PB84-910408

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

FLYING TIGERS, INC., FLIGHT 2468
McDONNELL DOUGLAS DC8-63, N797FT
CHAMBERS FIELD, NAVAL AIR STATION
NORFOLK, VIRGINIA
OCTOBER 25, 1983
(REVISED: SEPTEMBER 1, 1984)

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16. Abstract
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The weather at Chambers Field was, in part, 200 feet scattered, ceiling 600 feet overcast, visibility 1 mile. moderate rain showers and fog, wind 360°, 20 knots. Large portions of runway 10 were flooded with standing water 1/2 to 3/4 inches deep. The runway condition was not assessed by airport or air traffic personne!., and consequently was not reported to the flightcrew of Flight 2468.

The captain flew the ground controlled approach (GCA) instrument approach about 15 knots above the proper reference speed to compensate for a pilot report of the existence of windshear near the runway threshold. The airplane crossed the threshold of runway 10 about 10 knots above referenee speed and landed between 3,100 and 3,800 feet beyond the runway threshold. Runway 10 was 8,068 feet long. The flightcrew was unable to stop the airplane on the runway. At 0909, the airplane went off the side of the runway and slid into a swamp at the end of the runway.

17. Key Words
GCA, inadequate runway assessment. flooded runway, overrun, entiskid. hydroplane, crosswind, tailwind, V_{ref}, excessive airspeed, missed approach. cockpit management, long landing. air traffic control. airspeed management,

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The National Transportation Safety Board determines that the probable cause of this accident was the flightcrew's mismanagement of the airplane's airspeed, resulting in an excessively long landirg on a wet, partially flooded runway: mismanagement of thrust reversers; and hydroplaning. Contributing to this accident was the failure of airport management to identify, assess. and disseminete hazardous runway conditions warnings and the failure of air traffic controllers to inform the flightcrew tnat there was standing water on the runwey.

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WASHINGTON, D.C. 20594

AVIATION ACCIDENT REPORT

Adopted: May 30, 1984

FLYING TIGERS, INC., FLIGHT 2468, MCDOWNEL DOUGLAS DC8-63, N797FT, CHAMBERS FIELD NAVAL AIR STATION NORFOLK, VIRGINIA OCTOBER 25,1983

SYNOPSIS

On October 25, 1983, Flying Tigers, Inc.., Flight 2468, a McDonnell Douglas DC8-53, N797FT, was operating as a ferry flight under 14 CFR Part 91 from John F. Kennedy International Airport (JFK), New York, to Chambers Field, Naval Air Station (NAS) Norfolk, Virginia. A flightcrew of three and two company employees were onboard. Upon arrival at NAS Norfolk, Flight 2468 was to convert to a military charter flight under 14 CFR Part 121 to transport cargo to Keflavik, Iceland.

The weather at Chambers Field was, in part, 200 feet scattered, ceiling 600 feet overcast, visibility 1 mile, moderate rain showers and fog, wind 360°, 20 knots. Large portions of runway 10 were flooded with standing water 1/2 to 3/4 inch deep. The runway condition was not assessed by airport or air traffic personnel, and consequently, was not reported to the flightcrew of Fiight 2468.

The captain flew the ground controlled approach (GCA) instrument approach about 15 knots above the proper reference speed to compensate for a pilot report of the existence of windshear near the runway threshold. The airplane crossed the threshold of runway 10 about 10 knots above reference speed and landed between 3,100 and 3,800 feet beyond the runway threshold. Runway 10 was 8,068 feet long. The flightcrew was unable to stop the airplane on the runway. At 0909, the airplane went off the side of the runway and slid into a swamp at the end of the runway. There were no injuries to the five occupants.

The National Transportation Safety Board determines that the probable cause of this accident was the flightcrew's mismanagement of the airplane's airspeed, resulting in an excessively long landing on a wet, partially flooded runway; mismanagement of thrust reversers; and hydroplaning. Contributing to this accident was the failure of airport management to identify, asses, and disseminate hazardous runway conditions warnings and the failure of air traffic controllers to inform the flightcrew that there was standing water on the runway.

1 FACTUAL INFORMATION

1.1 History of the Flight

At 0700 1/ on October 25, 1983, the flightcrew reported for duty at John F. Kennedy International Airport (JFK) for a ferry flight of a DC8-63 airplane to Chambers Field, Naval Air Station (NAS), Norfolk, Virginia. The airplane was being operated by the Flying Tigers Line, Inc. The flightcrew consisted of the captain and the first and second officers. Two company employees also were flying with the flightcrew.

The captain and the first officer examined the dispatch package and the weather forecast for the arrival at NAS Norfolk. The captain recalled that the 0900 forecast, in part, was 500-foot ceilings, visibility 5 miles with light rain and fog. The forecast wind was 20° at 10 knots. There were no NOTAMS, 2/ but the dispatch package indicated that runway 28 was the preferred runway for landing: and that it was wet. The captain stated that if a report of poor or nil braking conditions had been included in the dispatch package he would not have attempted a landing since the crosswind limitation for landing with those braking conditions was 10 knots. The dispatch package also indicated that the maximum allowable gross weight for landing was 275,000 pounds. The captain checked the expected tailwind component and noted that he could accept a tailwind of 4 to 6 knots based on the anticipated landing weight of about 252,000 pounds.

The second officer performed the predeparture walk-around of the airplane. He checked and noted that the tire pressures were in the proper range. He said the tread condition of seven of the tires was "excellent" but the serviceability of one tire was questionable. The second officer consulted a maintenance representative who said that the tire met the tread serviceability criteria of Flying Tigers, Inc. The second officer then inspected the condition of the brakes and the accumulators. All were satisfactory for the flight.

Before departure, the airplane was refueled so that there was about 114,192 pounds of fuel on board. The fuel loaded was sufficient for a scheduled continuing flight to Iceland since the airplane would not be refueled at Chambers Field.

At 0815, the airplane departed JFK on an instrument flight rules (IFR) flight plan. The captain flew the first leg to NAS Norfolk. He stated that the en route portion of the flight was uneventful.

Flight 2468 was transferred by Washington Air Route Traffic Control Center (ARTCC) to the East Feeder. radar controller at the Norfolk International Airport Terminal Radar Approach Control Facility (TRACON) after the Washington ARTCC controller cleared Flight 2468 to descend from FL 310 3/ to 10,000 feet. The East Feeder controller advised Flight 2468 that the weather at Chambers Field was 200 feet scattered, measured ceiling was 500 feet overcast, visibility was 5 miles, light rain showers, fog, wind was 20° at 13 knots, and the altimeter was 29.81 inches. The controller also advised the flightcrew that, although Chambers Field was not reporting gusts, Norfolk International Airport, which was located 5 miles away, was experiencing gusts up to 19 knots.

1/ All times herein are eastern daylight, based on the 24-hour clock unless otherwise indicated.
2/ Notice to Airmen.
3/ A level of constant atmospheric pressure related to a reference datum of 29.92 inches of mercury. Each level is stated in three digits that represent hundreds of feet.

Chambers Field was broadcasting Automatic Terminal Information Service (ATIS) Delta at the time of Flight 2468's arrival. However, the flight could not receive the ATIS because it was broadcast only on ultra-high frequency (UHF) and Flight 2468 was equipped only with very high frequency radios (VHF). In any event, no information was available to the flightcrew from the controller or the ATIS concerning the runway surface condition since no braking reports had been made to the tower controllers.

The East Feeder controller advised Flight 2468 that the precision approach radar (PAR) procedure was in use to runway 10 at Chambers Field. Runway 10 was 8,068 feet long. Flight 2468 was vectored to the west of the airport and descended to 5,000 feet. The flight then was handed off to the Norfolk TRACON Arrival One controller who cleared the flight to descend further to 2,000 feet. The Arrival One controller then made a radar handoff to the Chambers Field ASR 4/ feeder controller.

The ASR feeder controller cleared the flight to descend to 1,500 feet and provided vectors to position Flight 2468 on the final approach course. Meanwhile, the flightcrew completed the before-landing checklist. At 0904:58, when the airplane was about 8 miles west of Chambers Field and 1 mile south of the centerline of the final approach course, the ASR feeder controller released control of Flight 2468 to the GCA 5/ final controller. The final controller turned the airplane to a heading of 75°, and at 0905:16, said "Twenty four sixty eight, expect a heavy wind shear two to one miles from touchdown, had a heavy one-forty-me report it when coming in last."

When the flightcrew received the windshear pilot report, the captain instructed the first officer to monitor the No. 2 inertial navigation system (INS) for the ground speed-true air speed differential. The captain used the No. 1 INS to monitor the drift angle. He stated that in addition to monitoring the windshear possibility, he added 10 knots to his "bug" 6/ speed to compensate for a windshear and he used an approach speed of 157 knots.

At 0905:48, the airplane was 7 miles from touchdown. slightly above the glide path and right of the center of course. At 0906:15, the first officer noted that the headwind was "thirty knots on the nose." At 0906:30, the airplane was 5 miles from touchdown and the wind at Chambers Field was given as 360° at 20 knots. The airplane was flown slightly above the glide path until just before decision height. At 0907:12, full flaps were extended. At 0907:38, the drift angle was 12° right drift, and the headwind component had decreased to 15 knots "on the nose." At 0907:47, the controller said the airplane was 2 miles from touchdown. At 0907:49, the first officer announced that he had runway 10 in sight. At 0908:04, the headwind component was 15 knots and the drift was 12° to the right. At 0908:11, the captain announced "everything complete." The controller said "slightly above glidepath, one mile from touchdown, wind check 360 degrees at 18, you are on course turn left two degrees." At 0908:20, the first officer said the' the indicated air speed was 154 knots and the headwind was "five knots--winds should be gone by now." At 0908:26, the controller said "decision height, you are on glidepath, on course." At 0908:31, the first officer said "OK no wind." and the second officer said "hundred feet."

4/ Airport surveillance radar which provides azimuth and range information at lower altitudes of flight within about 30 miles of the airport.

5/ Ground Controlled Approach.

6/ Flying Tigers procedure for approach speed was to determine the reference speed (141 knots) and add 5 knots for a bug speed. Wind additives are applied to the bug speed in accordance with company procedures.

The second officer stated that the true air speed on the INS was 157 knots and the ground speed was 161 knots as the airplane approached the runway threshold. Just before touchdown, the true air speed (TAS) was 160 knots and the ground speed was 161 knots. The first officer recalled that the ground speed at the threshold was 161 knots, and that there were a few knots of tailwind. The captain said that with a wind of 360° at 20 knots, he expected a very slight tailwind at touchdown.

At 0908:34, the controller said, "just passed over the landing threshold, you are on course." At 0908:36, the second officer said "Fifty feet."

The captain said that the GCA had been conducted well by the controller and that the airplane was in a proper position at decision heigh? to complete a normal landing. He had no probfem seeing the runway once the airplane broke out of the overcast, despite the rain, which he described as not being heavy enough to use rain removal on the windshield.

The captain said that he would have accepted a threshold crossing speed of 147 to 157 knots. As the airpiane crossed the threshold, the captain reduced thrust to get below the glideslope, with the intention to 'plant the airplane firmly on the first 1,000 feet of the runway." He said that the flare was normal and that the airplane touched down in the proper attitude. He said that the left main landing gear made contact with the runway very softly; however, the airplane skipped back into the air. According to the captain, the airplane did not bounce, and the skip into the air was "measured not in feet but in inches."

The first officer believed that the approach was normal and that the airplane touched down firmly on the first 1,500 feet of the runway. He did not recall a skip or a bounce. After the spoilers deployed, he heard the second officer call out that the reverse lights were illuminated.

The second officer believed the approach, flare, and touchdown were normal, except that the airplane may have floated slightly. The touchdown was firm, with the left wing low. He said that there was no skip or bounce.

At 0908:44, someone in the cockpit said "Ooh." At 0908:46, the first officer said "Get it down," and at 0908:47, the captain said "let it sink."

The captain said the airplsne touched down again on the runway within the first 3,000 feet of the runway, with the main landing gears making firm contact followed shortly by the nose gear. He said that after touchdown the spoilers deployed and he reversed the thrust and immediately applied the brakes. The captain stated, however, in stopping the airplane, the brakes were ineffective and it appeared to accelerate. The captain considered a go-around from the runway at that point, but rejected it because the spoilers were deployed, the engines were in reverse thrust, and the runway remaining was rapidly becoming too short to reconfigure the airplane.

At 0908:48, the first officer said "Four thousand left." He stated that he made this call with reference to the 4,000-foot marker on the right side of the runway. He saw the marker through the windshield at the 1 or 1:30 o'clock position from his seat. The first officer stated that he began to be concerned with the ability to stop the airplane when he saw the 4,000-foot marker.

At 0908:49, the second officer said "spoilers extend." One second later, the first officer said "You got three thousand feet left." The captain recalled that he had applied full brakes yet the airplane was not slowing down.

At 090855, the second officer said "Flashings on one, two, and three" in reference to the indication #at the engines were in reverse. He looked outside before he saw the light which indicated that the No. 4 engine was in reverse. At 0908:56, the cockpit voice recorder (CVR) recorded the sounds of the engines going into reverse. However, neither the second officer nor a company mechanic who was sitting on the jump seat recalled the normal deceleration effect of reverse thrust.

At 0908:57 and 0909:02, the captain told the first officer to get on the brakes with him. The first officer complied, and tho second officer noted that the first officer's seat leaned backward as he pushed heavily against the brake pedals.

At 0909:06, the CVR recorded the sound of decreasing engine power. Both the captain and the first officer stated that the brakes had been applied fully, but that they were totally ineffective, and that they never had control of the forward velocity of the airpiane. Additionally, both pilots stated that they did not feel the antiskid cycle.

As the airplane passed the 2,000-foot marker, the airplane drifted to the right side of the runway as the nose "weather cocked" to the left. All three landing gears went off the right side of the runway. The first officer said the airplane slowed down slightly as it went through the mud. However, as the airplane drifted to the right, it moved toward a car stopped on the road at the end of the runway. The captain steered the airplane left toward the runway. At 0909:21, the power to the CVR was interrupted.

The local controller, who was located in the tower cab (see figure 1), stated that the airplane touched down at the No. 1 arresting gear and bounced 50 to 100 feet into the air and finally touched down a second time abeam of the tower, or just before reaching the tower. An off-duty ground control trainee saw the airplane touch down by the No. 1 arresting gear, bounce about 50 feet, and touch down a second time abeam of the tower just before midfield. Neither the local controller or any other controllers was aware about a tendency for the runway to flood under certain meteorological conditions.

A flight data controller who first saw the airplane at midfield said the airplane was "going very fast." Both the flight data controller and the local controller said that they did not hear the sound of reverse thrust. The flight data controller recalled seeing water spray emanating from the airplane as it went down the runway. The airfield aviation safety officer, a Naval aviator, was driving to work and saw a DC8 touch down on runway 10 "just east of the southwest taxiway centerline" which was between the intersection of the two runways and a point abeam of the tower.

Three firemen were located at the "hot spot" located about 1.200 feet east of the intersection of the two runways. They said that they saw the airplane touchdown abeam of the tower, that they heard the engines in reverse thrust as the airplane passed their position, and that they saw spray from behind the airplane. The lieutenant in charge of the crash-fire-rescue (CFR) truck ordered the vehicle to respond while the airplane was still moving down the runway because he believed the airplane would not be able to stop on the runway.

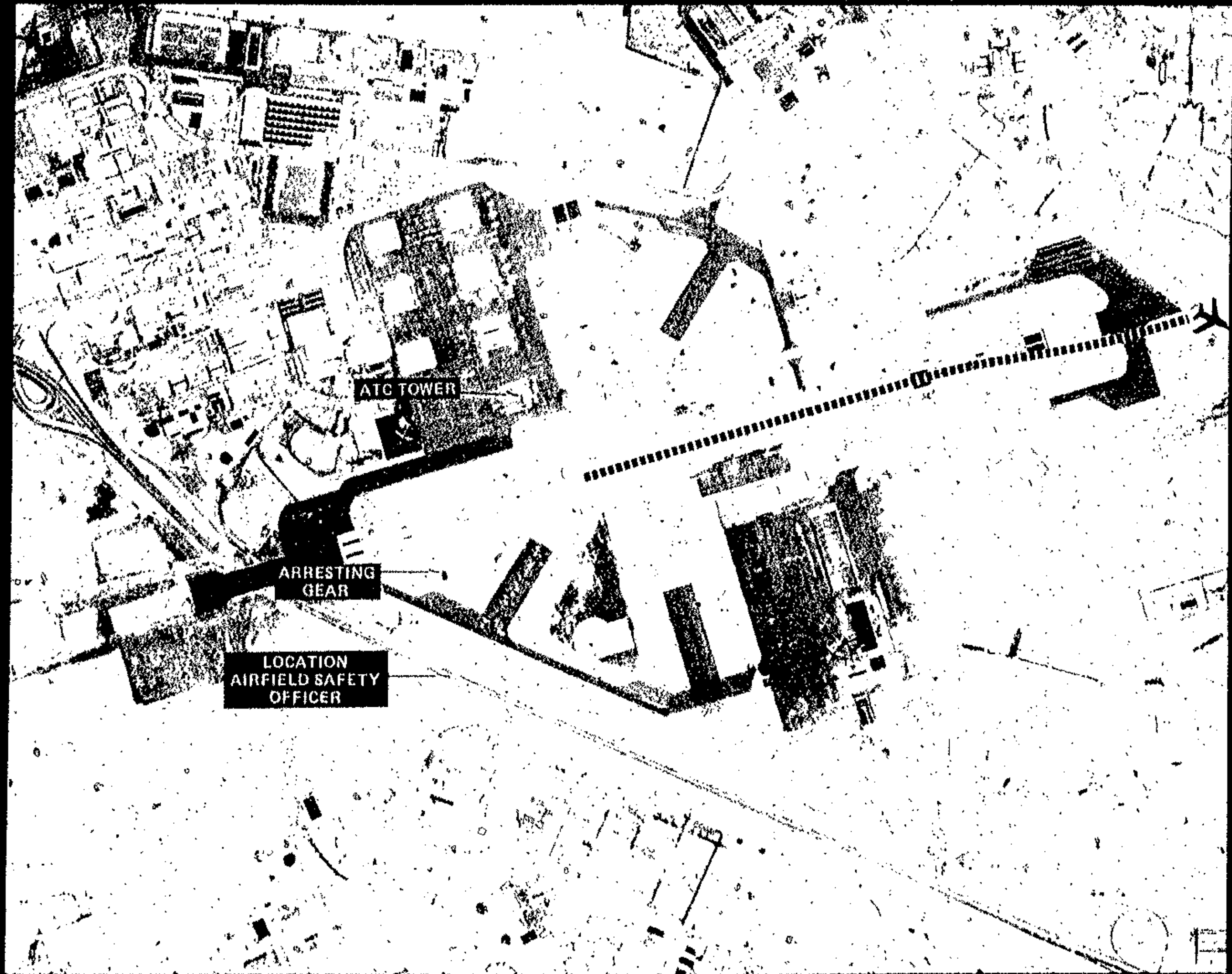

Figure 1.—Airfield diagram and ground track of airplane.

