity precipitation levels of the storm, the aircraft's radar clearly should have shown a contour hole. However, since the aircraft was in rain at the time, the aircraft's radar might have been affected by attenuation to the extent that, when combined with the steep gradients associated with levels 3, 4, and 5 of the storm, the contour hole was distorted and interpreted by the captain as an area free of precipitation. The captain's comment, "All clear left approximately right now...," at 1606:01 seems to confirm this possibility because the aircraft's course was then altered to the left, through the steep gradient, and into the highest intensity level of the storm. (See Appendix E.) The first officer's comment at 1606:41, "He's got to be right through that hole about now," was made about the time the aircraft passed through the area of steep gradient which further confirms this possibility.

There is circumstantial evidence to indicate that fatigue might have influenced the captain's decision to continue into an area that he had initially decided was too heavy. The flightcrew's rest period from the end of their duty on April 3 to the beginning of duty on April 4 just met the 8-hour rest period required by regulation. Consequently, the rest time combined with inadequate food intake and long duty hours on April 4 could have produced fatigue.

Observations by the two flight attendants on Flight 242 did not indicate any overt signs of fatigue in either pilot. However, some of the subtle signs, such as increased effort to carry out work, feeling of "not being sharp," diminished range of attention, deterioration of judgment, acceptance of unnecessary risks, and unusual preoccupation and forgetfulness, could have easily escaped their attention. Consequently, the Safety Board believes that the circumstances surrounding the flightcrew's activities on April 3 and 4 could have slowed the captain's mental processes and could have led to a deterioration of his judgment; however, since there is no information available regarding the captain's reaction to either long-term or short-term fatigue, a finding that his decision was affected would be purely speculation.

The Safety Board concludes that the flightcrew of Flight 242 clearly had no knowledge of the weather conditions just west of the Rome VOR other than the knowledge they acquired about 2 hrs previously and the knowledge they acquired from the aircraft's radar. However, we it equally apparent that the NWS had information about the weather in the Rome area that probably would have altered the flightcrew's decision to fly through the area had they received timely information. Numerous reports of tornadoes in the Gadsden, Alabama, area, and radar identification of very strong thunderstorms and intense thunderstorms with hail and cloud tops above 40,000 ft to the southwest, west, and northwest of Rome were not made available to the flightcrew. The latter information was prepared by the NWS about 20 min before Flight 242 departed Huntsville.

The normal conduit for passage of this information to Flight 242 was Southern's flight dispatch system. However, the central dispatchers were not aware of the storms or of their severity until after the accident, even though thunderstorms were reported near Rome at 1459. The Safety Board concludes that Southern's system of providing only weather reports from selected terminals along the proposed route did not fulfill Southern's responsibilities under 14 CFR 121.601(b) and did not enable the captain to fulfill his obligations under 14 CFR 91.5. Although Rome was directly on Flight 242's route, Southern's dispatch weather package did not include weather reports from Rome. Additionally, although the dispatchers attempted to get NWS radar information from the Athens office, they did not seek similar information from other sources, including the Atlanta office and the Centerville, Alabama, office. The Safety Board believes this reflects a major flaw in Southern's dispatch system--an apparent inability to identify and monitor severe storm systems that affected Southern's route structure.

An alternate conduit for the passage of severe weather information to Flight 242 would have been through en route air traffic control facilities. Additionally, these facilities possessed capabilities to detect and track severe weather systems by means of air route surveillance radars. Except for the advisories by the Huntsville departure controller and the SIGMET advisory from Memphis Center, the flightcrew of Flight

242 did not receive, nor did they request, any weather information from air traffic control before entering the weather west of the Rome VOR.

Although the ATC surveillance radars can detect severe weather, the NAS Stage-A display systems were designed to deemphasize the display of weather because of interference with aircraft targets and, hence, interference with ATC's primary function of separating aircraft. Therefore with current NAS Stage-A systems, the controller needs additional information, such as pilot reports, to confirm the areas, altitudes, and intensity levels of precipitation shown on his display.

According to the controllers, Atlanta Center had little information to confirm the severe weather in the Rome area. In fact, the only severe weather information distributed internally to the controllers was a report of a tornado near Gadsden and SIGMET alerts. None of the radar reports from the NWS offices at Atlanta and Athens were made available to center personnel, and few definitive pilot reports about weather conditions were received. The Atlanta Center controller's attempt to solicit weather information from the Eastern flight was obviously prompted by concern about flying conditions in the area where Southern 242 was also crossing. Eastern's response would have had an alleviating effect on his concern.

In this era of sophisticated weather detection and tracking systems, including automated and digitized radar, doppler radar, and satellite cameras that take and transmit pictures of weather systems every 30 min, the Safety Board believes that current systems for passing information rapidly to the aviation user apparently remain unable to assure an adequate level of safety. About 3 years before this accident, the Safety Board recommended [17] that the FAA and NWS develop a system to expeditiously relay severe weather information to flights operating in terminal areas. Although this recommendation was related to terminal area operations, and we realize that some progress has been made with respect to these type operations, we believe that a system for relaying current severe weather information directly to ATC facilities for immediate internal distribution would significantly improve controllers' awareness of the location and intensity of severe weather systems. The controllers could thereby disseminate such information directly to pilots. Under the current system the en route controller can be of little assistance until he receives confirmation of the severe weather, and the flightcrew that is knowledgeable of ATC's limitations must rely exclusively on its airborne weather radar.

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17/ NTSB Safety Recommendation A-74-14, issued April 18, 1974.

Scientific studies show that the X-band frequency radar is comparatively susceptible to attenuation by water vapor and precipitation. This may be particularly true when precipitation covers the antenna radome. If a pilot fails to consider this limitation, he may misinterpret the display in the process, which is a significant reason why airborne radar should not be used as a storm penetration aid. For maximum effectiveness, interpretation of X-band radar displays should be accomplished when the aircraft is in areas free of water vapor or precipitation.

For local service carriers operating on short flights, such as Southern Airways, radar display interpretation can be critical. As demonstrated in this accident, the aircraft can frequently be in precipitation much of the flight. Therefore, flightcrew training on the limitations of the airborne radar is vital. Since little was contained in the Bendix manuals about the effects of attenuation on the RDR-1E radar, the flightcrew of Flight 242 may not have been fully aware of these limitations. We believe, therefore, that existing airborne radar should not be relied on exclusively for severe weather detection under these circumstances.

## 3. CONCLUSIONS

### 3.1 Findings

1. Flight 242 penetrated a severe thunderstorm between 17,000 and 14,000 ft near Rome, Georgia, while en route from Huntsville, Alabama, to Atlanta, Georgia.

2. The ingestion of intense rain and hail into N1335U's engines caused the rotational speed of both engines to decrease below the engine-driven electrical generator operating speeds, and resulted in normal electrical power interruption for 36 secs.

3. Rotational speed on at least one engine increased sufficiently to restore its generator to operation and provide normal electrical power.

4. The rotation speed of one or both engines was probably increased by advancement of the thrust lever(s).

5. Shortly after the initial loss of rotational speed, both engines' high-pressure compressors began to stall severely.

6. The stalls probably resulted from a change in high-pressure compressor operating characteristics induced by trust lever advancement and ingestion of massive quantities of water.

7. The severe compressor stalls produced an overpressure surge which deflected the compressor blades forward in the sixth stage of the low-pressure compressors; these blades clashed against the fifth-stage stator vanes and broke pieces from the blades and vanes.

8. Pieces of blades and stator vanes were then ingested into the high-pressure compressors and damaged them severely.

9. Continued high thrust settings following the severe damage to the high-pressure compressors probably caused severe overheating in the turbine sections of both engines, and the engines ceased to function.

10. Normal electrical power was again lost for 2 min 4 sec until the APU-driven generator restored electrical power.

11. After the engines failed, an accident was probably inevitable because Southern Airways' flightcrews had not received, nor were they required to receive, training or information on emergency landings with all engines inoperative.

12. Before departing Huntsville, the flightcrew of Flight 242 had no information on thunderstorms immediately west of the Rome VOR.

13. While en route to the Rome VOR, the flightcrew received no information on the existence of the storms immediately west of the Rome VOR except for the indications displayed on their airborne radar system.

14. Based on information from the airborne radar, the captain of Flight 242 initially decided that the storms just west of the Rome VOR were too severe to penetrate.

15. Shortly after his initial assessment of the storm system, the captain decided to penetrate the storm area near the Rome VOR.

16. Insufficient evidence precluded a positive determination regarding the possible effects of fatigue on the flightcrew's reactions and decisions.

17. The captain's decision to penetrate the storm area was probably based on his interpretation of the weather radar display.

18. At least 20 min before Flight 242 departed Huntsville, the NWS had identified by radar the precipitation in the Rome area as very strong and intense with indications of hail and cloud tops over 40,000 ft.

19. Southern Airways' flight dispatch personnel did not monitor adequately the storm system which moved into the Rome area, and the information that the dispatch section provided to Flight 242 did not alert the flightcrew to the weather hazards along their route.

20. The Atlanta Center controllers had insufficient information about the storm system in the Rome area.

21. Atlanta Center's surveillance radars were of limited value in displaying severe weather systems.

22. The Atlanta Center controllers acquired limited knowledge of the storm system in the Rome area from the surveillance radar.

23. The Atlanta Center controllers provided no information to Flight 242 about the storm system in the Rome area, and the flightcrew of Flight 242 did not request any information from the controllers.

24. The accident was partially survivable.

25. The flight attendants acted commendably for initiating a comprehensive emergency briefing of the passengers for their protection in preparation for a crash landing. This contributed to the number of survivors.

## 3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the total and unique loss of thrust from both engines while the aircraft was penetrating an area of severe thunderstorms. The loss of thrust was caused by the ingestion of massive amounts of water and hail which in combination with thrust lever movement induced severe stalling in and major damage to the engine compressors.

Major contributing factors included the failure of the company's dispatching system to provide the flightcrew with up-to-date severe weather information pertaining to the aircraft's intended route of flight, the captain's reliance on airborne weather radar for penetration of thunderstorm areas, and limitations in the Federal Aviation Administration's air traffic control system which precluded the timely dissemination of real-time hazardous weather information to the flightcrew.

## 4. RECOMMENDATIONS

As a result of this accident, the Safety Board, on September 27 and September 28, 1977, recommended that the FAA:

"Expedite the development and implementation of an aviation weather subsystem for both en route and terminal area environments, which is capable of providing a real-time display of either precipitation or turbulence, or both, and which includes a multiple-intensity classification scheme. Transmit this information to pilots either via the controller as a safety advisory or via an electronic data link. (Class II - Priority Followup) (A-77-63)

"Establish a standard scale of thunderstorm intensity based on the NWS' six-level scale and promote its widespread use as a common language to describe thunderstorm precipitation intensity. Additionally, indoctrinate pilots and air traffic control personnel in the use of this system. (Class II - Priority Followup) (A-77-64)

"Transmit SIGMET's more frequently on navaids so that pilots can receive more timely information about hazardous weather. (Class II - Priority Followup) (A-77-65)

"Code, according to geographic applicability, Severe Thunderstorm Bulletins and Tornado Watch Bulletins issued by the National Severe Storms Forecast Center so that they may be transmitted to appropriate air traffic control facilities by the FAA Weather Message Switching Center; thus, air traffic control facilities can relay the earliest warning of severe weather to flightcrews. (Class II - Priority Followup) (A-77-66)

"Require that each air traffic control facility depict on the map portion of its radar displays, those airports immediately outside of that facility's jurisdiction to the extent that adjacent facilities depict those airports on their displays. (Class II - Priority Followup) (A-77-67) to spread out

"Formulate rules and procedures for the timely dissemination by air traffic controllers of all available severe weather information to inbound and outbound flightcrews in the terminal area. (Class II - Priority Followup) (A-77-68)"

The Federal Aviation Administration's responses to these recommendations were as follows:

A-77-63

"Comment. In August 1975, the Air Traffic Service (ATS) initiated an R & D effort requesting: (a) en route and terminal radars be evaluated to ascertain their capabilities to detect and display weather; (b) a comparison of ARSR/ASR and National Weather Service (NWS) radar detection capabilities; (c) identification of modifications to improve ATC radars; and (d) improve ATC radar weather detection without derogation in aircraft detection."

A-77-64

"Comment. ATS has taken appropriate steps for implementing the NTSB recommendation to establish a standard scale of thunderstorm intensity, based upon the NWS six-level scale. Action has been taken to promote widespread use throughout the Air Traffic Service of a common language to describe thunderstorm intensity. The DOT/FAA Notice N7110.510 dated June 12 served to acquaint air traffic control specialists with the descriptive terms developed by the NWS, and authorizes their use in the air traffic system.

"Thunderstorm intensity levels were published in the Airman's Inforhation Manual, Part 3A, on September 1 (Enclosure 2). This publication advised pilots of the NWS standard six-level scale and cites examples of standard phraseology to be used by controllers describing thunderstorm intensity levels. Definitions, and an explanation of the standard six-level scale, will also be contained in the Pilot-Controller Glossary of the Air Traffic Control Manual and the Flight Service Station Manual, effective January 1, 1978."

A-77-65

"Comment. The Federal Aviation Administration (FAA) has taken action to provide for enhanced dissemination of SIGMETs and to provide Severe Thunderstorm Watch Bulletins and Tornado Watch Bulletins.

"Prior to the S0242 accident, the FAA had taken action to have both centers and towers make broadcasts on receipt of all SIGMETs. This broadcast would identify the area and alert pilots to the potentially adverse conditions that had developed If the identified area was of concern, the pilot could call the FSS for complete information.

"At the present time, it is nearly impossible due to manpower limitations to broadcast SIGMET's more frequently in the current manual FSS configuration and we do not have equipment to broadcast the data automatically. As the FSS Modernization program develops and new equipment is placed in service, we should be able to provide a continuous broadcast of advisories through automated methods.

"To enhance the broadcast program as an immediate measure, in May 1977, a revision to the priority of duties for FSS specialists was issued. This revision elevated notification actions to other Air Traffic facilities by the FSS and in FSS broadcasts of SIGMETs and AIRMETs. Required notifications now are only ranked after emergency actions and NAVAID malfunctioning requirements. Broadcast of SIGMETs and AIRMETs now are rauked only below services to airborne aircraft (other than above actions). This provided for dissemination of vital information to pilots and controllers in a more timely and effective manner."

A-77-66

"Comment. In June 1977, we proposed to the NWS that Severe Weather Forecasts or Bulletins (WWs) be implemented for aviation use. We have had subsequent letters between the two offices in trying to optimize the product. Our last reply from the NWS on September 19 outlined a separate aviation severe local storm watch for Service A that would be distributed geographically according to states by the FAA Weather Message Switching Center. This proposed format appears to meet the needs of the pilot and the FAA. Barring unforeseen problems, this product should be available shortly after the first of calendar year 1978. This project has and will continue to have a high priority."

A-77-67

"Comment. We are presently exploring the feasibility of the following methods for display of emergency airports:

Display all airports with approved approaches within the display area, either by automated or mechanical/electrical means.

In NAS Stage A, place the display of all airports not required for normal operations on a separate filter key. These airports could then be brought up for display in emergency situations by depressing this key.

We hope to be able to decide the appropriate course of action by December 23 and will advise the Board accordingly."

The FAA's response to recommendation A-77-68 has not been received.

In conjunction with the adoption of this report, the Safety Board issued the following recommendations to the FAA.

"Initiate research to determine the attenuating effects of various levels of precipitation and icing on airborne radomes of both x- and c- band radar, and disseminate to the aviation community any data derived concerning the limitations of airborne radar in precipitation. (Class II - Priority Action) (A-78-1)

"Expedite its review of Recommendation A-73-40 with a view toward early requirement of properly designed shoulder harnesses at flight attendant stations in air carrier aircraft. (Class II - Priority Action) (A-78-2)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ KAY BAILEY (See concurring statement below.)
Acting Chairman

/s/ PHILIP A. HOGUE
Member

/s/ JAMES B. KING
Member

KAY BAILEY, Acting Chairman, Concurring:

I agree with the report and probable cause because I am not convinced that if the flightcrew had attempted to secure further weather information it would have been sufficient to dictate a delay in takeoff or a change in route. However, when our previous recommendations to improve weather dissemination are fully implemented, pilots will have the benefit of real-time information.

This accident should serve to remind pilots, even when they have flown through the same area within the previous 2 hours, that they still must, in preparation for a flight, familiarize themselves with the latest information. We cannot stress enough, as part of preflight planning, the importance of caution in severe or potentially severe weather and the avoidance of thunderstorms altogether.

FRANCIS H. McADAMS, Member, filed the following dissent:

I do not agree with the Board's probable cause for two reasons: (1) it is merely a statement of what happened rather than being an explanation of why the accident occurred, and (2) it is not clear as to the effect of throttle movement upon the loss of the engines.

In my opinion, the probable cause of this accident involves the captain's critical decision to penetrate rather than to avoid a known area of severe weather. Further, the Board's analysis of the engine failures seems to conclude, or at least implies, that the engines were damaged to the extent they could not be restarted due to overpressures and overtemperatures resulting from an advanced throttle setting. If this is a fact, it should be stated clearly in the probable cause.

It is obvious that the captain flew a route, or directed the first officer to fly a route, into an area which the aircraft should not have entered. Southern Airways, and all air carriers, prohibit flying into convective storms (thunderstorms) because these types of storms are known to be serious hazards. The primary hazard relates to forces in these storms that can destroy an aircraft structurally; however, other hazards exist which are not well defined. Consequently, although the loss of thrust from Flight 242's engines might have been unusual, it -- or some other equally destructive consequence -- could not have been an entirely unexpected event given the multiple hazards associated with flight into severe convective storms.

An analysis of the events leading to the point where the captain was faced with a critical decision shows that he was inadequately prepared to make such a decision. Despite numerous warnings in the form of SIGMET's, SIGMET alerts and tornado warnings, he made no attempt to seek information on the development of these conditions. The most logical source of this information would have been the company's flight dispatch section. However, alternate sources were available -- the flight service station at Muscle Shoals, other flight service stations while en route from Muscle Shoals, and inquiries to air traffic control or other flights operating in the area. Instead, he apparently chose to rely exclusively on his own recent experiences in the area and on his airborne weather radar. In effect, part of his decision to continue the flight was made before he departed Muscle Shoals and another part of his decision was made before he departed Huntsville for Atlanta. If the captain had sought additional weather information from any of these sources, it is probable he would have altered his route of flight to avoid the Rome area.

As Flight 242 approached the area of severe weather west of the Rome VOR it is considered likely that, notwithstanding the possible effects of attenuation, the captain could not reconcile the contradiction between his radar display and his impressions of the weather as it existed about 2 hours earlier (tops of clouds less than 19,000 feet). Under these circumstances a comparatively routine piece of confirming information, such as the 1459 weather report from Rome, probably would have reinforced sufficiently his initial assessment to cause him to deviate around the storm system rather than risk penetration. As the evidence shows, the captain decided to continue into the area. The latest and most significant information available to the crew was that from the aircraft's airborne radar display. According to the CVR, the crew was aware from this display that there was an intense storm system along the intended flightpath. The captain made the following remarks with respect to the weather:

At 1602:57: "I think we better slow it up right here in this."

At 1603:45: "Looks heavy, nothing's going through that."

The first officer, at 1603:56: "That's a hole, isn't it?"

The captain replied immediately, "It's not showing a hole, see it."

At 1604:08, the first officer stated: "Do you want to go around that right now?"

The captain's reply was at 1604:19: "Hand fly it about 285 knot

At 1605:53, the first officer asked: "Which way do we go acro here or go out? I don't know how we get through there, Bill."

Consequently, his decision must be considered crucial and caus because the consequences that flowed from that decision, although p unique, could not have been entirely unexpected.

*Therefore, I would state the probable cause as follows:*

"*The National Transportation Safety Board determines that* the probable cause of this accident was the captain's decision to penetrate rather than avoid an area of severe weather, the failure to obtain all of the available weather information despite *having prior knowledge of the severity of the storm system, and* the reliance upon airborne weather radar for penetration rather than avoidance of the storm system. The penetration resulted in a total loss of thrust from both engines due to the ingestion of massive amounts of water and hail which in combination with advanced throttle settings induced severe stalling in, and major damage to, the engine compressors, which prevented the crew from restarting the engines. Furthermore, if the company's dispatching system had provided the flightcrew with timely severe weather information pertaining to the aircraft's intended route of flight, it is possible that the severe weather would not have been penetrated.

"Contributing to the cause were the inadequacies of the Federal Aviation Administration's air traffic control system which precluded the timely dissemination of real-time hazardous weather information to the flightcrew."

/s/ FRANCIS H. McADAMS
Member

January 26, 1978

# 5. APPENDIXES

## APPENDIX A

## INVESTIGATION AND HEARING

### Investigation

The National Transportation Safety Board was notified of the
lent about 1630 on April 4, 1977. The Safety Board immediately
atched an investigative team to the scene. Investigative groups
established for operations, air traffic control, witnesses, weather,
factors, structures, powerplants, systems, flight data recorder,
tenance records, and cockpit voice recorder.

Parties to the investigation were: The Federal Aviation
nistration, Southern Airways, Inc., Air Line Pilots Association,
ssional Air Traffic Controllers Organization, Transport Workers
of America, Pratt & Whitney Division of United Technologies
pration, and Douglas Aircraft Company.

### Hearing

A public hearing was held in Atlanta, Georgia, on June 6
ugh June 10, 1977. Parties to the hearing were: The Federal
tion Administration, Southern Airways, Inc., Air Line Pilots
ciation, Professional Air Traffic Controllers Organization,
onal Weather Service, Transport Workers Union of America, Pratt
itney Division of United Technologies Corporation, Douglas
raft Company, and Aviation Consumer Action Project.

## APPENDIX B

## PERSONNEL INFORMATION

Captain William W. McKenzie

Captain McKenzie, 54, was employed by Southern Airways, Inc., on October 12, 1960. He held Airline Transport Pilot Certificate No. 1118118 with commercial privileges and airplane single-engine land, multi-engine land, instrument, and flight instructor ratings. He held type ratings for the DC-3, M-404, and DC-9 aircraft. His first-class medical certificate was issued on October 6, 1976, with the limitation that he wear corrective lenses for near vision while flying.

Captain McKenzie was Dromoted to captain on the DC-9 on February 23, 1977. He passed his last proficiency check on February 22, 1977, and his last line check on February 25, 1977. He last completed recurrent training on November 24, 1976. During his flying career, Captain McKenzie accumulated 19,380 flight-hours, 3,205 of which were in the DC-9. In the 90-day, 30-day, and 24-hour periods preceding the accident, he flew 124.7, 90.4 and 8.6 hours, respectively, in the DC-9.

First Officer Lyman W. Keele

First Officer Keele, 34, was employed by Southern Airways, Inc., on February 12, 1973. He held Commerical Pilot Certificate No. 1965768 with airplane single-engine land, multi-engine land, and instrument ratings. His second-class medical certificate was issued with no limitation on January 22, 1977.

First Officer Keele initially qualified as a first officer on the DC-9 on August 24, 1973, and he last requalified on the DC-9 on March 7, 1976. His last proficiency check was completed in the DC-9 on March 28, 1977. He last completed recurrent training on November 30, 1976. During his flying career, First Officer Keele accumulated 3,878 flight-hours of which 235 were in the DC-9. In the 90-day, 30-day, and 24-hour periods preceding the accident, he flew 191.7, 84.2, and 8.6 hours, respectively.

Flight Attendant Anne M. Lemoine

Flight Attendant Lemoine, 26, was employed by Southern Airways, Inc., on May 15, 1972. She was qualified for duty in DC-9 and Martin 404 aircraft. Her total flight time was about 3,562 hours.

Flight Attendant Lemoine successfully completed her most recent recurrent training October 29, 1976, and she passed her last check ride on January 8, 1977. On October 30, 1976, she demonstrated her ability to remove the overwing exits and open the cockpit windows on the DC-9.

Flight Attendant Sandy M. Ward

Flight Attendant Ward, 22, was employed by Southern Airways, Inc., on January 2, 1977. She was qualified for duty on DC-9 and Martin 404 aircraft. Her total flight time was about 2,750 hours.

Flight Attendant Ward successfully completed her most recent recurrent training October 28, 1976. On November 24, 1976, she demonstrated her ability to remove the overwing exits and open the cockpit windows on the DC-9.

## APPENDIX C

## AIRCRAFT INFORMATION

Southern Airways, Inc., leased N1335U, serial No. 47393, on June 29, 1971, and operated it until the accident. The aircraft had been in service 15,405.6 hours.