A motorist had stopped his car on the road at the end of runway 10. He estimated that when he first saw Flight 2468, it was 400 to 600 feet from the end of the runway, He said that he realized that the airplane would not be able to stop on the remaining runway. According to the motorist, water was "flying up under the wings," and the airplane appeared to be "unstable in that the wings were slowly dipping somewhat from side to side." The motorist said that when the airplane turned right, it was pointed directly at his car and he saw mud and grass coming up from beneath the right wing. He said the airplane appeared to be sliding the entire time. He also said that as the airplane moved closer to his car, he saw "that the wheels of the aircraft appeared to be locked and that the aircraft still appeared to be sliding." The motorist said that when he put his car into reverse gear and moved away from the airplane, the airplane left the runway, crossed the road in front of him with the right wing passing over the hood of his car. He estimated that the airplane was traveling at 35 miles per hour as it crossed the road. (See appendix E.)

About 0909, the airplane left the confines of the airfield on a heading of about 90° while tracking about 100°. It crossed the airport boundary road, went through a chain link fence, and came to rest in a swamp. The airplane then pivoted on the right main landing gear to the south and stopped on a heading of 155°. The airplane came to rest 8,375 feet from the displaced threshold of runway 10. The tail of the airplane was 77 feet beyond the airport boundary road. There were no injuries to the three flightcrew members or the two company employees on the airplane.

The accident occurred during the hours of daylight at coordinates 36° 56' N latitude and 76" 17' W longitude.

A Boeing 727 departed on runway 10 at 0835. The captain said that he did not encounter any control difficulties. He reported that the wind was from the north at 15 to 20 knots but that there was no windshear.

A U.S. Air Force C141B landed on runway 10 at 0840. The captain said that he had no problems with the weather, although the winds were 360" with gusts to 18 knots. The rain was moderate. The airplane touched down in the first 1,000 feet of the runway and completed the landing and rollout with no problems. He did not experience hydroplaning or directional control problems. The captain saw Flight 2468 during the final stage of the rollout on runway 10. He stated that there was a "visible plume of water being thrown up by the main gear."

A Navy C-12 Beechcraft departed on runway 10 at 0844. The pilot said that portions of the ramp and taxiways were flooded with puddles, some 4 inches deep. The rain was heavy and the winds were 030° at 20 knots. During the takeoff roll, the airplane drified to the right side of the runway and began to hydroplane. The pilot said that he maintained directional control with differential power and rudder and made an uneventful takeoff. However, he made no pilot report to the controller.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	3	2	0	5
Total	3	2	0	5

1.3 Damage to Aircraft

The airplane was damaged substantially, but was later repaired at Chambers Field.

1.4 Other Damage

A large section of chain link fence was destroyed.

1.5 Personnel information

The flightcrew was qualified for the flight and had received the required training. (See appendix B.)

1.6 Aircraft Information

The airplane, a McDonnell Douglas DC8-63, N797FT, was operated by the Flying Tiger Line, Inc. It had been maintained in accordance with applicable regulations, and its maximum allowable takeoff gross weight was 287,800 pounds. The actual takeoff gross weight at JFK was 263,628 pounds. The center of gravity was within the acceptable range.

Before being refueled at JFK with 84,192 pounds (12,566 U.S. gallons) of jet fuel, 30,000 pounds of jet fuel were onboard the plane. When the plane departed JFK, 114,192 pounds of fuel were onboard the airplane, although the final fuel loading sheet listed the total fuel as 111,500 pounds. Based on the fuel burn off from takeoff until arrival at Chambers Field, the gross landing weight was 250,828 pounds.

The airplane was powered by four Pratt and Whitney model JT3D-7 engines. A review of the inspection records for the engines, tires, wheels, brakes, and antiskid systems, and the airplane's logbook did not reveal any significant maintenance deficiencies.

1.7 Meteorological Information

The National Weather Service Forecast Office, Washington, D.C.. prepared the foilowing terminal forecasts for Norfolk International Airport:

Valid: 0600, October 25, 1983 to 0600, October 26, 1983
(transmitted 0540)
Ceiling--500 feet broken; visibiiity 3 miles in light rain; light drizzle and fog; wind--030 degrees 10 knots; occasionally 500 feet scattered, ceiling 1,500 feet broken. After 1400: ceiling 1,500 feet broken, occasionally ceiling 600 feet broken, visibility 2 miles in light rain, light drizzle, and fog.

Amendment 1 (transmitted 0755)
Valid: October 25, 0800 to October 26, 0600
Ceiling--500 feet broken; visibility 2 miles in light rain, and fog: wind--050 degrees 14 knots; occasionally 500 feet scattered, ceiling 1,500 feet broken. After 1800: ceiling--1,500 feet broken, occasionally ceiling 600 feet broken: visibility 2 miles in light rain, light drizzle, and fog.

There were no AIRMET's or SIGMET's 7/ valid for Virginia at the time of the accident.

The surface weather observations before and after the time of the accident at Chambers Field, NAS, Norfolk were as follows:

> Time--0855, type--record special; clouds—200 feet scattered, ceiling measured 600 feet overcast; visibility--1 mile; weather-moderate rain showers and fog; temperature--58° F; dewpoint--57° F; wind--020 degrees, 19 knots; altimeter—29.88 inches; remarks—peak wind 010 degrees, 27 knots at 0837, wet runway.

> Time--0913, type--special; ceiling--estimated 200 feet broken, 600 feet overcast; visibility--1 1/2 mile; weather-moderate rain showers and fog; temperature--58° F; dew point--57° F; wind--020 degrees, 18 knots; altimeter—29.88 inches; remarks--peak wind 010 degrees, 27 knots at 0913, aircraft mishap.

The surface weather observation before the time of the accident at Norfolk International Airport was as follows:

> Time--0850, type--record special; ceiling--measured 400 feet broken, 800 feet overcast; visibility--1 1/8 miles; weather-heavy rain and fog; temperature--59° F; dewpoint--56° F; wind--030 degrees, 16 knots; altimeter--29.87 inches.

The National Weather Service recorded the following hourly rainfall amounts at the Norfolk International Airport for October 25, 1983:

Hour Ending At	Rainfall Amount (inches)
0200	trace
0300	0.04
0400	0.14
0500	0.27
0600	0.05
0700	0.03
0800	0.36
0900	0.30
1000	0.31

The manual measurement of the rainfall at NAS Norfolk for the period 0200 through 0800 was 2.91 inches of rain. An additional .19 inch was recorded between 0800 until just after the time of the accident.

7/ AIRMET - Airman's Meteorological Information - inflight weather advisories for aircraft having limited capability.
SIGMET - significant meteorological Information - inflight weather advisory concerning weather signfieant to the safety of all aircraft.

1.8 Aids to Navigation

The precision approach radar to runway 10 provides the pilot with a 3° glideslope and a threshold crossing height of 37 feet above the runway. The glideslope intersects the runway 710 feet beyond the displaced threshold.

1.9 Communications

There were no known communications problems.

1.10 Aerodrome Information

Facilities.--Chambers Field, NAS Norfolk is located at an elevation of 16 feet mean sea level (m.s.l.). The landing surfaces consist of two runways: runway 10/28, which is oriented 98.5° magnetic, and runway 01/19. Runway 01/19 is 4,300 feet long by 250 feet wide. Runway 10 is 8,068 feet long beyond a 300-foot displaced threshold and 200 feet wide. In the summer of 1981, runway 10 was resurfaced with an asphalt concrete bituminous overlay. The runway is not grooved, except for a 500-foot extension on the west end which is grooved concrete. It is crowned at the centerline to allow water to drain off as it falls, and it is equipped with high intensity runway lights, runway centerline lights, an approach light system with sequenced flashing lights in ILS Category II Configuration (ALSF-II), and a visual approach slope indicator (VASI). The approach light system, runway edge, and centerline lights, the rotating beacon, and the VASI were on when Flight 2468 conducted the GCA. There was no record of the intensity setting. However, the tower supervisor said that she believed they were at step 3. The air traffic control tower and all ATC facilities are operated by the U.S. Navy.

Airport Management.--The Air Operations Officer, who is the equivalent to the manager of a civilian airport, is responsible for the day-to-day operation and safety of the airport. The activities of the fire department. the transient line crew, the ATC facility, the flight operations section, and other airport elements are coordinated by the Air Operations Officer. An Airfield Operations Duty (AOD) Officer is on duty 24-hour a day. The duty is rotated on a duty roster basis among a pool of officers assigned to the Naval Air Station. AODs are not necessarily experienced in airport operations and are not qualified as airport operations officers, unlike civilian airports which have full time operations officers to manage the airfield. An aviation safety officer is assigned to the airfield on a full-time basis and is responsible to promote the safety of all aviation airfield activities.

Airport Certification.--Chambers Field is certificated for operations under Subpart B of 14 CFR Part 139 although certification under Subpart B is not required for operations similar to Flight 2468, which are considered by the Federal Aviation Administration (FAA) to be military charter operations. Under an agreement between the FAA and the Department of Defense (DOD) before 14 CFR Part 139 was implemented for military airports in 1973, an inspection of the airport was not Conducted by the FAA to determine if the airport was properly and adequately equipped to conduct scheduled or unscheduled air carrier operations under 14 CFR Part 139. The FAA airport inspection is waived because military airport operations were determined to be conducted under requirements which equaled or exceeded those required under 14 CFR Part 139.

Title 14 CFR 139.69, Airport Condition Assessment and Reporting, requires that the applicant for an airport operating certificate "show that it has appropriate procedures for identifying, assessing, and disseminating information to air carrier users of its airport concerning conditions on and in the vicinity of the airport that affect, or may affect, the safe operations of aircraft." The section includes the requirement that airports establish a procedure to detect the presence and depth of snow, ice, or water on runways or taxiways.

Runway Surface.--A group consisting of the Aviation Safety Officer, a Naval Aviator, and two enlisted air traffic controllers conducted en inspection of the entire runway within 15 minutes after the accident. The consensus of the group was that the runway was wet with numerous patches of standing water estimated to be 1/2 to 3/4 inch deep. The Aviation Safety Officer said that "approximately 1/2-inch to 3/4-inch of water was on the center and south side of runway **10** in the last **3,000** feet. Water run off to the north side was prevented by a strong wind even though the runway is graded. This situation is routine at Chambers Field and causes water to pool rather than drain even long after rain has stopped." He also noted that there were no rubber skid marks anywhere along the track of the main landing gear. The driver of the CFR truck stated that there was so much water on the runway as he drove the vehicle onto the runway that he was concerned about losing control of the firetruck.

The Air Operations Officer said that whenever there are strong north winds, there is a standing water problem on runway 10/28. The winds prevent water runoff from the crown, while some water is blown over the crown to the south edge of the runway. He also stated that the runway is inspected daily for rubber deposits and that the NAS Norfolk Civil Engineering Office is notified to analyze and clean the runway if rubber contaminants are reported.

Runwav Friction Testing.--Friction tests at Chambers Field are conducted by the Naval Facilities Engineering Command, NAS Norfolk once every **3** years unless inspections by airport personnel and pilot reports indicate *e* deterioration in surface conditions. The most recent friction test was concluded in June **1983** using **a** Mu-meter on .2 inch of water on the runway.

A report entitled, "Runway Friction Measurement and Airfield Condition Survey," contained the results of the survey. Table I, extracted from the report, provides guidance for the interpretation of mu-values:

Table 1.--Mu-Meter friction interpretation.

Mu-Values	Anticipated Braking Response	Hydroplaning Potential
0 - **0.25**	Unacceptable	Very High probability for hydroplaning
0.25 - 0.41	Marginal	Potential for hydroplaning exists for some aircraft under certain conditions
0.42 - 0.50	Fair	Transitional
GREATER than 5.50	Good	No hydroplaning problems expected.

The conclusions of the friction test were, in pari:

(1) The grooved portion of the runway on the west end provided good drainage and little reduction in surface friction.

(2) Major ponding exists on the pavement at the intersection of runway 1-19. A test at that location resulted in a .38 coefficient of friction at inundation "indicating a marginal braking response and potential for hydroplaning during inclement weather."

(3) Fifteen minutes after inundation, the area at the intersection of the two runways had a coefficient of friction of .54.

(4) The remaining friction measurements indicated good braking response and little to no potential of hydroplaning.

The airport management makes runway condition reports (RCR) when the temperature is 34° or less and there is visible moisture. A James Brake Decelerameter is used to determine RCR information. No RCR information was gathered before the accident, and no information on runway conditions was available to be transmitted to Flight 2468.

There is no procedure in the airport operations manual which assigns responsibility to monitor the runway surfaces for water depth. A general surveillance of the runway surfaces is conducted by the fire and rescue division twice each day. The airport operations manual states that "These inspections are conducted to provide safe aircraft operations. Foreign Object Damage (FOD) holes or any other discrepancies will be recorded and reported by the assistant fire chief directly to the Airfield Operations Duty Officer for dissemination and closure of a runway or taxiway if required." Personnel assigned to the transient line crew are on duty 24-hour: a day, and as part of their duties can be used to check runway surface conditions. The Air Operations Officer stated that runway inspections for water depth, snow, ice or other contaminants are made at the request of pilots or if air traffic controllers observe runway contaminants.

Tht controllers in the tower at the time of the accident stated that they were aware of the rain and that they saw water spray from the wheels of landing and departing airplanes. However, they did not request a measurement of runway water depth, nor did the local controller relay any information concerning runway conditions to the GCA feeder or find controller.

No pilot braking action reports were received by controllers at Chambers Field, nor were any requested of pilots by the controllers.

Crash-Fire-Rescue.—A CFX vehicle is on standby for all aviation activities at Chambers Field. The fire lieutenant in charge of the vehicle ordered an immediate response as the airplane went pest his iocation which was just east of the intersection of the two runways. He also ordered a full CFR response as he drove down the runway and saw that the airplane had crashed. No fire or rescue activities were conducted at the accident site scene.

1.11 Flight Recorders

The airplane was equipped with a Sundstrand modei AV557-B, serial No. 7137A, cockpit voice recorder. The CVR had recorded only 15 minutes 44 seconds rather that the required 30 minutes because of a defect in the tape. A small hole was found in the tape which allowed enough light to trigger the end of the tape sensor and caused the tape to reverse each 7 minutes 52 seconds. Normally a clear the leader at the 15 minute point in the tape triggers the reverse cycle. A transcript of the last 6 minutes was prepared.

The airplane also was equipped with a Sundstrand FA-542 flight data recorder (FDR), serial No. 3596. The FDR was removed from the airplane and taken to the Safety Board's FDR laboratory in Washington. D.C., for examination and readout of the flight record. (See appendix D.) The FDR recorded airspeed, altitude, heading, and vertical acceleration data. The final 4 minutes 32 seconds of the recording were examined during the accident investigation to analyze the airplane's landing flightpath.

The flight recorder was undamaged and intact. There was no evidence of recorder malfunction or recording abnormalities.

1.12 Wreckage and Impact Information

There were no indications on the runway of any marks of heavv braking. Faint, but clear indications of the track of the left and right main gears were evident on the runway, starting about 6,000 feet from the threshold of the runway. (See appendix E.) The tracks could be seen as light! double tire tracks. The trscks left the runway centel-line at approximately the 6,000-foot point and went off the right side of the runway 19 feet beyond the landing threshold of runway 28. The tracks of the right main landing gear extended 29 feet from the right edge of the runway before turning toward the runway. Both main landing gears remained off the runway, but were within a few feet of the right edge of the runway until the airplane crossed the road.

The fuselage of the airplane sustained significant structural damage in the area of the nose. The radome and the associated radar components separated from the fuseiage. The cabin compressor access doors aft of the forward bulkhead were damaged. A 12-inch slice was found in the left side of the fuselage below the cabin floor at fuselage station (FS) 357 and compression wrinkles were found on the underside of the fuselage at FS 1440.