N1335U was equipped with Pratt & Whitney model JT8D-7A engines. Pertinent information pertaining to the engines is as follows:

| | Left Engine | Right Engine |
|---|---|---|
| Serial No. | P-656922 | P-657686 |
| Date installed | May 28, 1976 | December 13, 1976 |
| Time since new (hours) | 18,555.6 | 12,942.3 |
| Cycles since new | 31,647 | 21,374 |
| Time since heavy maintenance | 2,336.2 | 878.7 |
| Cycles since heavy maintenance | 3,608 | 1,270 |

APPENDIX D

TRANSCRIPT OF A COLLINS 642 C-1 COCKPIT VOICE RECORDER
S/N 581, REMOVED FROM THE SOUTHERN AIRWAYS, INC. DOUGLAS DC-9
IN AN ACCIDENT AT NEW HOPE, GEORGIA, ON APRIL 4, 1977

## LEGEND

| | |
|---|---|
| CAM | Cockpit area microphone voice or sound source |
| RDO | Radio transmission from accident aircraft |
| -1 | Voice identified as Captain |
| -2 | Voice identified as First Officer |
| ST-A | Voice identified as Stewardess A (forward cabin) |
| ST-B | Voice identified as Stewardess B (rear cabin) |
| PA | Public address system in the aircraft |
| IC | Aircraft's intercom |
| HG | Huntsville Ground Control |
| HT | Huntsville Tower Control |
| CR | Company Radio |
| HD | Huntsville Departure Control |
| MC | Memphis Center |
| AC | Atlanta Center |
| AA | Atlanta Approach Cotnrol |
| UNK | UNK |
| * | Unintelligible word |
| # | Nonpertinent word |
| % | Break in continuity |
| ( ) | Questionable text |
| (( )) | Editorial insertion |
| --- | Pause |

**Note:** Times are expressed in Greenwich Mean Time (GMT).

INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| 2041:45 CAM-1 | Let's see, what did we put on here? |
| CAM-2 | You got one hundred sixteen in your window |
| CAM-1 | Yeh, I got it all set up --- one hundred sixteen |
| STUB | (Time out of the blocks) two forty-five |
| CAM-2 | Two forty-five |
| STUA | Is it going to he bad again from here to Atlanta? |
| CAM-1 | Maam? |
| CAM-2 | Eighteen fifty-three |
| STUA | What is it going to he like from here to Atlanta? |
| CAM-2 | Twenty twelve |
| CAM-1 | Just like it was coming up here * * |
| CAM-2 | One oh seven |
| STUA | Going to have to keep ourselves in our chairs, huh? |
| CAM-1 | Depends on how many people you got, we only have about ten miles, ten minutes level |

AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2041:53 RDO-2 | Southern two forty two, IFR to Atlanta |

| TIME & SOURCE | CONTENTS | TIME & SOURCE | CONTENTS |
|---|---|---|---|
| STUB | ((Greeting passengers in cabin)) | | |
| SNA | Do you need anything? | | |
| CAM-2 | Yeah I want a good uh * well done * * | | |
| SNA | Tell you later really | | |
| CAM-2 | Well done | | |
| STU-? | Where do you live at | | |
| CAM-2 | (La Place) | | |
| STU-? | Where is that, oh, you go to the right --- | | |
| CAM-2 | Yeah I go to the right | | |
| STU-? | I think Cathy will give me a ride, I didn't realize I was late for a minute | | |
| SN-? | I was so lucky to even be here | | |
| STU-? | La Place? | | |
| CAM-2 | The Place | | |
| CAM-? | * * * | | |
| STU-? | * * just spent eighteen dollars to get my hair done just waiting for the time being | | |
| CAM-1 | You ought to be proud you got some hair, I don't have any hair | | |
| STU-? | * * | | |
| CAM-1 | I don't care what color it is, just so I get some hair | | |

INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| STU-? | Really |
| CAM-1 | Do we change airplanes going * * * |
| STU-? | Sure, you don't think * * are you, we're going to make this trip as difficult as possible |
| CAM-2 | God, we're in and out of Atlanta three times in one day and we change airplanes three times in one day |
| CAM-1 | Yep |
| CAM-2 | * * * |
| STU-? | * * open for suggestions, what day will have your car next week |
| STU-? | I don't know, I dont't know if I'll be able to go next week |
| CAM | ((Continuing small talk between STU A and B and CAM-1 and CAM-2 |
| CAM-2 | Yeah, okay, our battery's on * * |
| STU-? | ((Pretaxi safety instructions to passengers on intercom)) |
| CAM | ((Continuing crew small talk)) |

AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|

| INTRA-COCKPIT | | AIR-GROUND COMMUNICATIONS | |
|---|---|---|---|
| TIME & SOURCE | CONTENTS | TIME & SOURCE | CONTENTS |
| CAM | ((Sound of paper rustling)) | | |
| CAM-2 | Thank you sir, see you later | | |
| | ((Agent on the ground "see you)) | | |
| CAM-2 | Here Bill, Atlanta is twenty-seven hundred broken, five thousand broken, twenty five overcast and fifteen, and gusts, and the winds are thirty-one miles an hour peaks are forty-seven | | |
| CAM-2 | Who's got the landing? | | |
| CAM-1 | Not me says the captain | | |
| CAM-2 | Ignition sir | | |
| CAM-? | Guess we got to * * button up (* * door) | | |
| CAM-1 | It's starting to rain here now | | |
| CAM-2 | Quit raining (when we left) | | |
| CAM-1 | Eighty-one folk | | |
| CAM | ((Crew small talk)) | | |
| CAM-? | * * degrees | | |

**INTRA-COCKPIT**

| TIME & SOURCE | CONTENTS |
|---|---|
| CAM-? | * * * |
| CAM-1 | * * four minutes late * * --- |
| GNDCRW | Cockpit, ground |
| CAM-1 | Yes |
| CAM-2 | Ignition set |
| GNDCRW | Prepare to start number two |
| GNDCRW | I'm going to be off the headset here a minute, I'm going to shut that (bin) door |
| GNDCRW | Okay, clear on one |
| CAM-2 | (Here we go) |
| CAM-2 | Looks like you guys got a good one coming |
| GNDCRW | Have a good one |
| CAM-1 | Two good ones |
| CAM-2 | Two good starts |
| GNDCRW | Roger, I hold your hand signal |
| CAM-2 | Okay |

**AIR-GROUND COMMUNICATIONS**

| TIME 6 SOURCE | CONTENTS |
|---|---|
| PA | ((Stewardess announces twenty-eight minutes en route to Atlanta and Federal Regulations |

| INTRA-COCKPIT | | AIR-GROUND COMMUNICATIONS | |
|---|---|---|---|
| TIME & SOURCE | CONTENTS | TIME & SOURCE | CONTENTS |
| CAM-? | Pretaxi checklist | | |
| STU-? | If there's anything we can, as long as we can do it from our seats | | |
| 2050:25 CAM | ((Sound of windshield wipers)) | | |
| CAM-2 | Set your horizon | | |
| CAM-1 | (Set) your horizon when we're through the weather | | |
| | | 2050:33 RDO-2 | Two nine five zero |
| CAM-? | * * * | | |
| CAM-2 | Flaps Bill | | |
| CAM-? | * * * | | |
| SN-? | Yeah, I see that weather playing around there, yeah | | |
| CAM-2 | Flight controls, circuit breaker, flaps thirty degress one ninety-five, a hundred radar, you got that, radios are on | | |
| CAM-1 | There's thirty sir, he goes to (Detroit) out of New Orleans | | |
| CAM-1 | Now that I think of it, * * flying it three weeks ago direct Huntsville, up to (Nashville) Detroit | | |

| INTRA-COCKPIT TIME & SOURCE | CONTENTS | AIR-GROUND COMMUNICATIONS TIME & SOURCE | CONTENTS |
|---|---|---|---|
| CAM-2 | That's just like flying on the big airlines | | |
| CAM-? | ((Sound of whistling)) | | |
| CAM-1 | I got to call ole Steve Banks and tell him I want to give up my early morning trip Wednesday | | |
| | | 2052:11 RDO-2 | Huntsville, two forty two, times are forty, forty two, fifty one, and fifty-four |
| CAM-2 | (Skids) Bill | | |
| CAM-1 | On | | |
| CAM-2 | Ignition | | |
| CAM-1 | * * | | |
| CAM-2 | Panels checked (counters) on, five thousand | | |
| CAM-1 | Five thousand | | |
| CAM-1 | Five thousand? | | |
| CAM-2 | Yeah we • * ((blocked out by ATC)) | | |
| CAM-1 | Twenty-five six * * | | |

INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
| --- | --- |
| CAM-2 | Twenty-five six |
| CAM-2 | * in |
| CAM-1 | * * |
| CAM-2 | * * |
| CAM-1 | * * |
| 2053:45 CAM | ((Takeoff power is set)) |

AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
| --- | --- |
| 2052:42 AT | Two forty-two, Huntsville tower, cleared for takeoff |

## AIR-GROUND COMMUNICATIONS

| TIME h SOURCE | CONTENTS |
|---|---|
| 2041:53 RDO-2 | Southern two forty two IFR to Atlanta |
| 2041:58 HG | Two forty two cleared as filed, maintain five thousand, expect further clearance to one seven thousand within one zero minutes after departure, fly runway heading, departure frequency will he one two five point six - squawk zero three zero zero |
| 2042:11 RDO-2 | Atlanta as filed, maintain five and seventeen in ten, runway heading twenty six zero three hundred one two forty two good day |
| 2042:18 HG | Two forty two that's correct |
| 2050:22 RDO-2 | Southern two forty two on the taxi |
| 2050:25 HG | Two forty two, taxi runway one eight right, wind two six zero at one two, altimeter two nine five zero |
| 2050:33 RDO-2 | Two nine five zero |
| 2052:11 RDO-2 | Huntsville, two forty two, times are forty, forty two, fifty one, and fifty four |

## INTRA-COCKPIT

| TIME h SOURCE | CONTENTS |
|---|---|

## AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2052:23 CR | Understand, forty, forty two, fifty one, fifty three |
| 2052:27 RDO-2 | No, fifty four was that very last one |
| 2052:31 CR | Fifty four, roger |
| 2052:42 HT | Two forty two, Huntsville tower cleared for takeoff |
| 2052:45 RDO-2 | Two forty two, cleared for takeoff |

## INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| CAM | ((Sound of windshield wipers during the following period |
| 2053:37 CAM-1 | Spooled and stable |
| 2053:38 CAM-2 | Rog |
| 2053:45 CAM-1 | Takeoff power is set |
| 2053:54 CAM-1 | Got eighty, looking for twenty one twenty seven |
| CAM-2 | * * twenty seven |

**AIR-GROUND COMMUNICATIONS**

| TIME & SOURCE | CONTENTS |
|---|---|
| 2054:22 HT | Two forty two, contact departure good day |
| 2054:25 RDO-1 | Good day, now |
| 2054:35 RDO-1 | Departure, Southern two forty two, runway heading |

**INTRA-COCKPIT**

| TIME & SOURCE | CONTENTS |
|---|---|
| 2054:04 CAM-1 | One rotate |
| CAM | ((Sound of vibration)) |
| CAM-? | * * |
| 2054:10 CAM-1 | Positive rate |
| CAM-2 | Gear up |
| CAM | ((Sound of trim)) |
| 2054:18 CAM-2 | It's out of round, that is what it is |
| CAM-1 | * that takeoff I made in Atlanta |
| CAM-2 | Gee thanks |
| CAM | ((Sound of windshield wiper stopping)) |
| CAM | ((Sound of trim)) |
| CAM | ((Sound of trim)) |

| AIR-GROUND COMMUNICATIONS TIME & SOURCE | CONTENTS | INTRA-COCKPIT TIME & SOURCE | CONTENTS |
|---|---|---|---|
| 2054:39 HD | Southern two forty two, Huntsville radar contact, uh, turn left heading one two zero, vector around restricted area, climb and maintain one seven thousand | | |
| 2054:38 RDO-1 | Okay, one seven thousand heading turn left to one two zero | | |
| 2054:51 RDO | ((Click of mike)) | CAM | ((Click of mike acknowledgement)) |
| | | CAM-2 | Flaps up Bill |
| | | CAM | ((Clicking noise, trim noise)) |
| | | 2055:05 CAM-2 | Slats up, climb check |
| | | CAM | ((Trim noise)) |
| | | CAM | ((Trim noise)) |
| 2055:14 HD | Southern two forty two is clear restricted area, continue left turn resume own navigation direct to Rome | | |
| 2055:21 RDO-1 | Okay, direct Rome, two forty two | | |

AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2056:00 HD | Southern two forty two, I'm painting a line of weather which appears to be moderate to uh, possibly heavy precipitation starting about uh, five miles ahead and it's * • |
| 2055:14 RDO-1 | Okay, uh, we're in the rain right now. uh - it doesn't look much heavier than what we're in, does it? |
| 2056:22 HD | Uh it's painting - I got weather cutting devices on which is cutting out the, uh, precip that you're in now, this, uh, showing up on radar, however it doesn't - it's not a solid mass it, uh, appears to be a little bit heavier than what you're in right now |

INTRA-COCKPIT

| TIME 6 SOURCE | CONTENTS |
|---|---|
| 2055:31 CAM-1 | I don't know what direction Rome is |
| 2055:34 CAM-2 | About one hundred and ten * |
| CAM | ((Trim noise)) |
| CAM-1 | ((Sound of sneeze)) Excuse me ... |
| CAM-2 | Bless you |
| 2055:58 CAM-1 | Well, the radar is full of it, take your pick |

APPENDIX w

| AIR-GROUND COMMUNICATIONS | | INTRA-COCKPIT | |
|---|---|---|---|
| TIME 6 SOURCE | CONTENTS | TIME & SOURCE | CONTENTS |
| 2056:35 RDO | ((Sound of click)) | | |
| | | 2056:37 CAM-2 | I can't read that, it just looks like rain Bill, what do you think? There's a hole |
| | | 2056:40 CAM-1 | There's a hole right here ((simultaneous with "There's a hole" above |
| | | CAM-1 | That's all I see |
| | | CAY | ((Trim noise)) |
| | | 2056:43 CAM-1 | Then coming over we had pretty good radar |
| | | 2056:48 CAM-1 | I believe right straight ahead, uh, there the next few miies is about the best way we can go |
| | | 2057:04 CAM-1 | Rome's fifteen twenty |
| | | CAM-2 | Yeah |
| 2057:06 HD | Southern two forty two squawk five six two three | | |

| AIR-GROUND COMMUNICATIONS | | INTRA-COCKPIT | |
|---|---|---|---|
| TIME 6 SOURCE | CONTENTS | TIME & SOURCE | CONTENTS |
| | | 2057:06 CAM-2 | You can go ahead and put yours on Atlanta now if you like, cause I've already got mine on * |
| 2057:15 mo-1 | Two forty two, roger | | |
| | | 2057:34 CAM-1 | If it gets rough how about hand flying |
| 2057:36 HD | Southern two forty two you're in what appears to be about the heaviest part of it now what are your flight conditions? | | |
| 2057:42 RDO-1 | Uh, we're getting a little light turbulence now and uh, I'd say moderate rain | | |
| 2057:47 HD | Okay, and uh, what I'm painting, it won't get any worse than that and uh, contact Memphis Center on one two zero point eight | | |
| 2057:55 RDO-1 | Twenty point eight good day now and thank you much | | |
| 2057:58 RDO | ((Sound of garbled acknowledgement)) | | |

APPENDIX D

## AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2058:10 RDO-1 | Memphis Center, Southern uh, two forty two is with you climbing to one seven thousand |
| 2058:16 MC | Southern two forty two Memphis Center, roger |
| 2058:26 MC | Attention all aircraft, SIGMET, hazardous weather vicinity Tennessee, southeastern Louisiana, Mississippi, northern and western Alabama and adjacent coastal waters, monitor VOR broadcast within a hundred fifty miles radius of the SIGMET area |
| 2058:45 MC | Southern two forty two, contact Atlanta Center one three four point zero five |
| 2058:50 RDO-1 | Thirty four zero five two forty two good day |

## INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| 2058:22 CAM-1 | As long as it doesn't get any heavier, we'll he all right |
| CAM-2 | Yeah, this is good |
| CAM-1 | Oh # |
| 2058:41 CAM-1 | Southeast Louisiana |
| 2048:44 CAM-1 | Out of ten |

AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2058:54<br>MC | Good day |
| 2059:06<br>RDO-1 | Atlanta Center, Southern two forty two we're out of eleven for seventeen |
| 2059:11<br>AC | Southern two forty two, Atlanta Center roger, expect Rome runway two six profile descent |
| 2059:16<br>RDO-1 | Expect Rome two six |
| 2059:19<br>AC | TWA four eighty five expect Rome runway two six profile descent |
| 2059:24<br>TWA548 | Was that five eighty four? - |
| 2059:26<br>AC | (It was) |
| 2059:30<br>AC | Five eighty four, let me know where you're proceeding direct Rome |
| 2059:33<br>TWA584 | Okay, we're heading one sixty five now, it'll be a little while later before we can go Rome |

INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| 2059:00<br>CAM-1 | Here we go * hold 'em cowboy |

| AIR-GROUND COMMUNICATIONS | | INTRA-COCKPIT | |
|---|---|---|---|
| TIME & SOURCE | CONTENTS | TIME & SOURCE | CONTENTS |
| | | 2059:37 AC | ((Sound of mike key acknowledgement)) |
| 2059:46 SCAT 16 | Southern Jax, this is Scat one six | | |
| 2059:59 2100:00 RDO | ((Two unidentifiable noises on radio channel)) | | |
| 2100:06 (SCAT 16) | Be there in ten minutes, need a fuel truck | | |
| | | 2100:21 CAM-2 | I can handle this all the way over * |
| | | 2100:30 CAM | ((Sound of rain)) |
| 2100:51 RDO-? | Three forty two Birmingham | | |
| 2100:54 342 | Yeah, three forty two go ahead | CAM-2 | One thirty three in your window uh partner |
| | | CAM-1 | Thirty three |
| 2100:55 RDO-? | Can you just, uh. let the passengers stay on for right now? | | |
| 2101:00 342 | Yeah. it looks good for that. that's a pretty good little shower moving across the field right now | | |

**AIR-GROUND COMMUNICATIONS** | **INTRA-COCKPIT**

| TIME & SOURCE | CONTENTS | TIME & SOURCE | CONTENTS |
|---|---|---|---|
| 2101:04 TWA584 | Uh, Center, TWA's five eighty four this - this is really not too good a corridor we're coming through here, it's too narrow between your limit and this line, uh, we're getting moderate uh, heavy moderate turbulence and quite a bit of precip in here | | |
| 2101:26 AC | Five eighty four, roger, it looks like uh, right now another fifteen miles to the south you should through the uh, southeastern edge of what I'm sharing and, uh, maybe, a little better | | |
| 2101:38 TWA584 | Okay, it's good to have hope anyway | | |
| 2101:40 AC | Looks like you might have vent through a little one right over there and uh, you ought to be out of it now, though | | |
| 2101:48 TWA584 | Yeah, ve were painting a little one, but, uh, you knov, you wouldn't let us go any further so we're sort of in a box | | |
| 2101:55 AC | You have another airplane on over there to your left hand side too, really couldn't go any other way | | |

| AIR-GROUND COMMUNICATIONS<br>TIME & SOURCE | CONTENTS | INTRA-COCKPIT<br>TIME & SOURCE | CONTENTS |
|---|---|---|---|
| 2102:01<br>TWA584 | Yeah I know, it's just too narrow through here | | |
| 2102:03<br>AC | He'd be a lot harder than the cloud though | | |
| 2102:31<br>DAL657 | Atlanta, Delta six fifty one, uh, two eight for two seven zero | | |
| 2102:35<br>AC | Six fifty one, Atlanta Center, roger | | |
| | | 2102:57<br>CAM-1 | I think we'd better slow it up right here in this uh, # |
| | | 2103:02<br>CAM-2 | Got ya covered |
| 2103:03<br>AC | Southern two forty two, contact Atlanta Center one two one point three five | | |
| 2103:07<br>RDO-1 | Twenty one thirty five good day | | |
| | | 2103:09<br>CAM | ((Sound of click)) |
| | | 2103:14<br>CAM | ((Sound of light rain)) |
| | | 2103:15<br>2103:17<br>CAM | ((Two short garbled transmissions)) |

INTRA-COCKPIT

| TIME & SOURCE | CO |
|---|---|
| 2103:20 RDO-1 | Atlanta, Southern two forty two with you level seventeen |
| 2103:24 AC | Southern two forty two Atlanta, roger altimeter two niner five six |
| 2103:29 RDO-1 | Roger two nine five six |
| 2103:30 AC | Eastern six eighty three, Atlanta altimeter two niner five six if I didn't give it to you |
| 2103:35 EAL683 | Okay six eighty three |

AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENT |
|---|---|
| 2103:48 CAM-1 | Looks heavy, nothing's going through that |
| 2103:54 CAM-1 | See that |
| 2103:56 CAM-2 | That's a hole isn't it? |
| 2103:57 CAM-1 | It's not sh ing a hole see it? |

| INTRA-COCKPIT TIME & SOURCE | CONTENT | AIR-GROUND COMMUNICATIONS TIME & SOURCE | CONTENT |
|---|---|---|---|
| 2104:01 EAL683 | Uh, six eighty three's in the clear over here, expect it looks sort of dark there | | |
| | | 2104:05 CAM | ((Sound of [illegible])) |
| | | 2104:06 CAM-2 | #! |
| | | 2104:08 CAM-2 | Do you want to go around right now? |
| 2104:09 AC | * * ((ATC to Eastern 683 garbled transmission - frequency change)) | | |
| 2104:18 EAL683 | Eastern six eighty three, good day | | |
| | | 2104:19 CAM-1 | Hand fly at about two eighty five knots |
| | | CAM-2 | Two eight five |
| 2104:20 AC | Thank you much | | |
| RD | ((Sound of static on radio channel)) | | |
| | | 2104:30 CAM | ((Sound of hail and rain)) |
| 2104:[illegible] TWA5[illegible] | Atlanta, TWA five eighty four, one nine zero | | |

| AIR-GROUND COMMUNICATIONS | | INTRA-COCKPIT | |
|---|---|---|---|
| TIME & SOURCE | CONTENTS | TIME & SOURCE | CONTENTS |
| 2104:46 AC | Atlanta, roger | | |
| 2104:50 RDO-1 | Southern two forty two, we're slowing it up here a little bit | | |
| 2104:53 AC | Two forty two, roger | | |
| 2105:03 AC | TWA five eighty four, would you like to go on and descend? | | |
| 2105:06 TWA584 | Yes sir we would - five eighty four | | |
| 2105:45 TWA584 | TWA five eighty four will take that lower altitude whenever you're ready | | |
| 2105:49 AC | TWA five eighty four, roger, descend and maintain one four thousand cross the forty mile fix north of Atlanta VOR at one four thousand, the altimeter Atlanta two niner five six, twenty nine fifty six | | |
| | | 2105:53 CAM-2 | Which way do we go cross here or go out --- I don't know how we get through there, Bill |

## AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2105:59 TWA584 | Fourteen thousand two niner five six cross the fix northeast of, uh, north-west of Atlanta, and uh, one four thousand and say again the fix |
| 2106:06 AC | Dallas intersection on the Rome arrival |
| 2106:09 TWA584 | Okay, Dallas at fourteen, five eighty four |
| 2106:18 AC | TWA five eighty four let me turn - know when you turn toward Rome |
| 2106:20 TWA584 | Five eighty four roger, looks like about --- that's about it for now, we're headed uh, to intercept, uh, the Atlanta three thirteen, that's about the best we can do for awhile |

## INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| CAM-1 | I know you're just gonna have to go out.* * |
| CAM-2 | Yeah, right across that band |
| 2106:01 CAM-1 | All clear left approximately right now, I think we can cut across there now |
| 2106:12 CAM-2 | All right, here we go |
| 2106:25 CAM-2 | We're picking up some ice, Bill |
| 2106:29 CAM-1 | We are above ten degrees |
| CAM-2 | Right at ten |

| AIR-GROUND COMMUNICATIONS TIME & SOURCE | CONTENTS | INTRA-COCKPIT TIME & SOURCE | CONTENTS |
|---|---|---|---|
| | | CAM-1 | Yeah |
| 2106:30 AC | I show the weather up northwest of that position north of Rome, just on the edge of it, I tell you what, maintain one five thousand | CAM | ((Sound of two clicks)) |
| 2106:38 TWA584 | Maintain one five thousand, we paint pretty good veather one or two o'clock | | |
| | | 2106:41 CAM-2 | He's got to be right througt that hole about now |
| 2106:42 AC | Southern two forty two descend and maintain one four thousand at this time | | |
| | | 2106:46 CAM-1 | Who's that? |
| 2106:48 AC | Southern two forty two, descend and maintain one four thosuand | CAM-2 | TWA |
| 2106:53 RDO-1 | Two forty tvo down to fourteen | | |
| 2106:55 AC | Affirmative | CAM | ((Heavy hail or rain sound starts and continues until power interruption)) |
| 2107:00 AC | Southern two forty two Atlanta altimeter two niner five six and cross forty miles northwest of Atlanta two five zero knots | CAM | ((Sound similar to electrical disturbance)) |

| AIR-GROUND COMMUNICATIONS | | INTRA-COCKPIT | |
|---|---|---|---|
| TIME & SOURCE | CONTENTS | TIME & SOURCE | CONTENTS |
| 2107:21 AC | TWA five eighty four what's your speed? | | |
| | | 2107:22 PA/ST-B | Keep your seatbelts on and securely fastened, there's nothing to be alarmed about, relax we should be out of it shortly |
| 2107:24 TWA584 | We're doing about two seventy five right now | | |
| 2107:26 AC | Roger, you can reduce to two five zero, if unable. advise | | |
| 2107:29 TWA584 | We can, that's okay, back to two fifty | | |
| 2107:31 AC | Southern two forty two, what's your speed now? | CAM | ((Sound similar to electrical disturbance)) |
| 2107:39 AC | Southern two forty two Atlanta, what's your speed? | | |
| 2107:49 AC | TWA five eighty four uh, descend and maintain one four thousand | | |
| 2107:53 TWA584 | Okay, one four thousand, five eighty four | | |
| 2107:55 AC | Yes, expedite to one four please | | |

| AIR-GROUND COMMUNICATIONS | | INTRA-COCKPIT | |
|---|---|---|---|
| TIME 6 SOURCE | CONTENTS | TIME 6 SOURCE | CONTENTS |
| | | 2107:57 CAM | ((Power interruption for 36 seconds)) |
| | | 2108:33 CAM | ((Power restored)) |
| | | CAM | ((Sound of rain continues for 40 seconds)) |
| 2108:34 AC | Southern two forty two Atlanta | | |
| | | 2108:37 CAM-2 | Got it, got it back Bill, got it back, got it back |
| | | 2108:38 PA/ST-B | * * check to see that all carry-on baggage is stowed completely underneath the seat in front of you, all carry-on baggage * * put all carry-on baggage underneath the seat in front of you, in the unlikely event that there is a need for an emergency landing ve do ask that you please grab your ankles, I will scream from the rear of the aircraft, there is nothing to be alarmed but ve have lost temporary APU power at times, so in the event there is any unlikely need for an emergency you do hear us holler, please grab your ankles, thank you for your cooperation and just relax, these are precautionary measures only |