The right wing sustained minor impact damage. The left wing sustained structural damage just aft of the leading edge where the No. 1 pylon forward attachment point was located.

The right and left wing trailing edge flaps were in the fully extended position. The right wing inboard flap assembly was partially separated from the wing attachment structure. The left wing inboard flap assembly was damaged by ground impact.

The flight and ground spoilers on both wings were extended. The spoiler system accumulator indicated 1,775 pounds of pressure. All thrust reversers were in the stowed position.

The No. 1 engine pylon assembly forward pyion-to-wing attachment structure had failed and the pylon-to-wing aft attachment structure had failed partially. The pylon and engine assembly had rotated in the inboard direction. The ??!on-to-wing aft attachment was detached completely by maintenance personnel before the airplane was removed from **the** eccident site.

The No. 2 engine pylon assembly evidenced a partial failure of both the forward pylon-to-wing and aft pylon-to-wing attachment struciure. The pylon and ***engine*** assembly had rotated in the inboard direction.

The Nos. 3 and 4 engine pylon assemblies remained intact and attached to the ***wing*** structure. All four engines ingested water. mud. end brush from the swamp and sustained internal damege.

The two main ianding gear assemblies incurred only minor impact damage. The nose gear was not damaged. although the forward and aft gear doors and the landing light assemblies were damaged.

All eight tires on the main landiag gears and the two nose wheel tires remained on the wheels and were infiated. There were no flat spots on any tires or indicarions of a maximum energy stop. The Nos. 1 and 5 tires (the front and rear outside tires) on the left main lending gear assembly received some cuts and gouges. The tire treads on all right ?ires were satisfactory.

Direct visual reading tire pressure gages were installed or. the main gear wheel tire assemblies. The tire pressures were read !I days after the accident.

Tire	Position	Pressure (lbs)
1	left iron: outside	188
2	left front inside	190
3	right front inside	190
4	right front outside	i70
5	left aft outside	185
6	left aft **inside**	189
7	right oft inside	185
8	right aft outside	200

The normal tire pressure was 200 to 205 pounds. The DC8-63 operating manual states that a tire should be checked and inflated if the pressure is in the 175 to 195 pound range, and removed if the pressure is below 175 pounds. A temperature compensation chart is included in the manual to relate temperature to tire pressure. The chart indicates that at 70° F. the tire pressure should be 205 pounds. The pressure decreases to 175 pounds as the temperature decreases to -20° F. At the time the tire pressure readings were made, the temperature was [illegible]° F.

Each main gear wheel was fitted with a hydraulically powered disc brake. The brake system is actuated by the hydraulic power system and is equipped with a backup air system which may be used in the event of a loss of hydraulic pressure. An electrically controlled antiskid system provides a locked-wheel protection feature and provides for maximum braking efficiency of the wheel brake system. The air brake nitrogen supply bottle was full at 3,000 pounds. The three brake accumulators read 1,275 pounds each.

The mechanical movement of the brake control valve located in the right gear well was checked by depressing the brake pedals in the cockpit. The control valve operations were normal.

Examination of the four left main gear and the four right main gear brake disc assemblies indicated that about 90 percent of the wear capability remained on each brake unit.

1.13 Medical and Pathological Information

There was no evidence of preexisting medical conditions which affected the performance of the flightcrew.

1.14 Fire

There was no fire.

1.15 Survival Aspects

The accident was survivable. The decelerative forces were not significant, the restraining systems were used and functioned properly, and there was no damage to the cockpit area.

1.16 Tests and Research

1.16.1 Antiskid Examination

The antiskid control unit was examined and tested functionally by the Safety Board at the Flying Tigers Lines Accessory Overhaul Facility, Los Angeles, California. The functional test was performed in accordance with Flying Tigers Lines Overhaul Manual, Specification No. 32-44-8.

Each wheel is equipped with a logic wheelboard, also known as a wheel-speed transducer, which monitors individual wheel speeds and modulates wheel brake pressure. All logic wheelboards, except the No. 1 logic wheelboard functioned in accordance with the manufacturer's specifications.

The examination of the No. 1 logic wheelboard circuitry indicated that the Q-2 transistor in the A-9 module was shorted from the collector to the base. If a wheel-speed transducer malfunctions, the antiskid control box treats the failure as a locked wheel condition and releases the brake, and the ANTISKID INOP light illuminates. There was no other evidence of pre-existing corrosion or damage to any part of the antiskid system.

1.16.2 Airplane Performance

Certification Landing Distances and Approved Field Lengths.--Manufacturers are required to demonstrate the stopping distance capability of their airplanes under the airplane type certification provisions of 14 CFR 25.125. The dry runway landing distances are determined from the sum of the demonstrated air distance (air run) from the 50-foot height and the ground stopping distances. Reverse thrust is not used in determining the landing distances. These values represent minimum landing distances for dry runway surfaces when the airplane is operated near its maximum performance capability and structural limits. The techniques used during the certification flights are not used in routine airline operations where environmental factors influence landing operations. 8/ Under the provisions of 14 CFR 121.195 (Transport Category Airplanes: Turbine Engine Powered: Landing Limitations; Destination Airports), an FAA-approved field length must provide a distance which will allow a full stop within 60 percent of the effective length of each approved runway from a point 50 feet above the intersection of the obstruction clearance plane and the runway.

The actual landing distances for wet runway stopping capability are not demonstrated during certification tests. As a result, FAA-approved landing field lengths for wet runways are based on estimates obtained by increasing the dry runway landing field length by an arbitrary factor of 15 percent. Approved landing field lengths were contained in the Flying Tigers DC-8 Operations Manual. The required landing field lengths were based on the airplane crossing the threshold at 50 feet and at reference speed. Section IV, Page 85 of the Flying Tigers DC-8 Operations Manual, indicates that, at 252,000 pounds landing weight, Flight 2468 required 6,000 feet of runway for dry conditions and 7,000 feet for wet conditions.

Determining Airplane Touchdown Point and Speed.--A time correlation between the FDR and the CVR was made based on radio transmissions between the flightcrew and the controllers. The FDR and the CVR tape readouts correlated to within 0.5 second.

If the final GCA controller's transmission at 0908:34 (just passed over the landing threshold) was accurate and if the second officer called out "Fifty Feet" at 0908:36 as the airplane was exactly at the 50-foot point, Flight 2468 was slightly above 50 feet when crossing the runway threshold. A threshold crossing distance slightly higher than 50 feet would have increased the air run distance and, therefore, the touchdown point. Additionally, if the airplane's ground speed was 161 knots as noted by the first and second officers, the air run distance would have been increased further. A theoretical additional air run was calculated based on the assumption that the airplane was slightly above 50 feet when the threshold was crossed. The theoretical additional air run was 544 feet.

The air run distance from a 50-foot height over the threshold to the touchdown point on the runway was determined by integrating the groundspeed (velocity) of the airplane over small time intervals (ΔT) from the time the first officer called "fifty feet" at 0908:36.5 until he called "spoilers extend" at 0908:49.5. The time of 0908:49.5 was judged to be within 1 second of the final touchdown time since (1) the second officer is required to call "spoilers extend" immediately as the blue spoiler light illuminates on touchdown, and (2) 2 seconds earlier, the captain had said "let it sink," indicating that the airplane had not yet landed completely. Based on a final touchdown time of 0908:49.5, the indicated air speed at touchdown was about 129 knots.

8/ Aircraft Accident Report--"McDonnell Douglas Corporation DC-9-80, N980DC, Edwards Air Force Base, California, May 2, 1980" (NTSB-AAR-82-2).

The following equation **was** used to calculate the landing air run distance from the 50-foot height above the runway to touchdown:

$$Sa = 1.688 \left[\frac{Vapp + V.t.d.}{2}\right] \Delta tair$$

Where:

Sa	=	Air run distance (feet)
Vapp	=	Approach ground speed-(FDR indicated airspeed **plus** 3.5 knots)
Vt.d.	=	touchdown ground speed-(FDR indicated airspeed plus **3.5** knots!
tair	=	**Air** time from 50 feat to touchdown in intervals
1.688	=	Knots to feet per second ronversion factor

Table I contains the time. airspeed, and time intervals recorded by the flight data recorder of Flight 2468 progressing from the **50-foot** point io the tcuchdown point — e 13-second interval. Groundspeeds in the tables were calculated **by** adding *3.5* knots *to* recorded airspeed values. The 3.5–knot additive was the difference between the INS groundspeed and INS TAS recalled by the flightcrew, and the repcrted wind at the airport.

Table II.—Landing air run distance.

Actual Time	FDR Time (Elapsed)	IAS (Knots)	Groundspeed (Knots)	Δt (Sec)
0908:36.5	0003:40:1	151	154.5	
0908:38.3	0003:41:9	148	151.5	1.8
0908:40.1	0003:43:7	138	141.5	**1.8**
0908:41.3	0003:44:9	146	149.5	1.2
0908:41.8	0003:45:4	144	147.5	0.5
0908:43.6	0003:47:2	144	147.5	1.8
0908:44.7	0003:48:3	139	142.5	**1.1**
0908:47.1	0003:50:7	138	141.5	**2.4**
0908:49.5	0003:53:1	129	132.5	**2.4**

Note: The IASs were obtained from the FDR. Generally. the IAS seen in the cockpit and recorded on the FDR foil is e few knots below actual IAS due to ground effect. Because of standard day. sea level conditions, it is not necessary to convert IAS to true airspeed. The air run distance **was** calculated by determining and summing the distances covered during ?he smaller time intervals. The air run distance was determined to be 3,178 feet.

if the increased air run distance of 544 feet *(due* to height above 50 fee:) is added to the air run distance of 3,178 feet calculated from the 50-foot height above: the threshold. the touchdown poin? could have been as far as **3,722** feet beyond the displaced threshold of runway 10. Ground witnesses placed the finai touchdown point between the air traffic control tower **(3.143** feet) and the intersection of the two runways (3,894 feet).

Required Runway Length Based on Actual Conditions.—The dry runway Landing distance. determined curing airplane certification, is the total horizontal distance necessary to land and stop completely, without use of reverse thrust, from a point 50 feet above the intersection of the obstruction clearance plane and the runway. This distance is the derived sum of the actual air run distance and the stopping segment. The distance represents the minimum landing distance possible for dry surfaces when the airplane is operated at or near its maximum capabilities end limits. To obtain FAA-approved operational landing field lengths for dry surfaces, the actual air and stopping segments obtained during certification tests are increased by 67 percent to adjust for the operational requirements of 14 CFR Part 121.195.

Table III indicates the demonstrated minimum dry landing distances: the dry runway required landing field lengths, which include a 67-percent safety factor: and the wet runway required landing field lengths. The speeds are computed based on Flying Tigers Operating Manual for various approach reference speeds. The reference speed of 141 knots was the proper Vref for Flight 2468; 146 was Vref plus 5 knots "bug" speed. One hundred fifty seven and one hundred sixty-one knots are the high end of the speed range which were recalled by the flightcrew as the TAS and groundspeed at the threshold.

Table III.--Runway lengths.

Approach Speed (Knots)	Dry Landing Distance (Feet)	Dry Runway Landing Field Length Required (Feet)	Wet Runway Landing Field Length Required (Feet)	Percent Increase In Wet Runway Landing Field Length Required
141	3.593	6,000	7.000	
146	4.240	7,080	8.260	18
151	4,922	8,220	9.453	37
157	5.749	9.600	11.000	60
161	6.144	10.260	11.799	71

1.17 Additional Information

1.17.1 Dispatch of Flight 2468

The data for the dispatch package for Flight 2468 was prepared by a Flying Tigers Flight Planner, a licensed dispatcher. The flight planner determined the maximum allowable landing weight for runways 10 and 28 and concluded that the forecast weather conditions would favor runway 10. However. the flight planner mistakenly referenced runway 28 as the appropriate runway. and incorrectly listed the maximum landing weight for runway 28-wet as 275,000 pounds. The correct maximum landing weight for runway 28-wet. under IFR conditions. was 240,208 pounds for a zero wind condition.

The correct information in the dispatch package should have indicated the landing runway as runway 10-wet based on the forecast surface winds. Since the forecast weather was for IFR conditions, the maximum landing weight for a zero wind component was 265,844 pounds. The airport performance manual shows that 4,770 pounds must be subtracted for each knot of tail wind. The reported wind of 360° at 18 knots produced a tailwind component of 2 knots, so the maximum allowable landing weight of Flight 2468 for runway 10 was 256.304 pounds rather than 275.000 pounds. as stated on the dispatch package.

The Flying Tigers Operation Manual states that the maximum allowable gross weight for landing on the release flight plan "provides a basis for the flightcrew to cross-check the flight plan against conditions which are anticipated by the flightcrew at the time the flight release is executed."

As a result of the accident investigation. Flying Tigers took the following measures to eliminate the confusion that the Director, Flight Planning and Operations Analysis, said had developed with regard to the takeoff and landing data on the flight plans:

- Flight Operations Bulletin #83-22 included a description of the intended purpose of the data. Although the bulletin was dated November 18, 1983, it was actually written and placed into the publication process either in late September or early October in order to be printed and distributed by the November date.

- A rewrite of the same information was included in the January issue of the company's publication, "Tiger Pride."

- The Sane rewrite will appear in the company's publication "Flight Operations Quarterly Review.

- The contents of Flight Operations Bulletin #83-22 *have* been included in Flight Operations Manual Revision #380, dated December 1, 1983 (distributed on January 3, 1984).

- The subject is being presented to and discussed with each company pilot as he takes required recurrent training.

I.17.2 Flying Tigers Landing Procedures

DC-8 Training Guide--Excerpts.— The following guidance was contained in the Flying Tigers DC8 Training Guide:

> Normal Landings.—The final approach speed with a steady state of wind of up to 10 knots is Reference +5 knots, reduced to Reference at an altitude of 50 feet over the threshold, at which time the flare should commence. When the reported headwind is in excess of 10 knots, add the recommended wind gradient factor (equal to 1/2 of the reported headwind) to the Reference speed to obtain the final approach speed. In any case, the wind gradient factor should not exceed a maximum value of 20 knots, and should be gradually removed during the last 200 to 300 feet of altitude so as to cross the threshold at Reference speed. When gusts are present, add the full value of the gusts PLUS the wind gradient factor to the Reference speed to obtain the final approach speed. The combined value of the gusts PLUS the wind gradient factor may not exceed a maximum value of 20 knots, and similarly remove the wind gradient factor during the final approach so that the speed over the threshold is Reference plus the full value of the gusts (only the wind gradient factor should be gradually removed.)
>
> When computing landing crosswind component, the maximum gust velocity must be used.
>
> * * *
>
> It is very important in jet aircraft to maintain good airspeed control, striving to maintain the approach speeds within 5 knots of desired. Too high a speed carries the danger of an overshoot, while too slow a speed carries an even greater danger of an undershoot, especially if gusts or a steep wind gradient change exists near the surface. Be prepared during the approach to add power immediately, should a sudden wind gradient cause a rapid speed decay.

The pilot should maintain an adequate airspeed above Reference to compensate for strong wind gradient and/or gust effects during the approach for a landing. The final approach speed is determined by first determining the prevailing conditions and then proceeding as follows:

Final approach speed for normal approach/winds of 10 knots or less: Reference + 5 knots.

Final approach speed with wind gradient effect/headwind exceeding 10 knots: Reference + 1/2 the reported wind value; MAX is Reference + 20 knots.

Final approach speed with gusts: Reference plus the full value of the gusts plus 1/2 the reported wind value: MAX is Reference + 20 knots.

Remember that as the airplane approaches the runway threshold the wind gradient correction should be removed: cross the runway threshold at Reference + the additive for gusts. If the wind gradient is not fully accounted for during the approach, be alert to the need for sudden thrust increases to maintain airspeed and position on the approach path.

The First Officer should report any deviations from desired airspeed and altitude that go beyond a 900-feet-per minute sink rate or a speed higher than reference plus 10 knots.

* * *

The optimum threshold speed should be Reference + gusts, with no-minus desired. Do not attempt to hold the aircraft off the runway during the flare: the object is to touchdown as soon as safely possible and achieve the maximum braking coefficient which will be achieved with nose wheels on the runway and the spoilers extended. If the pilot holds the aircraft off the runway, seeking to make a smooth landing, runway is being consumed that may not be available. Doing this will keep the aircraft airborne when it could otherwise be on the ground with the ground spoilers, engine reversers, and brakes working to stop the airplane. Deceleration on the runway is about three times greater than in the air. Therefore, get the wheels on the runway at about 1,000 feet from the approach end, even if the speed is slightly high.

Flying over the end of the runway at 100 feet altitude rather than 50 feet could possibly increase the total landing distance by approximately 900 feet on a 3° glide path. Glide path angle also affects total landing distance. If the altitude over the end of the runway is correct (50 feet), but the approach path is flatter than normal, total landing distance is increased. A combination of excess height over the end of the runway and a flat approach will most certainly use up valuable runway that may not be available.

* * *

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>
> Final approach speed with wind gradient effect/headwind exceeding 10 knots: Reference + 1/2 the reported wind value: MAX is Reference + 20 knots.
>
> Final approach speed with gusts: Reference plus the full value of the gusts plus 1/2 the reported wind value: MAX is Reference + 20 knots.

Remember that as the airplane approaches the runway threshold the wind gradient correction should be removed: cross the runway threshold at Reference + the additive for gusts. If the wind gradient is not fully accounted for during the approach, be alert to the need for sudden thrust increases to maintain airspeed and position on the approach path.