APPENDIX D

| INTRA-COCKPIT | | AIR-GROUND COMMUNICATIONS | |
|---|---|---|---|
| TIME & SOURCE | CONTENT | TIME & SOURCE | CONTENT |
| 2108:42 RDO-1 | uh, two forty two, stand by | | |
| 2108:46 AC | Say again | | |
| 2108:48 RDO-1 | Stand by | | |
| 2108:49 AC | Roger, maintain one five thousand if you understand me, maintain one five thousand, Southern two forty two | | |
| 2108:55 RDO-1 | We're trying to get it up there | | |
| 2108:57 AC | Roger | | |
| 2108:59 TWA584 | TUA five eighty four's in the clear for avhile | | |
| 2109:05 AC | Uh, TWA five eighty four report out of one five thousand | | |
| 2109:09 TWA584 | We're out of fifteen in the clear | | |
| 2109:11 RDO | ((Mike keyed)) | | |

| INTRA-COCKPIT | | AIR-GROUND COWNICATIONS | |
|---|---|---|---|
| **TIME 6 SOURCE** | **CONTENT** | **TIME & SOURCE** | **CONTENT** |
| 2109:15 RDO-1 | Okay, uh, two forty two uh, we just got our windshield busted and uh, we'll try to get it back up to fifteen, we're fourteen | | |
| | | 2109:24 CAM-2 | Fifteen thousand |
| 2109:25 AC | Southern two forty two you say you're at fourteen now? | | |
| 2109:27 Rw-1 | Yea - uh - couldn't help it | | |
| 2109:30 AC | That's okay, uh, are you squawking five six two three? | | |
| | | 2109:36 CAM-2 | Left engine won't spool |
| 2109:37 RDO-1 | Our left engine just cut Out | | |
| 2109:42 AC | Southern two forty two roger, and uh lost your transponder squawk five six two three | | |
| | | 2109:43 CAM-2 | I am squawkinn five six two three, tell him I'm level fourteen |
| 2109:49 RDO-1 | Five six two three, we're squawking | | |
| 2109:53 AC | Say you lost an engine and uh busted a windshield? | | |

## AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2109:56 RDO-1 | Yes sir |
| 2110:00 AC | Southern two forty two, you can descend and maintain one three thousand now, that'll get you down a little lower |
| 2110:05 RDO-1 | Got the other engine going too |
| 2110:08 AC | Southern two forty two, say again |
| 2110:10 RDO-1 | Stand by - we lost both engines |
| 2110:16 RDO-1 | Get us a vector to a clear area Atlanta |
| 2110:20 AC | Uh, continue present southeastern bound heading, TWA's off to your left about fourteen miles at fourteen thousand and says he's in the clear |

## INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| 2109:59 CAM-1 | Auto pilot's off |
| CAM-2 | I've got it, I'll hand fly it |
| 2110:02 IC | Sandy --- |
| 2110:04 CAM-2 | My #, the other engine's going to, # |
| 2110:14 CAM-'2 | All right Bill get us a vector to a clear area |

| AIR-GROUND COMMUNICATIONS TIME & SOURCE | CONTENTS | INTRA-COCKPIT TIME & SOURCE | CONTENTS |
|---|---|---|---|
| 2110:25 RDO-1 | Okay | | |
| 2110:27 RDO-1 | Want us to turn left? | | |
| 2110:30 AC | Southern two forty two, contact approach control one two six point nine and they'll try to get you straight into Dobbins | | |
| 2110:35 RDO-1 | One two - | | |
| | | 2110:36 CAM-2 | Give me - I'm familiar with Dobbins, tell them to give me a vector to Dobbins if they're clear |
| 2110:38 RDO-1 | Give me, uh, vector to Dobbins if they're clear | | |
| 2110:41 AC | Southern two forty two, one twenty six point nine, they'll give you a vector to Dobbins | | |
| 2110:45 RDO-1 | Twenty six nine. okay | | |
| RDO | ((Sound of click on radio channel)) | | |
| 2110:49 EAL683 | Eastern six eighty three | | |
| | | 2110:50 CAM-2 | Ignition override, it's gotta work by # - X |

## AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2110:52 AA | Learjet triple nine mike reduce speed to one seven zero knots |
| 2113:04 RDO-1 | Uh, Atlanta, you read Southern two forty two |
| 2113:08 AA | Southern two forty two Atlanta approach control uh. go ahead |
| 2113:11 RDO-1 | Uh, we've lost both engines - how about giving us a vector to the nearest place we're at seven thousand feet |
| 2113:17 AA 2113:18 | Southern two forty two roger, turn right heading one zero zero, will be vectors to Dobbins for a straight-in approach runway one one, altimeter two niner five two, your position is fifteen, correction twenty miles west of Dobbins at this time |
| 2113:31 RDO-1 | Okay, uh one forty heading and twenty miles |

## INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| 2110:56 CAM | ((Power interruption for 2 minutes and 4 seconds)) |
| 2113:00 CAM | ((Power restored)) |
| 2113:03 CAM-1 | There we go |
| 2113:03.5 CAM-2 | Get us a vector to Dobbins |
| 2113:17 PA/ST-B | Ladies and gentlemen, please check that your seatbelts are securely again across your pelvis area on your hips |
| CAM-2 | What's Dobbins weather, Bill? How far is it? How far is it? |

| AIR-GROUND COMMUNICATIONS TIME & SOURCE | CONTENTS | INTRA-COCKPIT TIME & SOURCE | CONTENTS |
|---|---|---|---|
| 2113:35 AA | Ah, make a heading of one two zero Southern two forty two, right turn to one two zero | | |
| 2113:40 RDO-1 | Okay, right turn to one two zero and, uh, you got us our squawk haven't you on emergency? | CAM-2 | Declare an emergency, Bill |
| 2113:45 AA | Uh, I'm not receiving it but radar contact your position is twenty miles west of Dobbins | | |
| 2113:50 RDO-1 | Okay | | |
| 2113:51 AA | Delta seven fifty nine, contact approach control one two seven point two five now | | |
| 2113:56 DAL759 | ((Sound of mike click)) | | |
| 2113:58 AA | Eastern six eighty three, contact approach control on one two seven point two five | | |
| 2114:02 EAL683 | Eastern six eighty three | | |
| | | 2114:03 CAM-2 | Get those engines (* --- ) |

**AIR-GROUND COMMUNICATIONS**

| TIME & SOURCE | CONTENTS |
|---|---|
| 2114:04 AA | Eastern one forty three reduce speed to one seven zero knots |
| 2114:07 EAL143 | Roger |
| 2114:09 AA | Eastern six eleven reduce speed to two one zero knots |
| 2114:12 RDO | * |
| 2114:14 AA | TWA five eighty four descend and maintain one one thousand, you can expect an ILS runway two six, and that altimeter two nine five two, localizer frequency one zero eight point seven |
| 2114:24 RDO-2 | All right, listen, we've lost both engines, and, uh, I can't, uh, tell you the implications of this uh, ve uh. only got two engines and how far is Dobbins now? |
| 2114:34 AA | Southern, uh, two forty two, uh, nineteen miles |
| 2114:40 RDO-1 | Okay, we're out of, uh, fifty eight hundred, two hundred knots |

**INTRA-COCKPIT**

| TIME 6 SOURCE | CONTENTS |
|---|---|
| 2114:44 CAM-2 | What's Out speed, let's see what's our weight Bill, get me a bug speed |

| AIR-GROUND COMMUNICATIONS TIME & SOURCE | CONTENTS | INTRA-COCKPIT TIME & SOURCE | CONTENTS |
|---|---|---|---|
| 2114:45 AA | Southern two forty two, do you have one engine running now? | | |
| | | 2114:47 CAM-2 | No |
| 2114:48 RDO-1 | Negative. no engines | | |
| 2114:50 AA | Roger | | |
| 2114:53 AA | Eastern one forty three fly heading one nine zero | | |
| 2114:56 EAL143 | Roger | | |
| | | 2114:59 CAM-1 | One twenty six |
| | | CAM-2 | One twenty six |
| | | CAM | ((sound of trim noise)) |
| | | 2115:04 CAM-1 | Just don't stall this thing out |
| | | CAM-2 | No I won't |
| | | CAM-I | Get your wing flaps |
| | | CAM | Sound of lever movememt |

| AIR-GROUND COWWUNICATIONS | | INTRA-COCKPIT | |
|---|---|---|---|
| TIME & SOURCE | CONTENTS | TIME & SOURCE | CONTENTS |
| | | 2115:11 CAM-2 | Got it, got hydraulics so we got |
| | | CAM-1 | We got hydraulics |
| 2115:13 AA | Eastern six eleven, reduce speed to one seven zero knots | | |
| 2115:17 EAL611 | Roger | 2115:17 CAM-2 | What's the Dobbins weather? |
| 2115:18 RDO-1 | What's your Dobbins weather? | | |
| 2115:22 AA | Stand by | | |
| | | 2115:25 CAM-2 | Get Dobbins on the approach plate |
| 2115:28 AA | TWA five eighty four reduce speed to one seven zero knots | | |
| 2115:32 TWA584 | One seventy, five eighty four | | |
| | | 2115:42 CAM-1 | I can't find Dobbins |
| | | CAM-1 | Tell me where's it at? Atlanta? |
| | | CAM-2 | Yes |
| 2115:46 AA | Southern two forty two Dobbins weather is two thousand scattered, estimated ceiling three thousand broken, seven thousand overcast, visibility seven miles | | |

**AIR-GROUND COMMUNICATIONS**

| TIME 6 SOURCE | CONTENTS |
|---|---|
| 2115:57 RDO-1 | Okay, we're down to forty six hundred nov |
| 2116:00 AA | Roger, and you're approximately uh, seventeen miles vest of Dobbins at this time |
| 2116:05 | I don't knov whether we can make that or not |
| 2116:07 AA | Roger |
| 2116:09 AA | Eastern one forty three, contact approach control one tvo seven point two five |
| 2116:13 EAL143 | Roger |
| 2116:15 AA | Eastern six eleven reduce speed to One seven zero knots |

**INTRA-COCKPIT**

| TIME & SOURCE | CONTENTS |
|---|---|
| 2115:59 CAM-2 | How far is it? How far is it? |
| 2116:02 CAM | ((Sound of vindshield wipers coming on)) |
| 2116:11 CAM-2 | Ah, ask him if there is anything between here and Dobbins? |
| CAM-1 | What? |
| CAM-2 | Ask him if there is anything between here and Dobbins |

## INTRA-COCKPIT

| TIME & SOURCE | CONTENT |
|---|---|
| 2116:18 EAL611 | We're doing it six eleven, what is h≤ a Martin or con - uh, nine? |
| 2116:22 AA | DC - nine |
| 2116:25 RDO-1 | Uh, is there any airport between our position and Dobbins, uh |

## AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENT |
|---|---|
| 2116:28 IC | ((Soun< of th<ee chimes)) |
| ST-A | Sa∩≤y |
| ST-B | Yω |
| ST-A | They would not talk to me --- when I looked in the whole front wind-shield is cracked |
| ST-A | Okaɟ so whac <o we Ɒo |
| ST-B | Ah, have they said anything |
| ST-A | Ah he screamed at me when I opened the door just sit down so I didn't ask him a thing, I don't know the results or anything, I'm sure we decompressed |
| ST-B | Ah xes we've losc ∃o engine --- |

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APPENDIX D

AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|

INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| ST-A | I thought so |
| ST-B | Okay Katty, have you briefed all your passengers in the front? |
| ST-A | Yes, I told them I checked the cockpit and help me take the door down |
| ST-B | Have you removed your shoes? |
| ST-A | No I haven't |
| ST-B | Take off your shoes, be sure to to stow them somewhere right down in the galley in a compartment in there with the napkins or something |
| ST-A | I got them behind the seat, so that's no good |
| ST-B | It might keep the seat down nw |
| ST-A | Okay |
| ST-B | Right down in one of those closets, I took off my socks so I'd have more ground pull with my toes, okay? |

## AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2116:29 AA | Southern two forty two uh. no sir, uh, closest airport is Dobbins |
| 2116:34 RDO-1 | I doubt we're going to make it, but we're trying everything to get some-thing started |
| 2116:38 AA | Roger, well there is Cartersville, you're approximately ten miles south of Cartersville, fifteen miles west of Dobbins |
| 2116:45 RDO-1 | Can you give us a vector to Cartersville? |
| 2116:47 AA | All right, turn left, heading of three six zero be directly, uh, direct vector to Cartersville |

## INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| ST-A | You'd have what? |
| ST-B | So I took off my socks so I wouldn't be sliding |
| ST-A | Yea |
| ST-B | Okay |
| ST-A | That's a good idea too |
| ST-B | Okay |
| ST-A | Thank you, bye bye |
| 2116:44 CAM-2 | We'll take a vector to that yes, we'll have to go there |

## AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2116:52 RDO-1 | Three six zero, roger |
| 2116:53 RDO-1 | What's the runway heading? |
| 2116:58 AA | Stand by |
| 2116:59 RDO-1 | And how long is it? |
| 2117:00 AA | Stand by |
| 2117:02 AA | Eastern one forty three, contact approach control one two seven point two five |
| 2117:17 AA | TWA five eighty four turn left heading one one zero |
| 2117:21 TWA584 | One hundred ten degrees five eighty four |

## INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| CAM-2 | what runways? what's the heading on the runway? |
| 2117:08 CAM-1 | Like we are, I'm picking out a clear field |
| 2117:12 CAM-2 | Bill, you've got to find me a highway |
| CAM-1 | Let's get the next clear open field |
| CAM-2 | No * ( --- ) |

## AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2117:25 AA | Eastern six eleven, uh, reduce speed to one seven zero knots and contact approach control one two seven point two five now |
| 2117:44 AA | Southern two forty two the runway configuration |
| 2117:55 AA | At Cartersville is uh, three six zero and running north and south and the elevation is seven hundred fifty six feet and, uh, trying to get the length of now - it's three thousand two hundred feet long |

## INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| 2117:35 CAM-1 | See a highway over - no cars |
| CAM-2 | Right there, is that straight? |
| 2117:39 CAM-1 | No |
| 2117:44 CAM-2 | We'll have to take it |
| 2117:58 CAM | ((Beep on gear horn)) |
| CAM | ((Gear horn steady for 4 seconds)) |

AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2118:02 RDO-1 | Uh, we're putting it on the highway we're down to nothing |

INTRA-COCKPIT

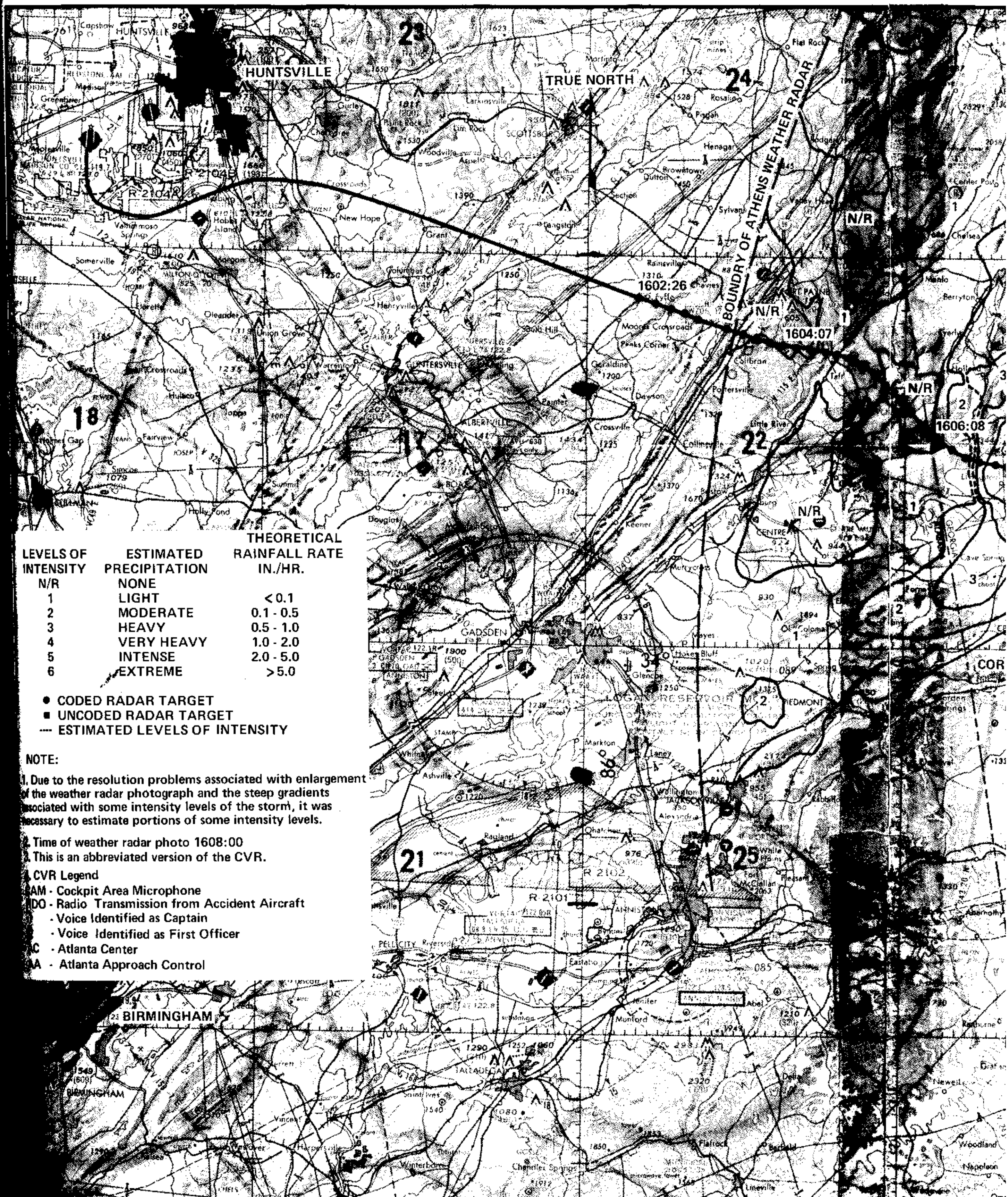
| TIME & SOURCE | CONTENTS |
|---|---|
| 2118:07 CAM-2 | Flaps |
| CAM-1 | There at fifty |
| CAM-2 | Oh # Bill, I hope we can do it |
| 2118:14 CAM-2 | I've got it, I got it |
| 2118:15 CAM-2 | I'm going to land right over that guy |
| 2118:20 CAM | * ( --- ) |
| CAM-1 | There's a car ahead |
| 2118:25 CAM-2 | I got it Bill, I've got it now, I got it |
| CAM-1 | Okay |
| 2118:30 CAM-1 | Don't stall it |
| CAM-2 | I gotta bug |
| 2118:31 CAM-2 | We're going to do it right here |

## AIR-GROUND COMMUNICATIONS

| TIME & SOURCE | CONTENTS |
|---|---|
| 2118:32 TWA584 | Eleven for five, five eighty four |
| 2118:43 | End of tape |

## INTRA-COCKPIT

| TIME & SOURCE | CONTENTS |
|---|---|
| 2118:33 *CAM-?* | ((Woman's voice)) Bend down and grab your ankles |
| 2118:34 CAM-2 | I got it |
| 2118:36 *CAM* | ((Sound of breakup)) |
| 2118:38 *CAM-?* | * (#) |
| 2118:39 CAM | ((More breakup sounds)) |
| 2118:43 | End of tape |

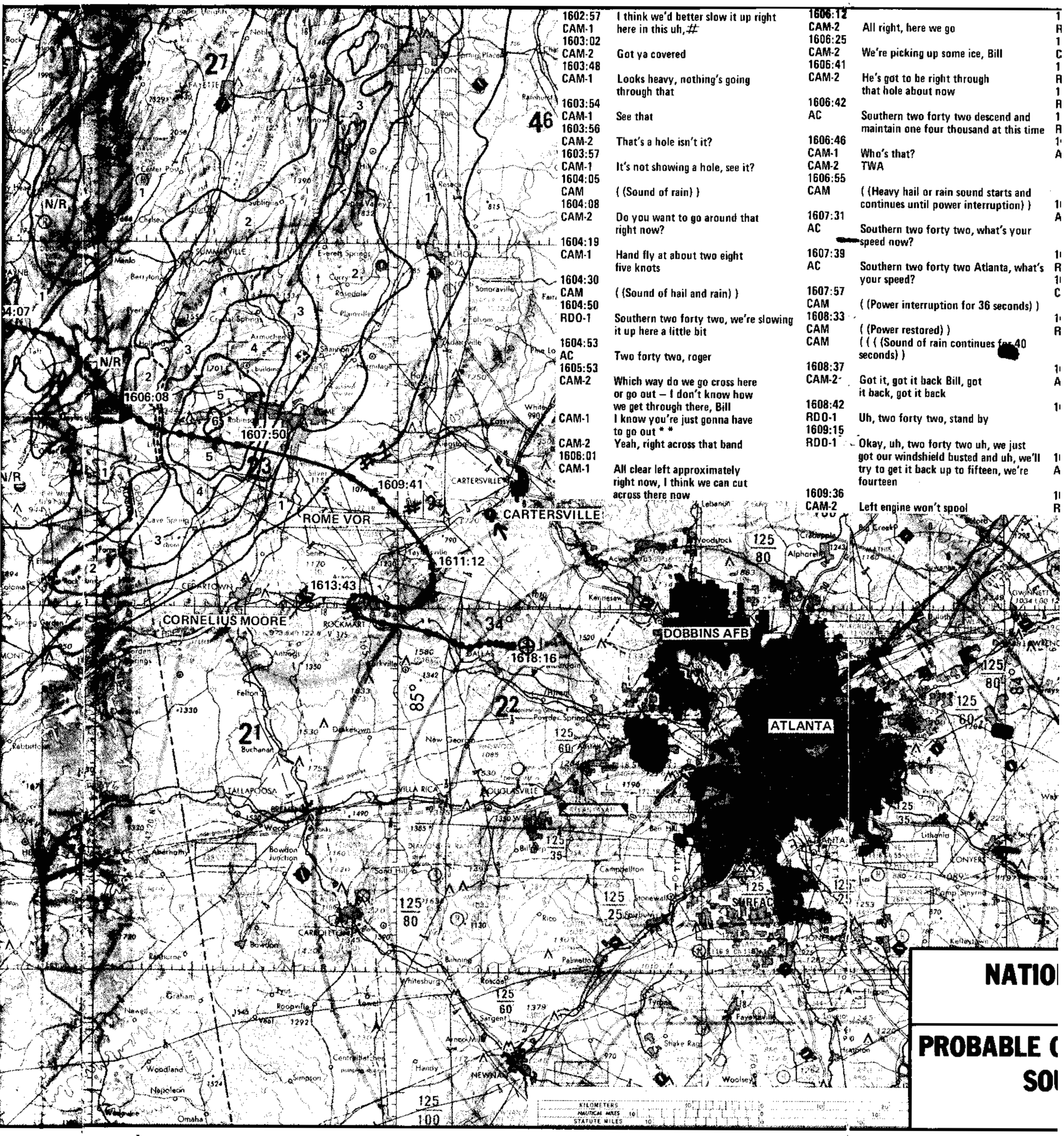


HUNTSVILLE
TRUE NORTH
BOUNDRY OF ATHENS WEATHER RADAR
1602:26
1604:07
1606:08
N/R
GUNTERSVILLE
ALBERTVILLE
GADSDEN
BIRMINGHAM
ANNISTON
TALLADEGA
PIEDMONT
CENTRE
SCOTTSBORO
LOGAN RESERVOIR
R 2101
R 2102
23
24
18
17
22
21
25

| LEVELS OF INTENSITY | ESTIMATED PRECIPITATION | THEORETICAL RAINFALL RATE IN./HR. |
|---|---|---|
| N/R | NONE | |
| 1 | LIGHT | <0.1 |
| 2 | MODERATE | 0.1 - 0.5 |
| 3 | HEAVY | 0.5 - 1.0 |
| 4 | VERY HEAVY | 1.0 - 2.0 |
| 5 | INTENSE | 2.0 - 5.0 |
| 6 | EXTREME | >5.0 |