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* * *

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Flying over the end of the runway at 100 feet altitude rather than 50 feet could possibly increase the total landing distance by approximately 900 feet on a 3° glide path. Glide path angle also affects total landing distance. If the altitude over the end of the runway is correct (50 feet), but the approach path is flatter than normal, total landing distance is increased. A combination of excess height over the end of the runway and a flat approach will most certainly use up valuable runway that may not be available.

* * *

When landing on a short, wet or icy runway, apply fuli pedal pressure early to reduce to a safe taxi speed.

* * *

Landing Data Card.--The landing data card for the accident flight was not retrieved from the airplane. A duplicate landing data card for the flight was prepared by Flying Tiger's supervisory flight personnel. (See table IV.)

'Table IV.—Landing data for Flight 2468.

Actual landing weight	252,00 pounds
Maneuvering speed Cor 0° flaps	204 kn (1.5 Vs)
Maneuvering speed tor 23 degrees flaps	173 kn (1.5 Vs)
Approach 35° flaps	139 kn (1.4 Vs)
Reference 50° flaps	141 kn (i.3 Vs)
Bug	146 kn
Go around EPR	1.83
Climb EPR	1.69

Interview with Flying Tigers Regions: Director-Flight Operations East.--The Regional Director, also a DC-8 check captain, stated that the reference speed for the approach was 141 knots with e 5-knot additive. An additive of 10 knots for the windshear report was proper. However. as the airplane approached tie runway threshold, all additives should have Seen removed. Flight 2468's airspeed should heve Seen approaching the reference speed of 141 knots at the 50-foot point. He stated that the maximum crosswind component ior a DC-8 wes 10 knots if there is X report of poor or nil braking.

He also stated that Flying Tigers teaches pilots to anticipate hydroplaning conditions when landing on a we? runway. The airplane should be landed firmly with no attempt to make R smooth lending. Hc said that, in any case, a pilot should avoid any float since the airplane decelerates more quickly on the runway.

The Regional Director stated that runway 10 was shorter than most runways used by Flying Tigers. He said. however, that he did not consider it a Short runway, and that it *did* not represent a problem for DC-8 landings.

1.17.3 Wheel Brake-Antiskid and Spoiler Systems

Wheel Brake-Antiskid Systems.--The hydraulically-operated disc brakes in each main landing gear wheel arc actuated by pressure from the main hydraulic system through a power brake control valve. The control valve is operated by the rudder pedals through a cable system. The antiskid system is a fully automatic pressure modulating wheel braking system which is controlled by individual wheel speed transducers, an antiskid control box, and individual antiskid control valves for each main wheel brake. The antiskid function *doe?.* not operate until the main wheels of the airplane spin up to about 80 knots. For efficient antiskid operation *or* 6 Wet runway, a firm touchdown should be made to ensure prompt wheel spin up.

When armed. the antiskid system (1)prevents locked wheels at touchdown and during rollout. (2) initiates automatic deployment of the ground spoilers when specfic pairs or all aft main wheels spin up past about 83 knots at touchdown, and (3) monitors wheel speeds to sense impending individual wheelskids and modulates the brake pressure to keep the wheels at the skid threshold.

The main gear wheel-speed transducers monitor individual wheel speeds which are transmitted to the antiskid control box. When the antiskid control box senses a wheel deceleration that requires antiskid control, the control box operates the corresponding antiskid hydraulic control valve to decrease brake pressure from the associated wheel brake.

The ground spoiler control box is powered from the antiskid control box. Wheel rotation signals from the aft wheel transducers provide ground spoiier actuation from the entiskid system.

Spoiler System.--The spoilers consist of five. hinged surfaces on the top of each wing. The purpose of the spoilers is to assist low-speed iatera! in-flight control and to spoil lift during the landing rollout. All ten spoilers act as ground spoilers after landing.

With the spoiler control iever armed. all spoilers will extend fully upon spin up oast 80 knots of certain Combinations of two of the aft main landing gear wheels after iouchdown if the antiskid system is armed. Should main wheels rotation fail to actuate the spoilers. they will be extended by compression of the nose gear oleo. A Slue light will illuminate when the ground spoilers are not fully retracted.

1.17.4 Timely Information of Airport Conditions

Airport traffic controliers in ?he terminal area are required to issue airport condition advisories necessary for an airplane's safe operation in time for the information to be useful to the pilot. 9/ This requirement includes information concerning braking conditions as affected by ice, snow, slush, or water. and factual information reported by airport management concerning the condition of the runway. The controller is required to furnish to all airplanes the quality of braking action reports as received from pilots or the airport management.

On December 23, 1962, the Safety Board issued safety recommendation A-82-156 following an airplane accident involving poor runway conditions. 10/ The Safety Board recommended that the Federal Aviation Administration:

> Amend air traffic control procedures to require that controllers make frequent requests for pilot braking action reports which include assessment of braking action along the length of the runway whenever weather conditions are conducive to deteriorating braking conditions and that the requests be made weli before the pilot lands.

9/ FAA Handbook: Air Traffic Control 7110-65C, Section 940(c) Chapter 5, dated January 21, 1982.

10/ Aircraft Accident Report--"World Airways. Inc., Flight 30H. N113WA. McDonnell Douglas DC-1030, Boston-Logan International Airport. Boston. Massachusetts, January 23, 1982" (NTSB-AAR-82-15); and Special Investigation Report--"Large Airplane Operations on Contaminated Runways" (NTSB/SIR-83/02).

In response to this recommendation, on May 18, 1983, the FAA amended Handbook 7110.65C, Air Traffic Control, to require controllers to request braking action reports from pilots when weather conditions are conducive to deteriorating or rapidly changing runway braking action. *As* a result of this response, the Safety Board classified the recommendation as "Closed—Acceptable Action."

The requirements of FAA Handbook 7110.65C are applicable to U. S. Navy air traffic controllers.

1.17.5 Hydroplaning

The Flying Tigers Operations Manual states, in part:

Aircraft Hydroplaning on Wet Runways

A film of water on runways can seriously affect aircraft ground controllability and braking efficiency. If the speed of the aircraft and the depth of the water increase: the water layer builds up and increases resistence to displacement, resulting in the formation of a wedge of water beneath the tire. The vertical component of this resistance progressively lifts the tire, decreasing the area in contact with the runway until, with certain aircraft configurations and depths, the tire is completely out of contact with the runway surface and starts hydroplaning on a film of water. In this condition, the tires no longer contribute to directional control and braking action is nil.

There are three types of hydroplaning:

(1) Dynamic Hydroplaning

This occurs when there is standing water on the runway surface. Water about 1/10 of an inch deep acts to lift the tire off the runwey as explained above.

(2) Viscous Hydroplaning

This type is due to the viscous properties of water. In this regard, a thin film of fluid not more than 1/1000 of an inch in depth cannot be penetrated by the tire and the tire rolls on top of the film. This can occur at a much lower speed than Dynamic Hydroplaning but requires a smooth or smooth-acting surface.

(3) Reverted Rubber Hydroplaning

This phenomenon requires a prolonged locked wheel skid, reverted rubber and wet runway surface. The reverted (curled back) rubber acts as a seal between the tire and the runway and delays water exit from the tire footprint area. The water heats and is converted to steam; the stesm supports the tire off the pavement.

From data adopted during hydroplaning tests, the minimum Dynamic Hydroplaning speed of a tire has been determined to be approximately 3.0 times the square root of the tire pressure in pounds per square inch. For the DC-8-63F and B747 the hydroplaning speed is 120-130 knots. The calculated speed referred to above is for the start of Dynamic Hydroplaning. During a landing roll, once hydroplaning has started, it may persist to a significantly slower speed depending upon the conditions encountered.

Therefore, it must be emphasized that when landing on a wet runway, close adherence to established operating procedures is essential with regard to touchdown point, speed control, and the use of spoilers, wheel brakes, and reverse thrust.

The following was excerpted from Flying Tigers Flight Operations Bulletin 83-19, issued October 2,1983:

Landing

Landing on wet or icy runways requires much greater stopping distances. Slush or water creates potential hydroplaning problems. The tremendous forces of splashing water or slush can cause flap or other damage. Water and slush can also freeze actuating mechanisms rendering the item inoperative. Loose snow on runways can obscure visibility when blown forward during reversing.

Beware of patchy surface conditions that can cause uneven braking action and directional control problems. Taxi-in after landing is often trickier than going out for takeoff. With ?he Same idle thrust, your aircrait (with a now-lower gross weight) will have a tendency to taxi faster.

1.18 New Investigative Techniques

None.

2. ANALYSIS

21 The Flightcrew

The flightcrew was properly certificated and qualified in accordance with existing regulations; there was no evidence that medical or physiological factors affected their performance. They had received the required rest period before beginning the flight.

22 The Aircraft

The airplane was properly Certificated, equipped, and maintained in accordance with existing regulations and approved procedures. There was no history of deficiencies with any component or system which would have affected She ability of the airplane to land and stop normally on the runway. The postaccident investigation revealed that the main landing gear tires, with the exception of the No. 7 tire, were in excellent condition and should have allowed a normal, effective braking process. The No. 7 tire exhibited more tread wear than the others. However, all treads were present on the tire, and there were no flat spots or other deficiencies which would have affected airplane braking.

The antiskid system functiened properly for seven of the tires. The logic wheelboard from the antiskid contro! box for the No. 1 tire was found to be inoperative during the postaccident examination. A failed logic wheelboard would disable antiskid controls from the No. 1 tire which would probably result in a locked tire situation upon the application of brakes at landing speed. This discrepancy probably would have caused a blown tire had it existed during the previous landing at JFX. Therefore, the Safety Board concludes that the logic wheelboard failed after Flight 2468 departed JFK. Moreover, the Safety Board concludes that the antiskid system operated properly during the larding and tnat the logic wheelboard failed as a result of it being submerged in the swamp for 11 days after the accident and before the airplane was removed. The Safety Board based this conclusion on the flightcrew's recollection that there were no malfunctions with the brake and antiskid systems and the absence of indicators'of antiskid malfunctions in the cockpit.

2.3 The Accident

The investigation revealed that the instrument approach and the landing were conducted in weather characterized by a low ceiling, reduced visibiiity, rain, and strong winds. However, rain, which resulted in the flooding of parts of the runway, and the crosswind and tailwind components were the only significant meteorological factors.

The CVR transcript and the flightcrew accounts indicate that the prelanding preparations were conducted in accordance with Flying Tigers procedures. In addition to properly configuring the airplane for landing, the captain instructed the first officer to use the No. 2 INS to monitor the winds for indications of windshear. The FDR information and the statements of the GCA air traffic controller established that the airplane was flown at or slightly above the 3° glide slope throughout the approach, and that the airplane was in the correct position to complete the ianding as it crossed the displaced threshold.

The investigation showed, however, that Flight 2468's indicated airspeed was 10 knots above the reference speed at the displaced threshold, and that the airplane landed as much as 3,800 feet beyond the displaced threshold. The long touchdown followed an extended air run as the airspeed was dissipated, with the result that as little as 4,268 to 4,968 feet of runway remained on which to stop the airplane. The investigation also indicated that, although all the decelerative devices were used, the flightcrew was unable to stop the airplane before it overran the runway.

The ineffectiveness of wheel braking was attributed to the flooded runway ,conditions and the manner in which the airplane was landed. The runway conditions had existed at the airport for at least 27 minutes before the accident but were not transmitted to the flightcrew or to the final GCA controller.

The Safety Board considered three factors significant to the cause of the accident:

- o The airport procedures to monitor and assess runway surface conditions, including the role of air traffic control in the development and transmission of runway surface data;
- o The captain's management of the approach and Ianding airspeeds, and his emphasis on planning for a windshear problem to the exclusion of planning for a wet runway landing; and
- o The effect of hydroplaning on the flightcrew's eiforts to stop the airplane.

Airport Procedures to Monitor and Assess Runway Conditions

Runway Condition.--The Norfolk area had recorded constant rain conditions for 6 hours before the accident, and moderate rainfall during the hour immediately preceding the accident. As a result, significant portions of runwey 10/28 were flooded with water depths of 1/2 to 3i4 inch. The general flooding conditions on the runway and some taxiways existed well before Flight 2468 first contacted the ASR feeder controller st Chambers Field and were confirmed by the Navy C-12 Beechcraft pilot who departed runway 10 at 0844. The presence of standing water on runway 10 was further confirmed by witnesses observations of water spraying from the landing gear of Flight 2468, and from runway observations made by Navy officials immediately after the accident. Consequently, the Safety Board concludes that significant portions of runway 10 were covered by standing water which was 3/4 inch deep in some places particularly the last half of zhe runway. Further, the standing water conditions had existed for at least 25 minutes before the accident occurred.

Airport Management Role in Assessing and Reporting Runway Conditions.--The airport management, in the person of the Air Operations Officer or the designated AOD, had the responsibility to monitor runway surface-concitions and to insure that runway surface condition reports were available to air traffic controllers and pilots. CFR personnel and the transient line crew were availabie to conduct runway inspections at the request of the Air Operations Officer, the AOD, the air traffic controllers, or piiots. Consequently, there was no organizational or staffing reason to preclude the close monitoring of runway surface conditions during periods of changing meteorological conditions. However, the investigation indicated that there were no clear procedures in effect to establish and conduct a program which would monitor and detect deteriorating runway conditions. The only reference to an inspection program was the FOD inspection conducted by CFR personnel, and these inspectiom were made at set times. Any other inspections to assess and monitor runway conditions depended on requests by the Air Gperations Officer, the AOD, or air traffic controllers. However, the Air Operations

Officer indicated that the initiative to conduct additional runway inspectiors came irom pilot requests through air traffic controllers, or as a result of observations of the tower controllers. Because AODs are not necessarily experienced in airport matters, AODs would not necessarily know when to initiate a request for a runway inspection based on changing or existing meteorological conditions. Consequently, without a specific procedure to govern a runway assessment and monitoring program, there is no guidance to insure that the airport personnel conducted an aggressive effort to detect runway contaminants and transmit the data to controllers and pilots.

Even before the October 25, 1983 accident, two factors were present which should have made the need for an active program to asses runway conditions in inclement weather obvious to airport management. The first factor was the documented history of runway flooding under certain meteorological conditions and the resulting low coefficients of friction which were recorded when the runway was flooded. The Air Operations Officer and the safety officer acknowledged they were aware that runway 10/28 had flooding problems when moderate rain coincided with strong northerly winds. Additionally, a survey of the runway, compieted 4 months before the accident, reported "major ponding "problems" with a low coefficient of friction when the runway was inundated. This produced "a marginal braking response and a potential for hydroplaning during inclement weether." The accident investigation revealed that, in fact, the runway did flood as predicted by the survey. However, no measures existed to (1) identify and correlate incipient weather conditions to possible runway flooding conditions, and (2) to alert appropriate personnel to begin monitoring the runway for deteriorating conditions. Additionally, there was no published notice which could have warned pilots of the tendency of the runway to flood under certain weather conditions. Finally, the controllers should have been informed by the airport management of the tendency of the runway to flood under certain conditions and, therefore, should have been ready to increase their surveillance of the runway conditions when there was the possibility that the runway might be flooded. The Safety Board believes that the airport management's failure to make provision for monitoring runway conditions in inclement weather contributed to this accident.

The second factor was the frequent use of Chambers Field by "heavy" 11/ transport category U.S. Air Force airplanes as well as commercial airplanes. The single main runway configuration, coupled with its modest 8,068 feet length, indicates to the Safety Board that formal procedures to develop and transmit data on runway conditions to the pilot are needed to maintain safe operations during inclement weather.

<u>Role of Air Traffic Controllers.</u>--Although flightcrews that have recently landed or taken off are best able to asses runway and taxiway conditions, the tower controllers must take the initiative to determine if adverse runway conditions exist or are developing as the result of the weather conditions. Piiots are the most direct source of runway surface information. However, visual assessments by controllers are as important as pilot reports since visual assessment of deteriorating conditions should promote controller requests to airfield menagement for a runway inspection and requests to pilots for braking aciion reports. Additionally. controllers should pass their observations of hazardous runway Conditions to arriving and departing pilots.

11/ Aircraft capable of takeoff weights of 300,000 pounds or more whether or not they are operating at this weight during a particular phase of flight.

The Safety Board believes that when runway conditions are deteriorating during continuing precipitation tower controllers should take the initiative to request braking action reports if they are not volunteered by pilots. As a result of Safety Recommendation **A-82-156,** controllers now are required to request braking action reports when deteriorating weather conditions affect the runway surface. Since only one airplane landed at Chambers Field during the hour before Flight 2468, there was no opportunity for the controllers to obtain a current braking report. However, the flooded runway and taxiway conditions should have been evident to the controllers despite the lack of pilot braking reports. The controllers did have the opportunity to request taxiway and runway condition reports from departing airplanes. The Safety Board believes that when the amount of water that was standing on the runway and taxiways produced a visible spray as the Navy **C12** departed at **0844** and the Boeing **727** departed at **0835,** tower controllers should have been alerted to the flooding conditions at the airfield if the actual presence of large puddles on the runway and taxiways had not done so. Consequentlv, the Safety Board concludes that the air traffic controllers did not exercise special care to monitor runway conditions during a time when weather conditions were conducive to deteriorating braking conditions. The controller's failure *to* inform the flightcrew of Flight 2468 that there was significant standing water on the runway resulted in a critical gap in the information the ceptain needed to make decisions about the approach and landing. The manner in which the captain would have used this information about standing water is only conjecture, although he stated that he would not have Ianded had the runway braking Conditions been "poor" or "nil." Consequently, the Safety Board concludes that the flightcrew of Flight **2468** lacked essential information, that the information should have been known by the controllers through informal observation and greater initiative, and that the latter's failure to provide the information to the flightcrew of Flight 2468 contributed to the accident.