● CODED RADAR TARGET
■ UNCODED RADAR TARGET
--- ESTIMATED LEVELS OF INTENSITY

NOTE:
1. Due to the resolution problems associated with enlargement of the weather radar photograph and the steep gradients associated with some intensity levels of the storm, it was necessary to estimate portions of some intensity levels.
2. Time of weather radar photo 1608:00
3. This is an abbreviated version of the CVR.
4. CVR Legend
CAM - Cockpit Area Microphone
RDO - Radio Transmission from Accident Aircraft
- Voice Identified as Captain
- Voice Identified as First Officer
AC - Atlanta Center
AA - Atlanta Approach Control




| | | |
|---|---|---|
| 1602:57 | CAM-1 | I think we'd better slow it up right here in this uh, # |
| 1603:02 | CAM-2 | Got ya covered |
| 1603:48 | CAM-1 | Looks heavy, nothing's going through that |
| 1603:54 | CAM-1 | See that |
| 1603:56 | CAM-2 | That's a hole isn't it? |
| 1603:57 | CAM-1 | It's not showing a hole, see it? |
| 1604:05 | CAM | ((Sound of rain)) |
| 1604:08 | CAM-2 | Do you want to go around that right now? |
| 1604:19 | CAM-1 | Hand fly at about two eight five knots |
| 1604:30 | CAM | ((Sound of hail and rain)) |
| 1604:50 | RDO-1 | Southern two forty two, we're slowing it up here a little bit |
| 1604:53 | AC | Two forty two, roger |
| 1605:53 | CAM-2 | Which way do we go cross here or go out – I don't know how we get through there, Bill |
| | CAM-1 | I know you're just gonna have to go out * * |
| | CAM-2 | Yeah, right across that band |
| 1606:01 | CAM-1 | All clear left approximately right now, I think we can cut across there now |
| 1606:12 | CAM-2 | All right, here we go |
| 1606:25 | CAM-2 | We're picking up some ice, Bill |
| 1606:41 | CAM-2 | He's got to be right through that hole about now |
| 1606:42 | AC | Southern two forty two descend and maintain one four thousand at this time |
| 1606:46 | CAM-1 | Who's that? |
| | CAM-2 | TWA |
| 1606:55 | CAM | ((Heavy hail or rain sound starts and continues until power interruption)) |
| 1607:31 | AC | Southern two forty two, what's your speed now? |
| 1607:39 | AC | Southern two forty two Atlanta, what's your speed? |
| 1607:57 | CAM | ((Power interruption for 36 seconds)) |
| 1608:33 | CAM | ((Power restored)) |
| | CAM | (((Sound of rain continues for 40 seconds)) |
| 1608:37 | CAM-2 | Got it, got it back Bill, got it back, got it back |
| 1608:42 | RDO-1 | Uh, two forty two, stand by |
| 1609:15 | RDO-1 | Okay, uh, two forty two uh, we just got our windshield busted and uh, we'll try to get it back up to fifteen, we're fourteen |
| 1609:36 | CAM-2 | Left engine won't spool |

# APPENDIX E

| | |
|---|---|
| | ink we'd better slow it up right in this uh, # |
| | ya covered |
| | ks heavy, nothing's going ugh that |
| | that |
| | t's a hole isn't it? |
| | not showing a hole, see it? |
| | ound of rain) ) |
| | you want to go around that t now? |
| | *nd fly at about two eight* knots |
| | ound of hail and rain) ) |
| | thern two forty two, we're slowing p here a little bit |
| | o forty two, roger |
| | ich way do we go cross here o out – I don't know how et through there, Bill ow you're just gonna have o out * * |
| | h, right across that band |
| | clear left approximately t now, I think we can cut ss there now |

| | | |
|---|---|---|
| 1606:12 | CAM-2 | All right, here we go |
| 1606:25 | CAM-2 | We're picking up some ice, Bill |
| 1606:41 | CAM-2 | *He's got to be right through that hole about now* |
| 1606:42 | AC | Southern two forty two descend and maintain one four thousand at this time |
| 1606:46 | CAM-1 | Who's that? |
| | CAM-2 | *TWA* |
| 1606:55 | CAM | ( (Heavy hail or rain sound starts and continues until power interruption) ) |
| 1607:31 | AC | Southern two forty two, what's your speed now? |
| 1607:39 | AC | Southern two forty two Atlanta, what's your speed? |
| 1607:57 | CAM | ( (Power interruption for 36 seconds) ) |
| 1608:33 | CAM | ( (Power restored) ) |
| | CAM | ( ( ( (Sound of rain continues for 40 seconds) ) |
| 1608:37 | CAM-2 | Got it, got it back Bill, got it back, got it back |
| 1608:42 | RDO-1 | Uh, two forty two, stand by |
| 1609:15 | RDO-1 | Okay, uh, two forty two uh, we just got our windshield busted and uh, we'll try to get it back up to fifteen, we're fourteen |
| 1609:36 | CAM-2 | Left engine won't spool |
| 1609:37 | RDO-1 | Our left engine just cut out |
| 1610:04 | CAM-2 | My #, the other engine's going to, # |
| 1610:05 | RDO-1 | Got the other engine going too |
| 1610:10 | RDO-1 | Stand by – we lost both engines |
| 1610:16 | RDO-1 | Get us a vector to a clear area Atlanta |
| 1610:20 | AC | Uh, continue present southeastern bound *heading, TWA's off to your left about* fourteen miles at fourteen thousand and say's he's in the clear |
| 1610:30 | AC | Southern two forty two, contact approach control one two six point nine and they'll try to get you straight into Dobbins |
| 1610:35 | RDO-1 | One two – |
| 1610:56 | CAM | ( (Power interruption for two minutes and four seconds) ) |
| 1613:11 | RDO-1 | Uh, we've lost both engines – how about giving us a vector to the nearest place we're at seven thousand feet |
| 1613:17 | AA | Southern two forty two roger, turn right heading one zero zero, will be vectors to Dobbins for a straight-in approach runway one one, altimeter two niner five two, your position is fifteen, correction twenty miles west of Dobbins at this time |
| 1613:18 | | |
| 1613:35 | AA | Ah, make a heading of one two zero Southern two forty two, right turn to one two zero |
| 1615:57 | RDO-1 | Okay, we're down to forty six hundred now |
| 1616:00 | AA | Roger, and you're approximately uh, seventeen miles west of Dobbins at this time |
| 1616:25 | RDO-1 | Uh, is there any airport between our position and Dobbins, uh |
| 1616:29 | AA | Southern two forty two uh, no sir, uh, closest airport is Dobbins |
| 1616:38 | AA | Roger, well there is Cartersville, you're approximately ten miles south *of Cartersville, fifteen miles west* of Dobbins |
| 1616:45 | RDO-1 | Can you give us a vector to Cartersville? |
| 1616:47 | AA | All right, turn left, heading of three six zero be directly, uh, direct vector *Cartersville* |
| 1617:35 | CAM-1 | See a highway over – no cars |
| | CAM-2 | Right there, is that straight? |
| 1617:39 | CAM-1 | No |
| 1617:44 | CAM-2 | We'll have to take it |
| 1617:55 | AA | At Cartersville is uh, three six zero and running north and south and the elevation is seven hundred fifty six feet and, uh, trying to get the length of now – it's three thousand two hundred feet long |
| 1617:58 | CAM | ( (Beep on gear horn) ) |
| | CAM | ( (Gear horn steady for four seconds) ) |
| 1618:31 | CAM-2 | We're going to do it right here |
| 1618:36 | CAM | ( (Sound of breakup) ) |


**NATIONAL TRANSPORTATION SAFETY BOARD**
**WASHINGTON, D.C.**

**PROBABLE GROUND TRACK AND WEATHER RADAR PLOT**
**SOUTHERN AIRWAYS, INC., FLIGHT 242**
**NEW HOPE, GEORGIA, APRIL 4, 1977**

# APPENDIX F

## SUMMARY OF PASSENGER AND FLIGHT ATTENDANT OBSERVATIONS

1/2

| SEAT LOCATION | SEAT INTEGRITY | CABIN INTEGRITY | FIRE | ESCAPE ROUTE | DIFFICULTIES | CLOTHING | INJURIES |
|---|---|---|---|---|---|---|---|
| 1-A | EJECTED WITH SEAT | BREAK IN FRONT OF SEAT | FIRE ALL AROUND AFTER EJECTION FROM AIRCRAFT | EFECTED FROM AIRCRAFT | LANDED WITH SEAT ON TOP OF HIM. | | ABRASIONS OF FACE. HEMATOMA. CONTUSION LEFT THIGH—ABDOMINAL CONTUSION WITH POSSIBLE INTERNAL INJURIES |
| 1-B | EJECTED | | | | | | SEVERE LACERATION OF SCALP, CEREBRAL CONCUSSION, FRACTURES RIGHT ARM, RIBS, LEG |
| 2-D | EJECTED | | | CRAWLED FROM WRECKAGE UNASSISTED | | | CONTUSIONS AND ABRASIONS OF FACE LOW BACK SPRAIN—COMPOUND DISLOCATED FRACTURE OF LEFT ANKLE TRAUMATIC AMPUTATION OF LEFT FOOT AND ANKLE |
| 4-E | EJECTED WITH SEAT? | | | UNCONSCIOUS—CARRIED OUT | | SYNTHETIC NECK TIE, WOOL JACKET, COTTON SHIRT | FRACTURE C-6, C-7-TRANSECTION SPINAL CORD—SEAT BELT ABRAISIONS |
| 9-C | SEAT AND SEAT BELT INTACT | BREAK—3 OR 4 FT. FORWARD | DURING IMPACT AIRCRAFT BURST INTO FLAMES, AFTER STOPPED, FIRE WAS ALL AROUND HIM | EXITED THROUGH FORWARD BREAK | SEATBELT HARD TO UNBUCKLE—SEATBELT WAS SAID TO BE "METAL TO FABRIC" TYPE | COTTON PANTS, POLYESTER SHIRT | 2ND DEGREE BURNS 40% BODY SURFACE |
| 9-E | SEAT AND SEAT BELT INTACT | BREAK—1 ROW FORWARD | FIRE AND SMOKE AFTER AIRCRAFT STOPPED | EGRESSED OVER ROW OF SEATS IN FRONT OF HIM | CLOTHING & PORTIONS OF SEATBELT ENTANGLED DURING IMPACT | MAN-MADE FIBERS | 2ND DEGREE BURNS HANDS (BILATERAL) MULTIPLE FRACTURES RIB, STERNUM-SHOCK |
| 10-A | SEAT AND SEAT BELT INTACT | CABIN BREAK—FRONT OF HIM | FIRE DURING IMPACT ON-FIRE AFTER STOPPED | IT IS BELIEVED PASSENGER WENT OUT FORWARD BREAK IN AIRCRAFT | PASSENGER WAS ON-FIRE WHEN HE EXITED AIRCRAFT | | 2ND DEGREE BURNS FACE, 35% BODY SURFACE, 3RD DEGREE BURNS 30% BODY SURFACE |
| 10-C | SEAT AND SEAT BELT INTACT | CABIN—BREAK FRONT OF HIM | FIRE DURING IMPACT | EXITED FORWARD—JUMPED ABOUT 10 FT. TO GROUND | NONE | DENIM JACKET AND TROUSERS | 2ND DEGREE BURNS 15% BODY SURFACE |
| 10-E | SEAT AND SEAT BELT INTACT | | FLAMES ALL AROUND HIM AFTER AIRCRAFT STOPPED | EXITED THROUGH FIRE | FIRE ALL ARONUD HIM | | 2ND DEGREE BURNS FACE, ARMS, HANDS. FRACTURED NOSE |
| 12-C | SEAT AND SEAT BELT INTACT | LEFT SIDE WAS INTACT | GROUND FIRE OUTSIDE OF AIRCRAFT—BURST OF FLAME FROM BEHIND DURING IMPACT | EXITED FORWARD AND TO THE RIGHT | HE AND PASSENGER IN SEAT 12-E OPENED WINDOW EXIT BUT CLOSED DUE TO FIRE | DENIM JACKET AND TROUSERS | 2ND DEGREE BURNS HEAD, FACE, LEFT THIGH, 2ND AND 3RD DEGREE BURNS HANDS (BILATERAL) |
| 12-E | SEAT AND SEAT BELT INTACT | FRONT SECTION OF AIRCRAFT WAS GONE | SAW FIRE INSIDE CABIN DURING IMPACT—FIRE AND SMOKE ALL AROUND AFTER AIRCRAFT STOPPED | EXITED FORWARD | TURNED AROUND IN SEAT, CAUSED DIFFICULTY IN UNBUCKLING SEATBELT. DEBRIS AND BODIES OBSTRUCTED EGRESS, SMOKE MADE BREATHING DIFFICULT (SEE BLOCK 12-C) | | 2ND AND 3RD DEGREE BURNS HEAD, FACE, CHEST, RIGHT LEG, SEAT BELT BURN |
| 13-C | SEAT AND SEAT BELT INTACT | FORWARD CABIN MISSING | SMOKE & FIRE EVERYWHERE AS CABIN BROKE APART ENTIRE LEFT WING SECTION ENGULFED IN FLAMES | EGRESSED FORWARD THROUGH BREAK | NONE | MAN-MADE FIBERS | 2ND DEGREE BURNS FACE, ARMS, HEAD, LEFT LEG, 3RD DEGREE BURNS LEFT HAND—FRACTURE 5TH TOE RIGHT FOOT CONTUSIONS TO ABDOMEN & LOWER SPINE |

APPENX
SUMMARY OF PASSENGERND LT ATTENDANT
OBSERVION

2/2

| SEAT LOCATION | SEAT INTEGRITY | CABIN INTEGRITY | FIRE | ESCAPE ROUTE | DIFFICULTIES | CLOG | RIES |
|---|---|---|---|---|---|---|---|
| 17-B | SEAT AND SEAT BELT INTACT | | FIRE IN CABIN DURING IMPACT | UPWIND TOWARD NOSE | SEAT AS ON TOP OF HIM AND HE HADOW SEAT OFF. DIFFICULTY REL SEAT BELT—HANDS WERE BUFE HE WAS ON FIRE. | | 2ND AND 3RD EE BURNS 70% BODY SURFACE |
| 18-B | SEAT AND SEAT BELT INTACT | BREAK AT TAIL | FIRE FORWARD OF ROW 18-LEFT SIDE DURING IMPACT. AFTER AIRCRAFT STOPPED, HEAVY SMOKE | WENT REARWARD THROUG BREAK AT TAIL | FLAE SMOKE MADE IT HARD TO UNE EAT BELT | PANTSHIRTDUBLE KNIT YESTCOAT LEATH | FRACTURES OF, LEFT SCAPULAR, LEFT FOOT, COSSION FRACTURE LUMBAR VERTEMULTIPLE LACERATIONS—IS FACE, LEFT HAND ARM, FEET |
| 18-C | EJECTED WITH SEAT SEAT BELT INTACT | | DURING IMPACT RIGHT ENGINE ON FIRE. AFTER EJECTION BURNING DEBRIS ALL ROUND HIM. | EJECTED | PASELANDED FACE DOWN WITH SEAP OF HIM. EXTREME DIFCIN UNFASTENING SEAT BELT. | WOOLCKEOOL SLACH | 2ND DEGREE BIFACE, LEG, FEET—BODY SURFACE |
| 18-D | EJECTED WITH SEAT SEAT BELT INTACT | | WHEN PLANE STOPPED FLAMING DEBRIS ALL OVER. EXPLOSION FOLLOWED SHORT TIME LATER. | EJECTED | PASELANDED FACE DOWN. HAD TO OUT OF SEATBELT | WOOLNTSENGTH COATNTH FIBEF BLOUS SC | 2ND DEGREE B 10% BODY SURFACE 3RD DEGREE B20% BODY SURFACE |
| 19-C | EJECTED WITHOUT SEAT | | FIRE BRIGHT AND INTENSE INSIDE CABIN TO HIS LEFT. | EJECTED | | U.S. AY UDRM M. OF CON POLYE | 2ND AND 3RD EE BURNS 20% BODY SURFACE, SUPIAL CUTS AND BRUISES SEAT BELT ABNS |
| 19-D | | | | | | | 2ND DEGREE B LEFT HAND—COMPRESSIONTURE LOWER CERVICAL, UPFIMBAR SPINE |
| 19-E | EJECTED WITH SEAT | | SAW FLASHES DURING IMPACT | EJECTED | HACOVE AN OBJECT FROM HER LAP | POLYER &TON UNIFC | 2ND DEGREE B, SCALP, NECK, FACE, LEFT ARM LOWTREMITIES MULTIPLE ABRASIONS, CSION SCALP |
| 20-B | SEAT AND SEAT BELT INTACT | | FORWARD LEFT SIDE OF CABIN BURST INTO FLAMES. FIRE ALL AROUND. | | | | 1ST AND 2ND EE BURNS, FACE AND HANDS |
| 20-C | SEAT AND SEAT BELT INTACT | BREAK AT TAIL | AFTER PLANE STOPPED FIRE EVERYWHERE. | EXITED AT LEFT REAR A TAIL SECTION | TRECUCTING EXIT TO LEFT. SEAT BELHTO UNBUCKLE (METAL HOT). DIF BREATHING DUE TO SMOKE. CLOHRE BURNING. | POLYER KPANTS, POLYER-CON SHI | 2ND AND 3RDREE BURNS OF HEAD, FACE, HANDS, IPLE RIB FRACTURES—LACERATION OHT EAR |
| FORWARD FLIGHT ATTENDANT (JUMP SEAT) | SEAT BELT INTACT. POSSIBLY LOOSE FROM BULKHEAD ATTACHMENT. | FUSELAGE BREAK AT GALLEY | "HOT" ELECTRICAL WIRES AT COCKPIT. | WENT UP THROUGH COCKPIT AREA— AND SLID DOWN SIDE OF FUSELAGE | WA"HNG" BY SEAT BELT AND HAD TO PWARD—FLOOR WAS SLIE | MAN-DE URM | ABRASIONS, CSIONS OF HANDS (BILATERAL) CAL SPRAIN |
| AFT FLIGHT ATTENDANT (JUMP SEAT) | SEAT AND SEAT BELT INTACT | BREAK AT TAIL | WALL OF FIRE IN FRONT OF HER. | THROUGH FIRE | | MAN-DE URM AN SMOC | CONTUSION ARASION OF LOWER BACK CERVICID LUMBAR SPRAIN |

APPENDIX G **AC NO:** 90-12B

**DATE:** 6/18/76

# DEPARTMENT OF TRANSPORTATION
## FEDERAL AYIATION ADMINISTRATION

**SUBJECT:** SEVERE WEATHER **AVOIDANCE**

. PURPOSE. This Advisory Circular (1) warns all pilots concerning flight in the vicinity of known or forecasted severe weather such as thunderstorm activity, severe turbulence and hail and (2) advises all pilots that air traffic control facilities (air route traffic control centers, control towers, approach control facilities, etc.), even though equipped with radar, might not always have the capability nor be in a position to provide assistance for circumnavigation of areas of severe weather.

. CANCELLATION. This Advisory Circular cancels and supercedes Advisory Circular 90-12A dated 21 February 1973.

. DISCUSSION. The need for exercising prudent judgment with regard to flight through areas of known or forecast severe weather is well recognized by experienced airmen. Flight through severe weather actiwity should be avoided if possible.

Present procedures provide for controllers assisting pilots, particularly when operating on IFR flight plans, in avoiding areas of known severe weather. It is important, however, that all parties concerned with aircraft flight operations be fully aware that there are, at times, limitations to an air traffic controller's capability to provide such assistance. There are several reasons for this. First, it should be recognized that the controller's primary responsibility is the provision of safe separation between aircraft. No additional services can be provided which will derogate performance of a controller's primary responsibility. Secondly, limitations of ATC radar equipment, communications congestion, other air traffic, etc., may also reduce the controller's capability to provide any additional services.

To a large degree, the assistance that might be rendered by ATC will depend upon the weather information available to controllers or the request by pilots desiring to avoid severe weather areas. Due to the

Initiated by: AAT-23

extremely transitory nature of severe weather situations, information available to controllers might be of only limited value unless frequently updated by pilot reports or radar weather information. In-flight reports from pilots in direct communications with controllers giving specific information as to area affected, altitudes, intensity and nature of severe weather can be of considerable value. Such reports, when received by controllers, should be relayed to other aircraft as appropriate.

Should a pilot desire to avoid a severe weather situation along his route, he should request such deviation from routelaltitude as far in advance as possible, including information as to the extent of deviation desired.

Obtaining IFR clearance to circumnavigate severe weather can often be accommodated more readily in the enroute areas away from terminals because there is usually less congestion and, therefore, greater freedom of action. In terminal areas, the problem is more acute because of traffic density, ATC coordination requirements, complex departure and arrival routes, adjacent airports, etc. As a consequence, controllers are less likely to be able to accommodate all requests for weather detours in a terminal area or be in a position to volunteer such routes to the pilot. Nevertheless, pilots should not hesitate to advise controllers of any observed severe weather and should specifically advise controllers if they desire circumnavigation of observed weather.

4. WEATHER PHENOMENON AS OBSERVED ON RADAR. It must be recognized that those weather echoes observed on radar (airborne or ground) are a direct result of precipitation. RADAR DOES NOT DISPLAY TURBULENCE. It is acknowledged that turbulence is generally associated with heavy areas of precipitation; however, the radar used for air traffic control purposes are not capable of equally displaying precipitation information. Under certain conditions, in the past, echoes received from precipitation rendered ATC radar unusable. To avoid such disruption to radar service, modifications designed to considerably reduce precipitation clutter were added to ATC radar systems. This feature, known as Circular Polarization (CP), eliminates all but the heaviest areas of precipitation. Terminal radar systems use this feature as necessary to reduce precipitation clutter during moderate to heavy rain or snow. Moderate to heavy precipitation areas appear on the radar scope as white areas - something like "snow" on your TV, only brighter.

Centers normally use CP only when the radar data processing computer is inoperative. When this occurs, a secondary radar system (Air Traffic Radar Beacon System) is used along with primary surveillance radar. This combination is normally used at the lower altitudes where positive control airspace is not applicable. Aircraft operating in positive control airspace are required to be equipped with operating radar beacon transponders and controllers handling such traffic normally utilize only the secondary radar system. These secondary ATC radar systems receive only those signals emitted by airborne radar beacon transponders and do not display weather echoes. Additionally, this permits filtering out non-pertinent traffic operating below the positive control areas. Though controllers using only secondary radar will not observe weather on their scopes, they can if alerted, often turn on the normal radar to observe weather, provided this will not result in weather clutter rendering the scope unusable for traffic control.

Air Route Traffic Control Centers normally operate in the radar data processing mode. In this configuration, the computers process radar returns and display them on the controller's scope as symbols or alphanumeric characters. This computer also analyzes radar returns from precipitation areas in degrees of intensity. It then displays the area of precipitation on the radar scope as a series of parallel or slightly diverging lines if the precipitation is light or as a series of the capital letter H if it is heavy. For this function, light precipitation has been classified as a precipitation fall of less than 5 but more than 1 inch per hour. Heavy precipitation is classified as 5 or more inches per hour. This system capability enables the controller to recognize variations in the intensity of precipitation without rendering the ATC radar unusable.

In accordance with current procedures, controllers will provide information concerning severe weather echoes observed on their radar when deemed advisable and will, upon pilot request, suggest vectors for avoidance whenever circumstances will permit. However, for the reasons outlined above, it is emphasized that pilots should not completely rely on air traffic controllers to provide this service at all times, particularly in terminal areas or in holding patterns. Pilots should also recognize that the controller's data are often far from complete due to the design of the radar and its location relative to the weather observed.

5. RECOMMENDED ACTIONS FOR PILOTS.

a. Avoidance of Known Severe Weather -- Recent research has proven beyond any doubt that all thunderstorms are potentially dangerous and should be avoided if possible or penetrated only when the pilot has no other choice.

b. Forward reports to ATC of any severe weather encountered giving nature, location, route, altitude and intensity. Pilots are also reminded to review Federal Air Regulation 91.125 pertaining to pilot reports.

c. Initiate requests to avoid severe weather activity as soon as possible being specific concerning route and altitude desired. Pilots are reminded to review the Airman's Information Manual pertaining to "Detouring Thunderstorms" and "Weather."

d. Adjust speed as necessary to maintain adequate control of aircraft in turbulent air and advise ATC as soon as possible.

e. Do not rely completely on air traffic controllers to provide information or to initiate radar vectors to aircraft for avoidance of severe weather, particularly when arriving and departing terminals or in holding patterns.

f. Plan ahead to anticipate the need for avoiding areas of known severe weather. If necessary, delay take-off or landing, as applicable.

Raymond G. Belanger

RAYMOND G. BELANGER
Director, Air Traffic Service