In summary, the safety of operations on runways during inclement weather depends upon coordination between airport management, controllers, and pilots. Pilot braking action reports must be made regularly, and other observations of deteriorating runway conditions must be transmitted to controllers; this information must also be passed through controllers to airport management so that intelligent decisions regarding runway inspection can be made by airport management. At the same time, fontrollers must actively observe the airport to note deteriorating conditions and report them to the airport management for further assessment. Finally, airport management must maintain aggressive runway assessment programs to detect unsafe conditions as they develop. The October **25, 1983** accident again illustrates that significant shortcomings existed in the area of runway assessment. and coordination of information transmission among the persons who must use runway and airport information for operational decisions. The NAS Norfolk airport management failed to develop and implement a program to detect deteriorating runway conditions, and the air traffic controllers did not take the initiative to inquire of pilots and airport personnel the state of actual braking and runway conditions. Additionally, pilots using the runway before Flight **2468** landed did not report standing water conditions on the runway or taxiway, which would have informed both the controllers and airport management of the flooded condition.

Captain's Management of Approach and Landing Airspeeds

Flightcrew Judgment and Performance.--Pilots expect airport personnel to maintain runways in an acceptable condition and to report runway hezards through NOTAM and air traffic control advisories when hazardousconditions develop. However, pilots also should be aware of the effects of contaminated runway conditions on airplane stopping performance. Consequently, pilots must expect some degradation of braking when operating on a wet or contaminated runway. Since the final decision to land rests solely with the pilot, he must consider all factors as they relate to the particular operation -- landing performance of the airplane, runway length, prevailing wind, pilot reports, and air traffic control advisories. The Safety Board explored all of these factors as they were known to the flightcrew of Flight 2468 during preparations for the landing at Chambers Field.

Dispatch of Flight 2468.--The dispatch package that was given to the captain of Flight 2468 included incorrect information. The maximum zero-wind landing weight should have been stated as 265,844 pounds for runway 10 rather than 275,000 pounds for runway 28. Upon arrival at Norfolk, the tailwind component of 2 knots would have reduced the maximum landing weight to 256,304 pounds (based on the reported winds of 360° at 18 knots which resulted in a 2-knot tailwind component). A report of actual landing conditions in the dispatch package would not have changed the decision to begin the flight, nor would it have required any different landing data at Chambers Field. However, the captain believed that the airplane could be landed safely and legally, even with a slight tailwind component of up to 5 knots, at weights of up to 275,000 pounds. Consequently, the knowledge that he was landing at 252,000 pounds, well below what he assumed was the maximum weight, probably created false confidence. The Safety Board believes that if the captain had known that the maximum allowable gross landing weight was 256,304 pounds, he may have considered the landing at Chambers Field more difficult, and he may have analyzed the factors and events of the approach and landing from a different perspective.

The error in the dispatch package concerning the landing weight and the preferred runway was made by the dispatcher who handled the flight. The error was as simple as determining the correct runway but then listing the wrong runway number on the dispatch package. The error was discussed by Flying Tiger's management and measures were taken to preclude a recurrence.

Notwithstanding errors by the dispatcher, there were two procedural redundancies which should have corrected the errors. The first redundancy was the captain's check of the dispatch package. The forecast wind of 020° favored runway 10, not runway 28, and this fact shouid have been recognized by the captain and corrected. Further, even if the captain had not noted the incorrect runway selection, he should have noted the different maximum landing weight by confirmation of the dispatch package data with the airport performance chart for runway 28. However, the captain accepted the information in the dispatch package without cross-checking the accuracy of the data as required by the Flying Tigers Operations Manual.

The second procedural opportunity was the preparation of the landing data by the second officer before landing. The second officer correctly determined the appropriate reference speed for runway 10, based on the actual landing weight of the nirplane, and informed the captain of the reference speed in accordance with normal Flying Tigers procedures. However, the captain retained his original misconception that the maximum allowable landing weight was 275,000 pounds, despite the fact. that the second officer had provided the prope: reference speed for the airplane and runway conditions.

Conduct of the Approach.--The flightcrew prepared properly for the approach and landing in accordance with applicable Flying Tigers procedures. The captain noted the pilot report for a "heavy windshear" near the runway and thoroughly briefed the first officer on the use of available cockpit instruments to detect and counteract the windshear. After the second officer had selected the proper approach reference speed (Vref) - 141 knots - the captain added 10 knots to the bug speed of **146** knots (Vref **plus** 5 knots) to compensate for the windshear. Consequently, the correct Flying Tigers procedures were followed when the approach was begun et an indicated airspeed of 157 knots even though the speed additives totaled 156 knots.

During the approach, the captain and Lhe first officer monitored continuously the indicated airspeed? the headwind component, and the drift angle as displayed on the INSs. Consequently, the captain was aware that the headwind component was decreasing. This condition was confirmed a? 0908:20, when the first officer announced that the headwind "five knots—should be gone by new." Ai that point. the indicated airspeed was announced as 154 knots, and the airplane was approaching decision height. According to flying Tigers procedures, the initial airspeed of **157** knots should have been reduced at that point so that the airplane would be at reference speed 141 knots at the threshold of the runway. At that point, the captain knew that the likelihood of a windshear was minimal, and that his priority was to attain the proper threshold crossing speed of 141 knots. The proper Vref should have Seen a critical milestone as the airplane approached a point 200 to 300 feet above the ground in the captain's decision io continue the landing or to make e missed approech. Flying Tigers procedures require the adjustment of the airspeed to i-ref a; this altitude and provide specific guidance to cross the threshoid at the proper Vref.

Additionally, tne captain was aware of ?he wet runway, that he needed 7,000 feet of runway to complete ?he landing, end that he would have a slight tailwind and a strong crosswind during the landing. The first *and* second officers recalled that the INS-depicted groundspeed was abou: 161 knots at the runway threshold, with a true airspeed of about 160 knots. However. the FDR data indicates that the indicated airspeed at tine runway threshold was about 151 knots. The difference between the FDR airspeeds and the observations of the flightcrew is attributed to the impact of ground effect on the IAS. Normally ground eiiect will lower the IAS from 1 to 4 knots. it is clear. in any event that the airplane was being flown faster than specified by Flying *Tigers procedures*, and that sufficient information was presented by the INS and the airspeed indicators to make the flightcrew aware of the deviations from procedures. Consequently, the Sefety Board concludes that the captain failed to manage the airspeed during the instrument approach in accordance with Flying Tigers procedures. The Safety Board also concludes that the first officer failed to announce that the indicated airspeed was at or above ?he maximum limit of 151 knots at the runway threshold, and that the captain nsd not decreased the indicated eirspeed significantly in ?he final 200 to 300 feet of altitude before touchdown. Tne failure of the captain to observe the procedures governing airspeed management during the approach and the failure of the first officer to announce the airspeed excursions were contrary to good cockpit menagement technique and approved company procedures.

The Safety Board further concludes that the principal reason for the mismanagement of the airspeed during the instrument approach may have been the flightcrew's preoccupation with a reported windshear near the runway. The captain's directions to use both INS for windshear detection, the 10-knot approach speed additive, and the conversations during the conduct *of* the approach about the windshear and the decreasing headwind component all support this conclusion. However, the flightcrew, in reality, was faced with two adverse situations--possible windshear and landing with a tailwind on a wet runway. The flightcrew focused on the potential windshear problem almost to the exciusion of the landing problem. There probably were two reasons why this division of attention occurred. First, the flightcrew was warned specifically of an earlier windshear, and had configured the cockpit to detect and counter tie windshear. Hence, as the airplane approached the runway without indication of a severe windshear, the flightcrew became more confident in eliminating windshear as a significant problem. In a sense, the flightcrew concentrated on a single aspect of the total approach and landing. Although the Safety Board considers the aforementioned as the primary reason for airspeed mismanagement, a second reason was the captain's perception that he was well below the maximum allowable gross landing weight, so that the actual touchdown and stopping on the runway should have presented no appreciable difficulties. Consequently, the important landing phase of the flight was minimized in the planning and briefing phase of the instrument approach. The flightcrew's focus on a single element of the approach rather than the approach and landing was incomplete cockpit management.

Although the flightcrew was not informed of the standing water on the runway, they were aware that it was raining and that the runway was wet. Consequently, the only conclusion the captain could have made was that he was landing on a wet runway with a strong crosswind and a slight tailwind. These facts alone should have compeiled him to manage the approach and touchdown airspeeds precisely to insure a landing at the proper place and at the proper speed. If the correct airspeeds and the landing point could not be achieved, a missed approach should have been made due to the complications involving the runway length and surface conditions, coupled with the crosswind and the tailwind components. The Safety Board concludes that the captain's poor management of the airspeed during rhe final portion of the instrument approach and his failure to identify and address ail the issues related to the landing led directly to the excessively long landing on e comparatively short runway.

Landing and Rollout on the Runway.--The data analysis, the statements of the GCA controller, and the CYR transcripts show that the approach profile was stabilized, and that the airplane crossed the threshold about the proper height. However, the indicated airspeed was a? least 10 knots higher than it should have been when the airplane descended through the 50-foot point at the threshold. At that poinr, the captain reduced thrust to fly the airplane below the glideslope to land the airplane as soon as possible. However. the airplane had excessive airspeed when the captain began the landing flare and the airplane entered an extended float. The Safety Board believes that the bounce reported by the tower controllers actually was the airplane rising and floating after the landing flare was initiated. It is possible, as the captain believed, that the initial touchdown was made on the left main landing gear. and that the airplane skipped back into the air. Nevertheless. regardless of whether the airplane bounced or began an extended float once past the threshold, the Safety Board concludes that the final touchdown on rhe runway was between 3,100 and 3,800 feet beyond tne threshold. The nominal touchdown point was about 1,000 feet past the threshold. according to Flying Tigers procedures and the runway-GCA-glideslope intercept point. The Safety Board based its conclusion regarding the touchdcwn point on the observations of ihe tower controllers and the airfield safety officer. Each witness was qualified in making accurate observations and had sufficiently different viewing angles so that their close correlation provides the basis for an accurate position determination. Additionally, the aerodynamic study of the airplane's flight profiie supported the observations of the witnesses.

The Safety Board recognizes the limits of the foil-type FDR to determine absolute values of airspeed, altitude, and heading. further, the Board recognizes that the 50-foot call by the second officer at 0908:36 and the 0908:34 calf by the GCA controiler were not necessarily precise. Therefore, it is not possible to determine whether or by how much the air run distance was estenaed due the approach profile relative to the threshold. However, the computation of air run distance from

0908:36, when the second officer announced "50 feet," to 0908:48, when the first officer said "four thousand left," involves a straight forward correlation and must be regarded as accurate. The Board believes that the captain's remark at 0908:47 ("let it sink") was made just before touchdown while the final tcuchdown and ground spoiler deployment occurred 2 seconds later at 0908:49, when the second officer said "spoilers extend." As a result, although the airplane may have touched down briefly at the 1,000-foot point, the Safety Board believes that the airplane landed on runway 10 between 3,100 and 3,800 feet beyond the runway threshold. Furthermore, based on FDR indications, the indicated airspeed at touchdown was about 129 knots.

The airport performance chart indicated that the required Ianding field length was 7,000 feet for lending on runway 10 while it was wet. At 146 knots at the 50-foot point over the threshold, the required landing field length was 8,260 feet. The required landing field lengths increase dramatically as the indicated airspeed increases. As a result, if the indicated speed and the tail wind equaled 157 knots, the landing field length required for a wet runway was 11,000 feet. The consequences of additional airspeed over Vfef and/or additional altitude above the 50-foot threshold crossing altitude are discussed in the Flying Tigers manuals. As a result. the captain. who knew he had about 1,000 feet sf "extra" runway if he was exactly at Vref for landing, should have been alarmed first by the extra airspeed at the threshold and secondly by the long touchdown on the runway.

Once the airplane landed on the runway by 0908:47, a point just before the intersection of runways 10/28 and 01/19, between 4,100 and 4,900 feet of runway was available in which to *stop*. This fact was announced **by** the first officer immediately after the iina! touchdown when he called "4,000 feet left." At that point, the ground spoilers had deployed and the captain had applied ?he wheel brakes. The captain also stated that he immediately applied reverse thrust on the engines. However, the CVR recordings indicate that the airplane's engines did not go into reverse thrust until 0908:55, and then for only about 10 seconds. It is likely that the initial delay in applying reverse thrust resulted from a momentary hesitation by the captain as he considered the possibility of a go-around from the runway. The captain stated that after the touchdown and the initial application of brakes, he knew the braking was totally ineffective and thtt he briefly considered a go-around from the runway. Assuming that the captain was aware ***of*** the iong touchdown, the brief consideration of a go-around after the final touchdown was almost unavoidable end explains the hesitation before the appiication of reverse thrust. However. the captain should have considered a missed approach et decision height when the indicated airspeed was excessive, or when the airplane started an extended flare. Once the captain accepted a iong touchdown, he should have been committed to either a maximum energy stopping effort, or an immediate go-around from the runway. Immediately after touchdown, the ground spoilers deployed and the engines had spooled down. The captain realized that wheel braking was totally ineffective. At that point, the prosoect of a go-around from the runway was poor, especially since a decision to go-around from the runway had to account for the time for the engines to spool up. As a result, the appiication of maximum reverse thrust was the only other means of slowing the airplane. However, reverse thrust was not selected until 7 seconds after landing. and then only used *for* about 10 seconds. Consequently, the Safety Board believes that after landing, the captain did not act in a timely manner to slow the velocity of the airplane.

The flightcrew was uneble to explain why or when the engines were brought out of reverse. However, it night have occurred *at* the time the airplane started off the right side of the runway and headed toward the car at the end of the runway. The captain remembered the *car* and his effort ***to*** steer the airplane back onto the runway. He may have inadvertently brought the engines out of reverse a! that time as he attempted to control the direction of the airplane. The latter action would be consistent with the Flying Tigers procedures, which states "on unusually slippery runways it should be noted that if the aircraft is permitted to weathervane into the wind, the use of reverse thrust could accelerate skid toward the downwind side of the runway. Under these conditions it may be necessary to reduce reverse thrust, use assymetrical reverse thrust, or possibly even return momentarily to forward thrust in order to regain good directional control and realign the aircraft with the runway.!'

In summary, several factors of the accident resulted from poor pilot technique, mismanagement of the cockpit procedures, and misjudgments of the captain. The failure to concurrently address the two problems of windshear and a landing on a wet runway was a matter of mismanagement and poor judgment. The lack of airspeed management in the final stages of the approach involved poor pilot technique and poor judgment since proper airspeed management is necessary without regard to the circumstances of a landing. Further, there were deficiencies in crew coordination in the approach. At decision height and thereafter, the first officer did not advise the captain that the airspeed was well above Vref. The excessive airspeed at decision height and the extended float should have prompted execution of a missed approach in accordance with Flying Tigers procedures. Finally, when the airplane landed well beyond the normal 1,000-foot touchdown point, the captain should immediately have applied maximum reverse thrust to slow the airplane.

The Safety Board believes that the airplane could have been stopped safely on the runway if the landing had been made at the 1,000-foot touchdown point at the touchdown speed of 129 knots. At least 2,000 feet of additional runway would have been avaiiable, as well as a better opportunity to utilize fully maximum reverse thrust and all other decelerative devices. Additionally, the first part of the runway was not flooded as badly as the middle and final portions, so more effective braking was available. That it was likely that the full runway distance was a sufficient distence for the flightcrew to stop the airplane is indicated by ?he fact the airplane had slowed to an estimated 35 to 50 knot at the time it left the runwey.

Hydroplaning

The final element in the accident considered by ?he Board was the role of hydroplaning. The evidence esrablishes that the airplane began to hydroplane immediately after touchdown on the runway. There were not any marks on the runway which indicated that maximum braking occurred. If any of the main landing gear tires had been in contact with the surface of the runway during the landing roll, some sign of braking would have been evident on :he runway surface and on the tires. Further, the examination of the brakes and the antiskid system showed no significant abnormalities.

The flooding of the runway provided the conditions for dynamic hydroplaning. It is likely that the landing and the speed of :he airplane created a situation where the wheels "skipped" across the surface of the water after lending. As in classical dynamic hydroplaning. the surface water could not escape from under wheels as the airplane moved down the runway. Each wheel pushed the water ahead of it, creating A wedge of water in front of, and under, each wheel. At a certain speed, the hydrodynamic pressure in the wedge of water between the wheel and the flooded runway surface exceeds ?he weight of the airplane and total dynamic hydroplaning speed is reached. At that point, the wedge of water penetrates the wheel contact area and the tire foot prints are iifted off the runway surface. The tire friction capability is reduced to zero since water does no? support shear forces sufficient to produce a significant coefficient of friction. Additionally. once total dynamic hydroplaning starts, it is likely to persist until the airplane reaches a speed which is well below the speed at which total hydroplaning is initiated.

In addition to the physical indications of dynamic hydroplaning and the presence of standing water on the runway, the landing speed of 129 knots would have been compatible with a hydroplaning situation. In fact, the theoretical spin up hydroplaning speed for the DC-8 is about 110 knots and the total dynamic hydroplanning during spin down would occur at a speed of about 128 knots. (See appendix F.) Therefore, the landing speed was sufficient to produce total dynamic hydroplaning at touchdown with delayed wheel spin up. Dynamic hydroplaning would have continued to decrease the braking coefficient as ?he airplane decelerated slowly.

After the airplane reached a point about 6,000 feet beyond the threshold, the ground speed had slowed and faint "steam cleaning" marks were evident on the runway. A set of white tracks was visible, emanating from each of the main landing gears. "Steam cleaning" is characteristic of the onset of reverted rubber skidding. This phase of hydroplaning did not develop fully since the tires did not have the physical characteristics of 'reverted rubber skidding. However, as the airplane slowed, the friction between the tire and the runway generate6 heat which turned the water to steam that cleaned the runway and left the white marks. It is likely that reverted rubber skidding would have developed fully if the airplane had not drifted off the runway at :he 7,000-foot point. Consequently, the Safety Board concludes that hydroplanning was a factor in the accident because (1) the physical evidence establishes that hydroplaning occurred, and (2) hydroplaning significantly reduced the effectiveness of wheel braking to the degree that, given the point on the runway where the captain landed the airplane, insufficient runway remained to stop the airplane safely.

The airplane's speed probably was in excess of 50 knots as the airplane drifted off the runway a? the 7,000-foot point and may have been 50 knots as the airplane crossed the airport boundry road. One witness estimated the ground speed as 35 mph. However, the momentum required to pass through ihe chain link fence and to plow through the swamp in the manner documented at the accident site indicates that the airplane could have been moving at 35 to 50 knots as it crossed the airport road.

While there is no question that the airplane encountered hydroplaning after landing, the Safety Board does not believe that hydroplaning and therefore an accident was inevitable because of the runway conditions, ?he meteorological conditions, and the dynamics of the airplane. Transport airplanes and flightcrews frequently operate on runways where hydroplaning is expected or encountered without losing control of the airplanes. Specific flight training is given pilots, and operational procedures are established to address the problems of operations on contaminated runways. Flying Tigers' operational guidance adequately addressed the problems of hydroplaning and provided specific procedures which governed airspeed management, landing technique, use of decelerative devices, and conservation of runway length. The Safety Board believes that the problems of hydropianing would have been minimized if the proper techniques were followed once the decision was made to !and. The touchdown at the 1,000-foot poin? should have been firm to allow wheel contact with the runway while wheel brakes and reverse thrust were applied. The additional runway would have allowed the captain to slow the airpiane by application of wheel brakes in the first one-third of the runway. and provided greater time for the proper and immediate use of maximum reverse thrust. The decelerative devices should have allowed the airplane to be stopped on the runway. When :he captain accepted an extended flare and long landing. and did not apply maximum reverse thrust immediately, he reduced the capability of the airplane to perform under the existing conditions. However, the earlier mismanagement of the approach and landing eliminated many of ?he options of the flightcren and made the hydroplaning conditions significantly more hazardous to Flight 2468.

The Safety Board conducted an in-uepth lnvestigation of the airport-controller-flightcrew relationship in its investigation of an accident involving World Airways, Inc., Flight 30H, McDonnell Douglas DC-10-30CF, N113WA, at Boston, Massachusetts, on January 23, 1982. 12/ The Board's report of that accident concluded that the actions and inactions of pilots, controllers, and airport management contributed to the cause of the accident. The facts of the Flying Tigers accident are similar to the World Airways accident, since it is apparent that information was available to pilots. controllers, and airport management which was no: developed, solicited, or communicated among the persons who required the information. As a result of the World Airways accident and the Special Investigation Report on Large Airplane Operations on Contaminared Runways, the Safety Board forwarded 17 safety recommendations to the FAA to address the regulatory inadequacies and safety deficiencies associated with operations on contaminated runways. The FAA had taken positive actio? cn mary of the safety issues referenced in the recommendations. The Safety Board believes: however, that civil airplanes operating from military airports are exposed to the same problems involving contaminated runways found at civil airports. Therefore. the Safety Board recommends that the Department of Defense consider the aoplicability of safety recommendations A-82-157 through -159 to military airports from which civil airplanes operate. Moreover, the Department. of Defense might wish to review the possible applicability of Safety Recommendations A-82-152 through -161, and A-82-163 through -169 to military aircraft operations.

3. CONCLUSIONS

3.1 Findings

1. The components and systems of the airplane functioned properly. Postaccident inspection found a defect in the wheel logic board on the No. 1 wheel, which probably failed after the accident.

2. The dispatch reiease for Flight 2468 incorrectly stated ?he maximum allowable gross ianding weight and the anticipated active runway.

3. The captain failed to discover the errcr in the dispatch reiease because he did not check the landing weight against the airport performance analysis chart.

4. The captain's mistaken belief rhat the maximum allowable gross landing weight for the runway was 275.000 pounds rather than 255.304 pounds probably influenced his management of the approach and landing.

5. The airplane's landing weight on runway 10 was below the maximum allowable gross landing weight prescribed by the operator for that length runway.

6. The before approach end landing briefing by the captain was complete and thorough with the exception of his failure to address the runway conditions for landing.

7. The flightcrew concentrated on the possibility of encountering windshear but failed io consider adequately the problems associated with landing on a 8,068-foot runway with a wet surface end a slight tailwind.

12/ Op. cit. Aircraft Accident Report World Airways, Inc.

8. The captain did not reduce the indicated air speed to the reference speed as the airplane approached decision height as required by the operator's procedures.

9. The first officer did not advise the captain when the indicated airspeed was at least reference speed plus 10 knots as the airplane approached an altitude between 200 and 300 feet above the runway.

10. The captain was aware that the headwind had changed to a slight tailwind, and that no gusty surface wind conditions had been reported for the landing on runway 10.

11. The captain did not execute a missed approach when the airplane passed over the threshold at an indicated airspeed about 10 knots above Vref with a slight tailwind component.

12. The cockpit management by the captain during the approach and landing was inadequate.

13. The captain's failure to manage the approach airspeed produced a longer-than-normal float distance. The airplane landed between 3,100 and 3,800 feet beyond the threshold which left a maximum of 4,968 feet for stopping.

14. Wheel brakes and ground spoilers were used immediately, but reverse thrust was not evident until about 7 seconds after landing.

15. The flightcrew never had effective braking since tne airplane encountered total dynamic hydroplaning immediately after landing.

16. Total dynamic hydroplaning was caused by the flooded runway conditions and the speed of the airplane on touchdown.

17. The airplane transitioned from dynamic hydroplaning to the initial stages of reverted rubber skidding jus: before the airplane went off the runway at the 7,000-foot point.

18. The flightcrew was unable to stop the airplane on the runway because of hydroplaning following an excessively long landing, and because reverse thrust was not used to the maximum degree possible.

19. The program at Chambers Field to monitor runwey conditions to detect the presence of standing water was inadequate.

20. Most of the runway fr( ) just before the intersection of the two runways to the departure end of runway 10 was covered with standing water 1/2 to 314 inch deep.

21. The problem of standing water on runway 10/28 was known to airport management, as well as the fact it caused a reduciion in runway friction.

22. Air traffic controllers should have observed the flooding conditions and reported that information to airport management and pilots.

23. The lack of data on the runway conditions resulted in a critical gap in the information upon which the flightcrew had to base their decisions.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the flightcrew's mismanagement of the airplane's airspeed, resulting in an excessively long landing on a wet, partially flooded runway; mismanagement of thrust reversers; and hydroplaning. Contributing to this accident was the failure of airport management to identify, assess, and disseminate hazardous runway conditions warnings and the failure of air Traffic controllers to inform the flightcrew that there was standing water on the runway.

4. RECOMMENDATIONS

As a result of its investigation, the National Transportation Safety Board recommended that the Department of Defense:

> Develop and institute procedures to meet the assessment and reporting requirements of 14 CFR 139.69 at military airports from which civil aircraft operate. (Class II, Priority Action) (A-84-61)

> Distribute to all military airports from which civil aircraft operate National Transportation Safety Board Special Investigation Report. Large Airplane Operations on Contaminated Runways (NTSB/SIR-83/02), and institute the actions recommended in Safety Recommendations A-82-157 and A-82-158 at military airports from which civil aircraft operate. (Class III, Longer-Term Action) (A-84-62)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ G. H. PATRICK BURSLEY
Member

/s/ VERNON L. GROSE
Member

Vernon Grose, Member, filed the following concurring and dissenting statement.

Concurring with the general content of the report, I nonetheless respectfully dissent on the adopted probable cause.

Any statement on probable causation should be based on the following recognition:

1. Its purpose is to point to accident prevention--not blame assessment.

2. It is only one of a list of subjective conclusions--and of itself cannot improve safety.

3. It will always involve multiplicity of factors, i.e., there is no single cause to an accident.

4. It is a means--not an end--to preventing future accidents of similar character.

5. It should be postulated with corrective/preventive measures in mind.

6. It must be linked, factor by factor, to appropriate and feasible corrective/preventive actions if it is to contribute to safety.

The adopted probable cause blames two groups of people--the flightcrew and airport management. Punishment is the logical action to be taken when blame is assessed. Since the Safety Board's role is not a punitive blame-setting one, it is inappropriate to point to human deficiency--unless the Board intends punishment for the indicated party.

A more profitable thrust for a statement on probable causation would focus on functions that in the instant case were not performed at the level required for safe operation. Such a functional statement logically leads to corrective or preventive measures that the Board can recommend to preclude future accidents.

Based on the foregoing reasoning, the following statement is offered as an alternative concerning probable causation:

> The National Transportation Safety Board determines that the probable causes of this accident were (a) lack of communication between aircraft and tower regarding the degenerated runway condition, (b) known and uncorrected lack of runway drainage, (c) flooded runway, (d) absence of a dynamic runway condition information reporting system for airport managers, (e) crossing the runway threshold at a ground speed about 16 knots above V_{ref}, (f) landing an aircraft over 2,000 feet beyond the nominal touchdown point, and (g) late application of reverse thrust.

/s/ VERNON L. GROSE
Member

Nay 30, 1984

APPENDIXES

APPENDIX A

INVESTIGATION

1. Investigation

The Safety Board was notified of the accident about 1015 e.d.t. on October 25, 1983. An investigative team was dispatched from Washington, D.C., and onsite investigative groups were set up for operations/ATC/witnesses, and airworthiness. The CVR and FDR groups convened in Washington, D.C. Safety Board specialists performed meteorological and airplane performance studies, and a sound spectral analysis of the CVR. A maintenance records group and a group to examine the antiskid system were convened at the Flying Tiger's facility in Los Angeles, California.

Parties to the onscene investigation were the Federal Aviation Administration, Flying Tigers, Inc., Air Line Pilots Association, and the Douglas Aircraft Company. The U.S. Navy was represented by an accident investigator from the Naval Safety Center.

2. Public Hearing

There was no public hearing nor a depositioned proceeding.

APPENDIX B

PERSONNEL INFORMATION

Captain James M. Baldwin

Captain James M. Baldwin, 48, holds Airline Transport Pilot Certificate No. 1640950, with airplane single and multiengine land and DC-8 ratings. He had a total of 7,804 flight-hours, of which 6,046 hours were in the DC-8. He had flown 123 hours in the previous 90 days. He had been off duty for 24 hours before departing on Flight 2468. His first class medical certificate was issued October 3, 1983, with the limitation that he possess glasses for near vision.

First Officer Robert Stickler

First Officer Robert Stickler, 42, holds commercial certificate No. 1715431, with airplane, single and multiengine land, and instrument ratings. He had a total of 6,759 flight hours, of which 5,447 hours were in the DC-8. He had flown 187 hours in the previous 90 days. Mr. Stickler had been off duty 12 hours before departing on Flight 2468. In the previous 24 hours, he had flown 2.4 hours before reporting for duty for Flight 2468. His first class medical certificate was issue September 19, 1983, and had no limitations.

Second Officer Stephen V. Gagliano

Second Officer Stephen V. Gagliano, 34, holds Airline Transport Pilot Certificate No. 2208791 with airplane, single and multiengine land, B707, and B720 ratings. He also holds flight engineer certificate No. 410805027 with a turbojet rating. Mr. Gagliano had a total of 5,017 flight hours, of which 2,126 hours were in the DC-8. He had flown 126 hours in the previous 90 days. He had been off duty for 24 hours before reporting for Flight 2468. His first class medical certificate was issued December 9, 1982 with no limitations.

APPENDIX C

AIRPLANE INFORMATION

McDonnell Douglas DC8-63 N797FT

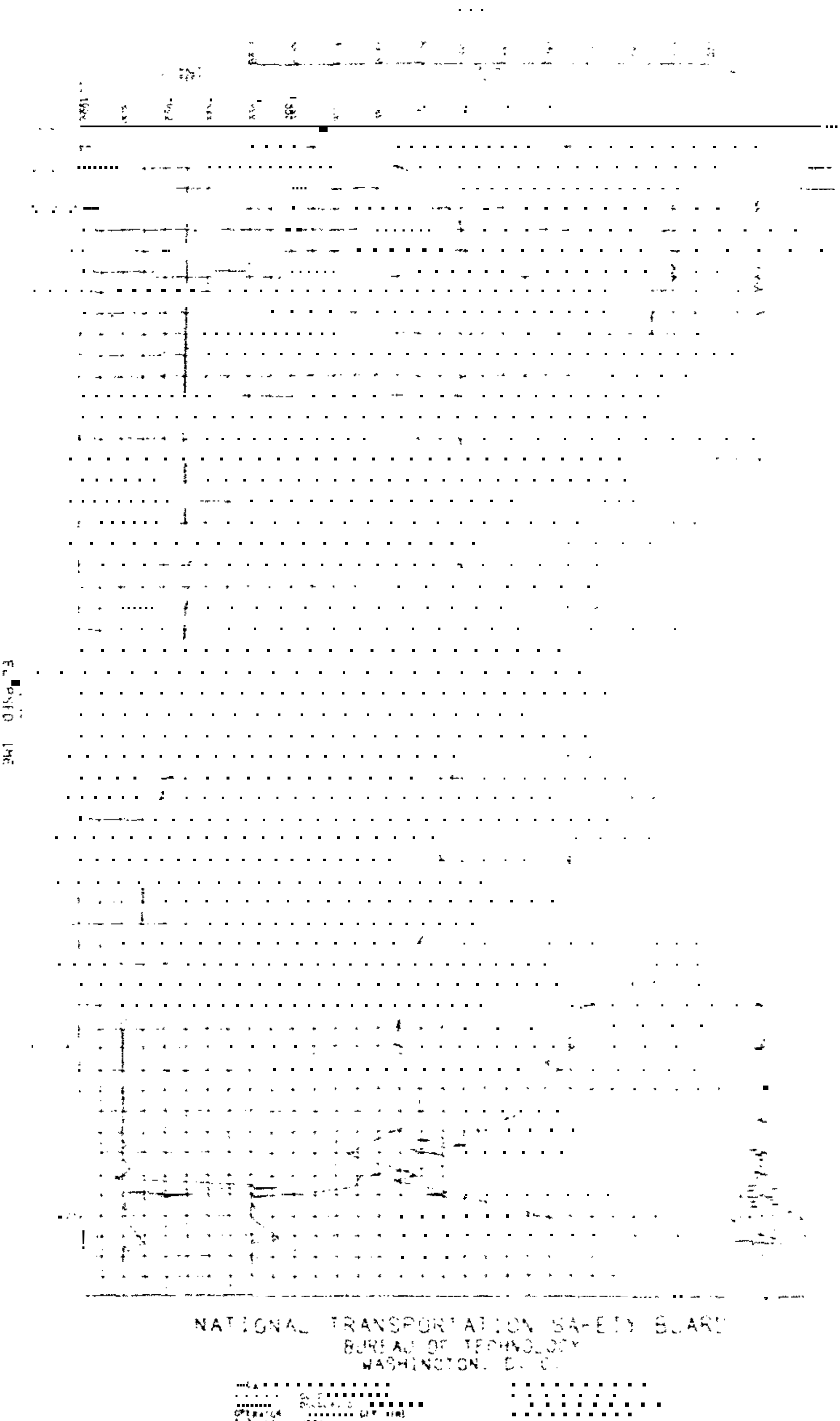
The airplane. manufacturer's serial No. 46140, was manufactured May 19, 1970. The total flying time was 46,317 hours. The airplane nad flown 85 hours since ?he lest major inspection. The sirplane was powered by four Pratt and Whitney JT3D-7 engines.

Powerplants

	Engine No. 1	Engine No. 2	Engine No. 3	Engine No. 4
Serial So.	671418	671159	671254	671102
Date of Manufacture	5-70	3-69	4-69	3-69
Total Time (hours)	39.224	38,787	37,743	40,893
Time since last shop visit (hours)	8,203	5,271	5,417	5,768

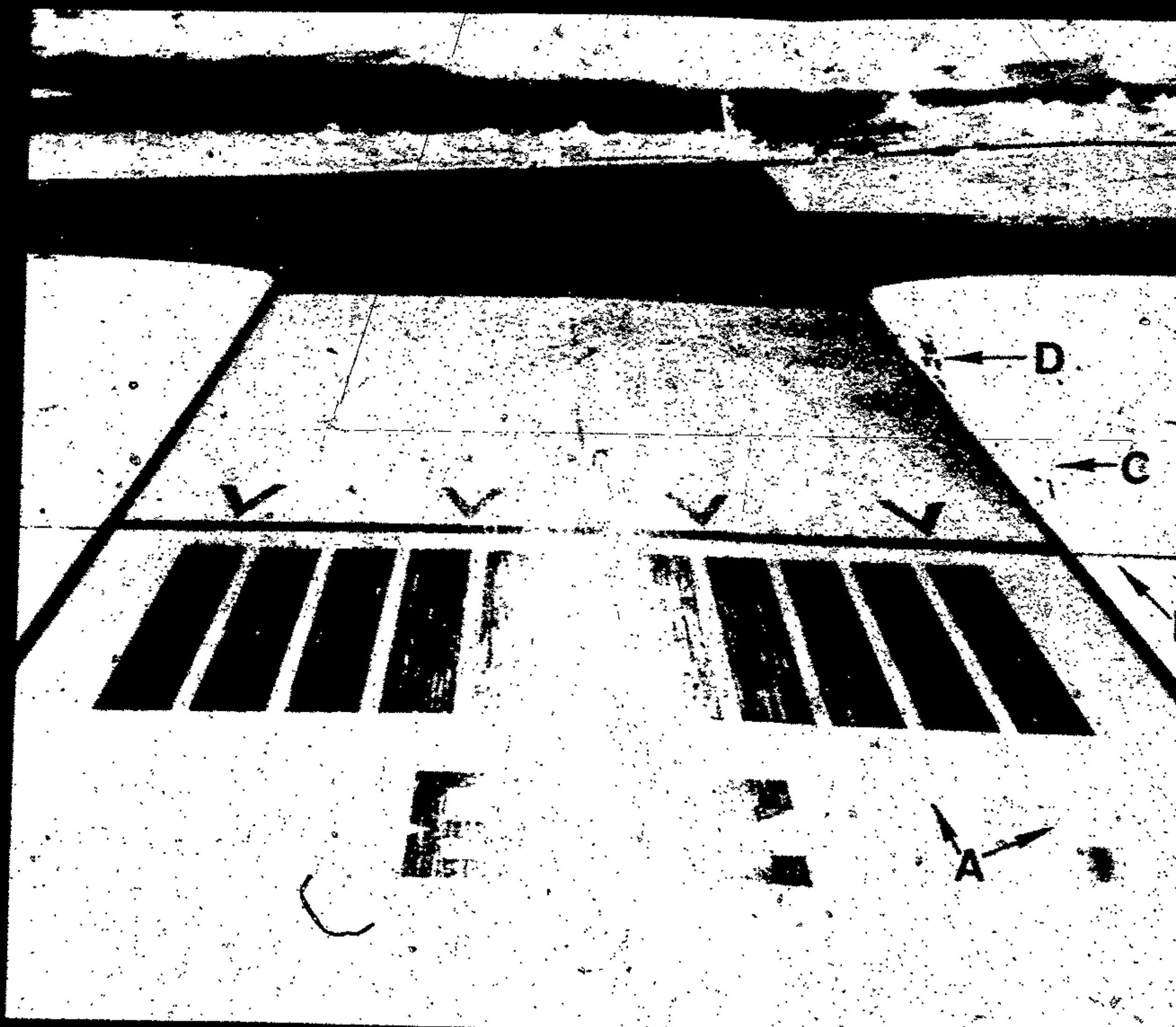
APPENDIX D

FLIGHT DATA RECORDER DATA



National

Flyi



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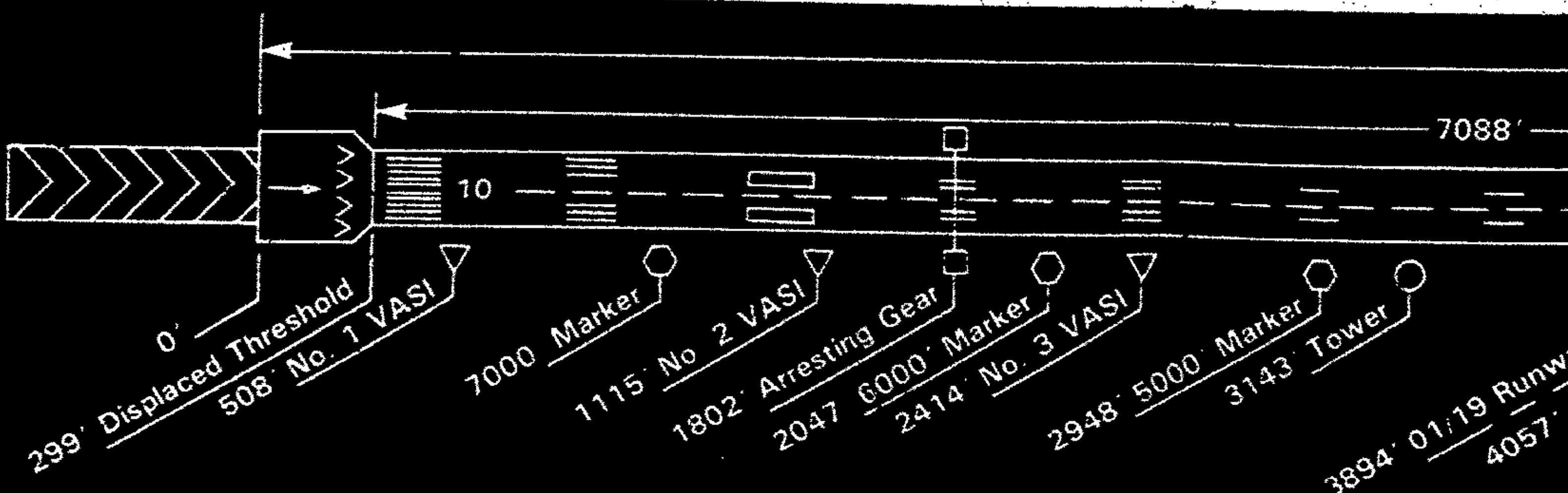
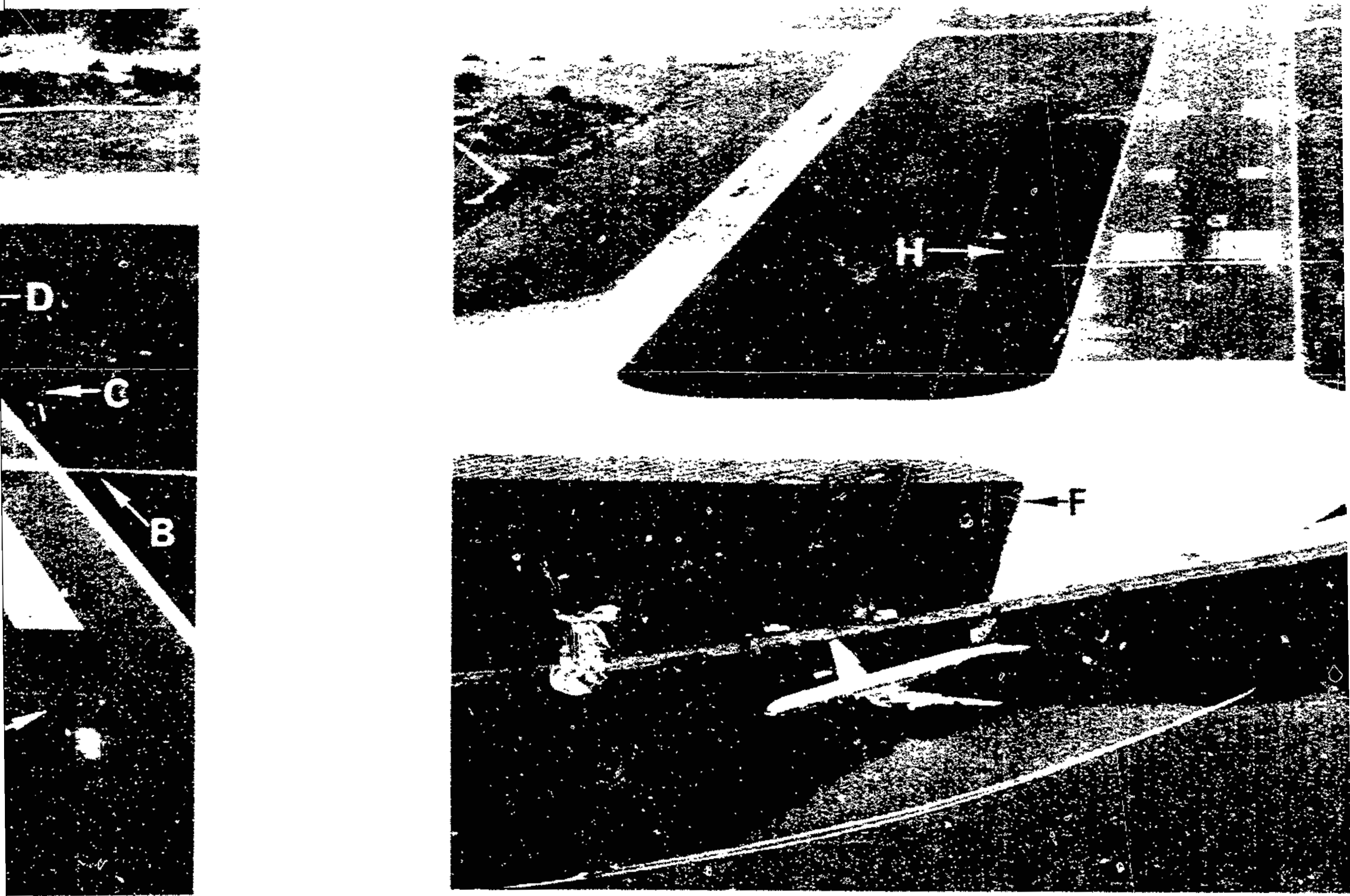
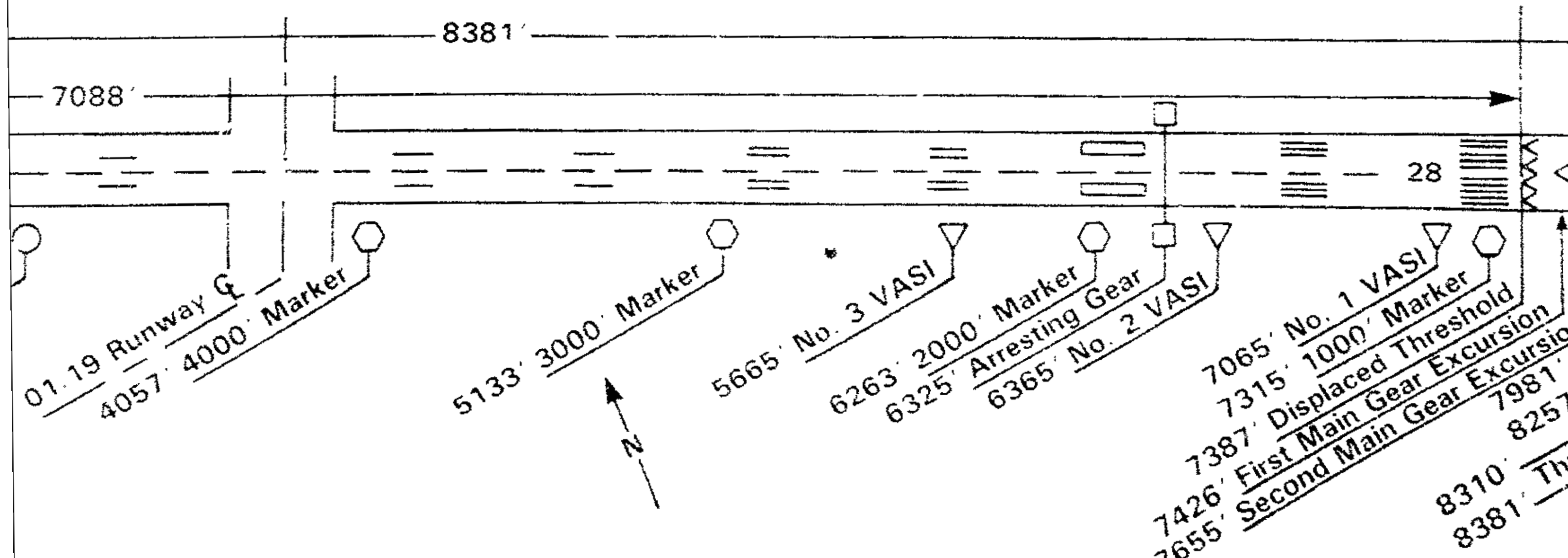


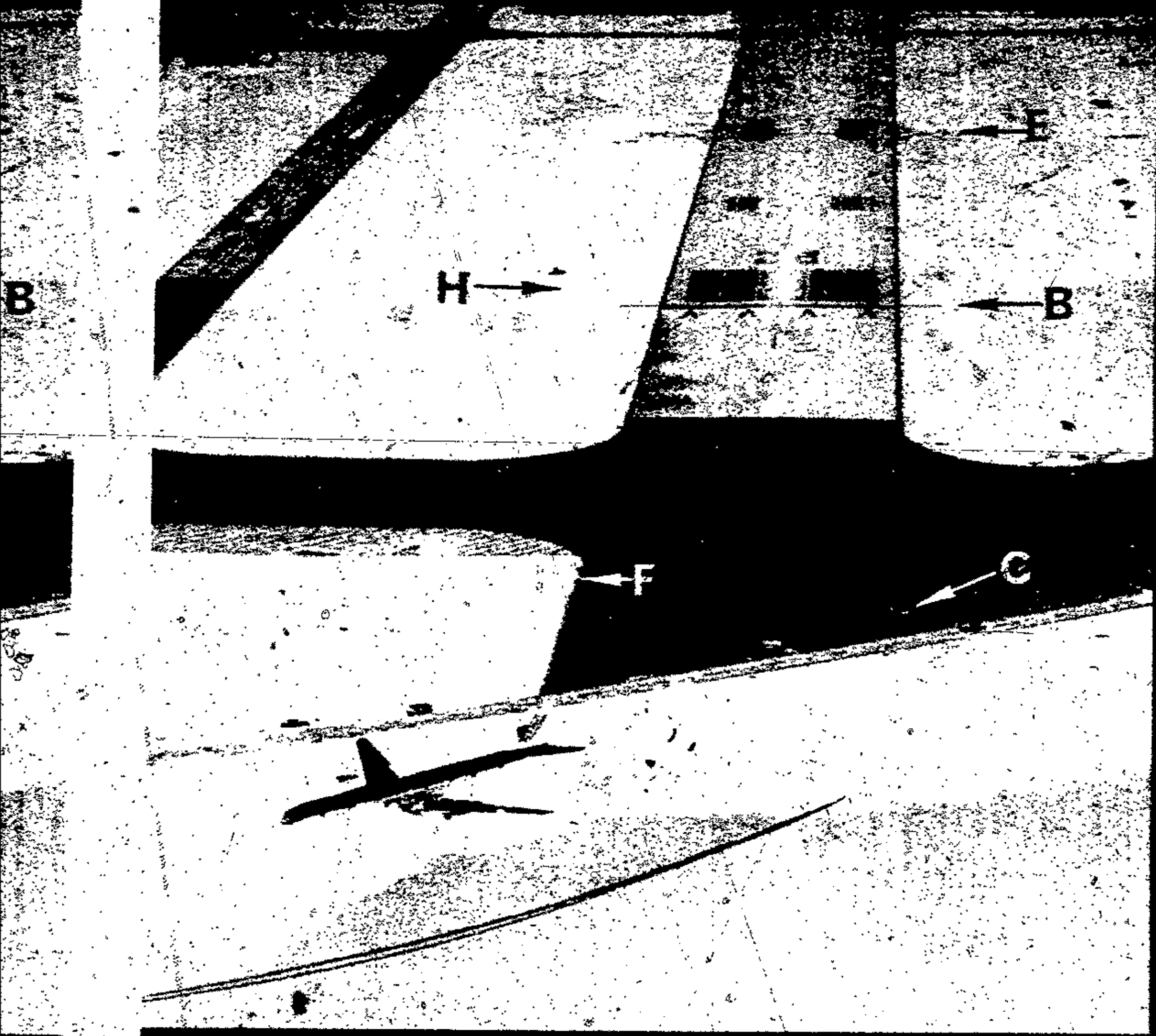
ational Transportation Safety Board

Flying Tigers DC 8-63
N797 FT
Norfolk, VA.

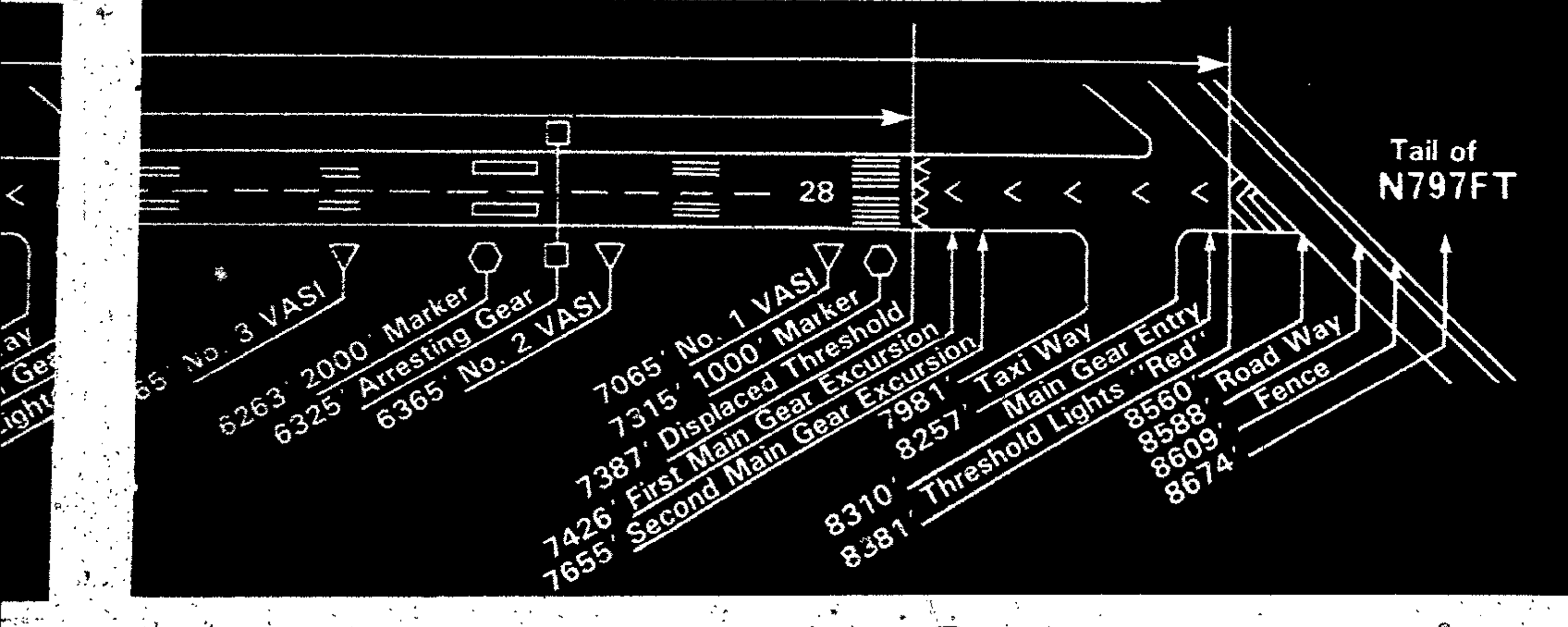




APPENDIX



Legend:
A. Runway Marks
B. Displaced Threshold Ligh
C. Right Main Gear Excursio
D. Left Main Gear Excursion
E. Arresting Gear
F. Left Main Gear Entry Ma
G. Threshold (Red Lights)
H. 1000′ Marker



APPENDIX F

HYDROPLANING TECHNICAL MEMORANDUM

<u>"FACTORS INFLUENCING AIRCRAFT GROUND HANDLING PERFORMANCE"</u>

The following are excerpts from a National Aeronautics and Space Administration Technical memorandum by Thomas J. Yager, issued June 1983:

Tire Friction Performance

<u>Viscous and Dynamic Hydroplaning</u>

During aircraft ground operations in wet weather, a water removal or drainage problem is created at tire/pavement interfaces. The runway surface water encountered by the moving aircraft tires must be rapidly expelled from the tire/pavement contact area or the viscous and dynamic water pressures that build up with increasing ground speed will significantly reduce tire friction performance. Research studies have shown that the slope of a tire friction-speed gradient curve is primarily a function of the surface macrotexture, and the magnitude of the friction at a given speed is related to the surface microtexture. Hence, an assessment of both surface micro- and macrotexture characteristics is necessary to fully relate tire friction performance to pavement texture.

The principal forms of these wet pavement tire friction losses are viscous and dynamic hydroplaning, and reverted rubber skidding. The speed regime, pavement and tire condition, and tire operating mode that contribute to loss in tire friction are identified together with the factors that tend to alleviate their occurrence. Viscous hydroplaning or thin-film lubrication results from the inability of the tire to penetrate and disrupt the very thin residual fluid film left on the pavement after the majority of the trapped water has been displaced from the tire footprint. In this case, the pressure buildup within the tire/pavement interface is due to fluid viscous properties. Smooth tires operating cn wet smooth pavements are particularly susceptible to this type of tire hydroplaning.

During dynamic hydroplaning, a buildup of hydrodynamic pressure between tire and flooded pavement occurs as the square of vehicfe speed. When this hydrodynamic pressure exceeds the tire-pavement bearing pressure, a wedge of water penetrates the tire contact area and the tire footprint is partially or totally detached from the pavement surface. Under total dynamic hydroplaning conditions. tire friction capability is reduced to near zero because of the inability of the fluid to support significant shear forces. It should be noted that for many wet pavement aircraft operations, reduced tire friction performance may occur from both viscous and dynamic fluid pressure buildup resulting in combined viscous/dynamic hydroplaning.

The contact pressure developed between tire tread and pavement establishes the escape velocity of bulk water drainage from beneath the tire footprint. High pressure tires can expel surface water more readily from the footprint than low pressure tires. When the aircraft ground speed equals or exceeds the escape velocity of water drainage from the footprint. choked water flow occurs. The tire has now reached the state of total dynamic hydroplaning. Test results indicate that the critical aircraft ground speeds required for this total hydroplaning condition to occur on flooded pavements with an unbraked tire are approximately:

Spin-down (Rotating tire) speed, knots $= 9\sqrt{\text{Infl. pressure, psi}}$

and

Spin-up (Nonrotating tire) speed, knots $= 7.7\sqrt{\text{Infl. pressure, psi}}$

For the nonrotating tire case (as at a aircraft touchdown), Langley track test results illustrate the delay in tire spin-up following touchdown on a flooded surface until the test carriage speed decreased to approximately **93** knots. It is important that pilots be aware that the iower hydroplaning spin-up speed, rather than the high hydroplaning spin-down speed, represents the actual tire situation for aircraft touchdown on flooded runways.

Reverted Rubber Skidding

The third form of tire friction loss, reverted-rubber skidding, *is* named for the appearance of the tire tread skid patch after a prolonged locked-wheel skid. It is believed that friction-generated heat within the skidding tire/pavement contact area is sufficient to produce steam and cause the tire tread rubber to revert back to its uncured state. The soft gummy reverted rubber forms a seal around the tire footprint periphery and the entrapped steam and water significantly reduce braking and cornering capability. This hypothesis would also explain the distinctive (stearn cleaned) mark left on the pavement in the path. Evidence indicates tha? once started, reverted rubber skidding results in very low tire/pavement friction which persists down lo verv low speeds. With tire operation in a nonrotating mode, the loss of tire cornering capability ior directional control is possibly a greater problem. considering runway geometry, for pilots to overcome than the low braking performance. Providing snd maintaining runway surfaces with high macretexture and good drainage characteristics is very important in alleviating the occurrence of this aircraft tire friction loss as well as those associated with tire hydroplaning.

APPENDIX G

AIRPORT PERFORMANCE CHARTS

FLYING TIGERS
AIRPORT PERFORMANCE MANUAL
DC-8-63 JT3D-7

82-01

4/1/82

-84-

NORFOLK, VIRGINIA
NORFOLK NAS
NGU 10

TOGW NOT TO EXCEED 355,000 LBS

FLYING TIGERS DC-8-63 JT3D-7 23. DEG FLAPS

NGU 10 LENGTH= 8350 ELEV= 16. GRAD= 0.50

• STANDARD TAKEOFF EPR PERMITTED •

TEMP-F THRU 84 / 85-96

G/W	V1	VR	V2	V1	VR	V2
200	112	124	142	110	121	139
210	112	124	141	110	121	138
220	112	124	140	110	121	137
230	112	124	139	110	121	137
240	112	124	139	110	122	138
250	112	126	141	111	126	141
260	114	129	143	114	129	143
270	117	132	146	118	132	146
280	121	135	148	121	135	148
290	124	138	150	124	138	150
300	127	141	153	127	141	153
310	130	143	155	130	144	155
320	132	146	157	133	147	157
330	135	149	159	135	149	159
340	138	152	162	138	152	162
350	141	154	164	141	155	164
355	142	155	165	142	156	165

TEMP-F 97-110 / 110-122

G/W	V1	VR	V2	V1	VR	V2
200	105	116	132	100	112	137
210	105	116	131	100	115	129
220	105	118	132	104	118	132
230	106	121	135	108	122	134
240	110	124	137	111	125	137
250	113	127	140	114	128	139
260	116	130	142	118	131	142
270	119	133	145	121	134	144
280	123	136	147	124	137	147
290	126	139	150	127	140	149
300	129	142	152	130	143	151
310	132	145	154	133	146	154
320	134	148	156	136	148	156
330	137	150	159	139	151	159
340	140	153	161	141	154	161
350	143	156	163	144	156	163
355	144	157	164	146	158	164

GROSS WEIGHT CORRECTIONS

BARO PRESS--FOR EACH .1 IN HG BELOW 29.70 USE 1 DEG HOTTER TEMP.

TEMP DEG F	ZERO WIND	CLIMB LIMIT	
-10	3337	3599	RWY
0	3303	3598	RWY
10	3270	3596	RWY
20	3237	3594	RWY
30	3204	3593	RWY
32	3198	3593	RWY
34	3191	3592	RWY
36	3185	3592	RWY
38	3179	3592	RWY
40	3173	3591	RWY
42	3166	3591	RWY
44	3160	3591	RWY
46	3154	3590	RWY
48	3148	3590	RWY
50	3142	3589	RWY
52	3135	3589	RWY
54	3129	3588	RWY
56	3123	3587	RWY
58	3117	3587	RWY
60	3111	3586	RWY
62	3105	3586	RWY
64	3100	3586	RWY
66	3094	3585	RWY
68	3088	3585	RWY
70	3082	3585	RWY
72	3077	3584	RWY
74	3071	3584	RWY
76	3065	3584	RWY
78	3059	3583	RWY
80	3054	3583	RWY
82	3048	3583	RWY
84	3042	3582	RWY
86	3023	3550	RWY
88	3003	3518	RWY
90	2983	3486	RWY
92	2963	3453	RWY
94	2944	3421	RWY
96	2925	3388	RWY
98	2905	3356	RWY
100	2886	3324	RWY
110	2795	3154	RWY
120	2690	2980	RWY
122	2671	2949	RWY

ADJUST ZERO WIND WT FOR
- WIND
- RUNWAY SHORTENING
- RUNWAY CLUTTER
- ANTI-SKID INOPERATIVE
- MEL PERF. DECREMENTS

ADJUST CLIMB LIMIT FOR
- MEL PERF. DECREMENTS

WIND-ADJUST ZERO WIND WT
ADD 553 LBS/KT EFF HW
SUB -2491. LBS/KT EFF TW

RUNWAY CLUTTER DECREMENT

DRY SNOW -IN-	STANDING WATER SLUSH OR WET SNOW -IN-	ZERO WIND WT RED -LBS-
4 TO 6	1/4 OR 1/2	22756

ANTI-SKID INOPERATIVE DECREMENT
- REDUCE RW LIMIT WT BY 11850 LBS
- TOGW NOT TO EXCEED 340,000 LBS
- LNDG WT NOT TO EXCEED 230,000 LBS

NOTES

1. LIMITING OBSTACLE — NONE
2. AT TOGW LESS THAN 200,000 LBS. USE V-SPEEDS FOR 200,000 LBS
3. FLAP RETRACT HT(OCH)= 1016 FTMSL
4. ---CAUTION NO REPORTED OBSTACLES-
5. LANDING LENGTH OF 8000' DUE TO DISPLACED THRESHOLD
6. LANDING LENGTH OF 7290' BASED UPON ILS GLIDE SLOPE

DC-8-63

LNDG FLAP	LENGTH	ANTI SKID	DRY MAX WT ZERO WIND	DRY HW ADJ	DRY CRIT TW	DRY TW ADJ	WET MAX WT ZERO WIND	WET HW ADJ	WET CRIT TW	WET TW ADJ	APT CRIT TEMP	SUB LB/F ABOVE CRIT TEMP	MAX OPER TEMP
50	8000	OPER	275000	0	10	0	275000	0	4	4949	122	0	12[illegible]
50	8000	INOP	211099	1003	0	3225	------NOT AUTHORIZED------						
50	7290	OPER	275000	0	7	5045	265844	1457	0	4770	122	0	12[illegible]
50	7290	INOP	------NOT AUTHORIZED------				------NOT AUTHORIZED------						

RESURVEYED

-95-

FLYING TIGERS

AIRPORT PERFORMANCE MANUAL

DC-8-63 JT3D-7

82-02 - 4/1/82

NORFOLK, VIRGINIA

NORFOLK NAS

NGU 28

TOGW NOT TO EXCEED 355,000 LBS

FLYING TIGERS DC-8-63 JT3D-7 23. DEG FLAPS

NGU -28 LENGTH= 8350. ELEV= 16. GRAD= 0.50

● STANDARD TAKEOFF EPR PERMITTED ●

TEMP-F	THRU 84			85-96		
G/W	V1	VR	V2	V1	VR	V2
200	112	124	142	110	121	139
210	112	124	141	110	121	138
220	112	124	140	110	121	137
230	112	124	139	110	121	137
240	112	124	139	110	123	138
250	112	126	141	111	126	141
260	114	129	143	114	129	143
270	117	132	146	118	132	146
280	121	135	148	121	135	148
290	124	138	150	124	138	150
300	127	141	153	127	141	153
310	130	143	155	130	144	155
320	132	145	157	133	147	157
330	135	149	159	135	149	159
340	138	152	162	138	152	162
350	141	154	164	141	155	164
355	142	155	165	142	156	165

TEMP-F	97-110			110-122		
G/W	V1	VR	V2	V1	VR	V2
200	103	116	132	100	112	127
210	105	116	131	100	115	129
220	105	118	132	104	118	132
230	106	121	135	108	122	134
240	110	124	137	111	125	137
250	113	127	140	114	128	139
260	116	130	142	118	131	142
270	119	133	145	121	134	144
280	123	136	147	124	137	147
290	126	139	150	127	140	149
300	129	142	152	130	143	151
310	132	145	154	133	146	154
320	134	148	156	136	148	156
330	137	150	159	139	151	159
340	140	153	161	141	154	161
350	143	156	163	144	156	163
355	144	157	164	146	158	164

GROSS WEIGHT CORRECTIONS

BARO PRESS--FOR EACH .1 IN HG. BELOW 29.70 USE 1 DEG HOTTER TEMP

TEMP DEG F	ZERO WIND	CLIMB LIMIT	
-10	3337	3599	RWY
0	3303	3598	RWY
10	3270	3596	RWY
20	3237	3594	RWY
30	3204	3593	RWY
32	3198	3593	RWY
34	3191	3592	RWY
36	3185	3592	RWY
38	3179	3592	RWY
40	3173	3591	RWY
42	3166	3591	RWY
44	3160	3591	RWY
46	3154	3590	RWY
48	3148	3590	RWY
50	3142	3589	RWY
52	3135	3589	RWY
54	3129	3588	RWY
56	3123	3587	RWY
58	3117	3587	RWY
60	3111	3586	RWY
62	3105	3586	RWY
64	3100	3586	RWY
66	3094	3585	RWY
68	3088	3585	RWY
70	3082	3585	RWY
72	3077	3584	RWY
74	3071	3584	RWY
76	3065	3584	RWY
78	3059	3583	RWY
80	3054	3583	RWY
82	3048	3583	RWY
[illegible]	[illegible]	[illegible]	[illegible]
84	3023	3550	RWY
88	3003	3518	RWY
90	2983	3486	RWY
92	2963	3453	RWY
94	2944	3421	RWY
96	2925	3388	RWY
98	2905	3356	RWY
100	2886	3324	RWY
110	2795	3154	RWY
120	2690	2980	RWY
122	2671	2945	RWY

ADJUST ZERO WIND WT FOR
- WIND
- RUNWAY SHORTENING
- RUNWAY CLUTTER
- ANTI-SKID INOPERATIVE
- MEL PERF. DECREMENTS

ADJUST CLIMB LIMIT FOR
- MEL PERF DECREMENTS

WIND-ADJUST-ZERO WIND WT
ADD 333 LBS/KT EFF HW
SUB -2491. LBS/KT EFF TW

RUNWAY CLUTTER DECREMENT :

DRY SNOW	STANDING WATER SLUSH OR WET SNOW	ZERO WIND WT RED
-IN-	-IN-	-LBS-
4 TO 6	1/4 OR 1/2	22736.

ANTI-SKID INOPERATIVE DECREMENT
- REDUCE RW LIMIT WT BY 13830 LBS
- TOGW NOT TO EXCEED 340,000. LBS
- LNDG WT NOT TO EXCEED 250,000 LBS

NOTES

1. LIMITING OBSTACLE — NONE —
2. AT TOGW LESS THAN 200,000 LBS. USE V-SPEEDS FOR 200,000 LBS
3. FLAP RETRACT HT(OCH)= 1016 FTMSL
4. ---CAUTION NO REPORTED OBSTACLES-
5. LANDING LENGTH OF 7350' DUE TO DISPLACED THRESHOLD
6. LANDING LENGTH OF 6678' BASED UPON ILS GLIDE SLOPE

DC-8-63

			DRY				WET					SUB LB/F ABOVE	
LNDG FLAP	LENGTH	ANTI SKID	MAX WT ZERO WIND	HW ADJ	CRIT TW	TW ADJ	MAX WT ZERO WIND	HW ADJ	CRIT TW	TW ADJ	APT CRIT TEMP	ABOVE CRIT TEMP	MAX OPER TEMP
50	7350	OPER	275000	0	7	8062	248359	1463	0	4785	122	0	122
50	7350	INOP	191724	971	0	934	NOT AUTHORIZED						
50	6678	OPER	275000	0	1	4868	240206	1397	0	4616	122	0	122
50	6678	INOP	NOT AUTHORIZED				NOT AUTHORIZED						

RESURVEYED