Sa-None File No. 1-0025

AIRCRAFT ACCIDENT REPORT

CAPITOL INTERNATIONAL AIRWAYS, INC.

DC-8-63F, N4909C

Anchorage, Alaska

November 27, 1970

Adopted: March 29, 1972

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20591
REPORT NUMBER: NTSB-AAR-72-12

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report NO. NTSB-AAR-72-12	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Aircraft Accident Report Capitol International Airways, Inc., DC-8-63F, N4909C, Anchorage, Alaska, November 27, 1970		5. Report Date March 29, 1972
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Aviation Safety Washington, D. C. 20591		10. Work Unit No.
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		13. Type of Report and Period Covered Aircraft Accident Report November 27, 1970
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract Capitol International Airways, Inc., Douglas DC-8-63F, N4909C, crashed following an unsuccessful takeoff attempt from the Anchorage International Airport . Anchorage, Alaska, at approximately 1705 A.s.t. The flight was being operated as a Military Airlift Command (MAC) contract flight from McChord Air Force Base, Tacoma, Washington, to Cam Ranh Bay, Republic of South Viet Nam, with en route fueling stops at Anchorage, Alaska, and Yokota Air Base, Japan. There were 219 military passengers and a crew of 10 aboard the aircraft. Forty-six passengers and one flight attendant received fatal injuries in the post-crash fire. At the time of the takeoff, precipitation, in the form of freezing drizzle, was occurring at the airport and the runway was covered with a light coating of ice. Evidence of tire skid marks, degraded rubber and shredded tire casings were found over most of the length of the runway. The National Transportation Safety Board determines that the probable cause of this accident was the failure of the aircraft to attain the necessary airspeed to effect lift-off during the attempted takeoff. The lack of acceleration, undetected by the crew until after the aircraft reached V_1 speed, was the result of a high frictional drag which was caused by a failure of all main landing gear wheels to rotate. Although it was determined that a braking pressure sufficient to lock all of the wheels was imparted to the brake system, the source of this pressure could not be determined. Possible sources of the unwanted braking pressure were either a hydraulic/brake system malfunction or an inadvertently engaged parking brake.

17. Key Words Aircraft accident, locked brakes, locked wheels, rejected takeoff, overrun.		18. Distribution Statement Released to Public. Unlimited Distribution.	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 46	22. Price

NTSB Form 1765.2 (11/70)

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CAPITOL INTERNATIONAL AIRWAYS, INC.
DC-8-63F, N4909C
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NOVEMBER 27, 1970

SYNOPSIS

Capitol International Airways, Inc., Flight C2C3/26, of Novemer 27, 1970, a Douglas DC-8-63F, N4909C, crashed and burned at approximately 1705 A.s.t., following a unsuccessful takeoff attempt from Runway 6R at the Anchorage International Airport, Anchorage, Alaska.

The flight was being operated as a Military Airlift Command (MAC) contract flight from McChord Air Force Base, Tacoma, Washington, to Cam Ranh Bay, Republic of South Viet Nam, with en route refueling stops at Anchorage, Alaska, and Yokota, Japan.

The investigation disclosed that the aircraft failed to become airborne during the takeoff run and overran the end of the runway. It continued along the ground and struck a low wooden barrier, the instrument landing system (ILS) structure, and a E-foot deep drainage ditch before coming to a stop approximately 3,400 feet beyond the end of the runway.

The aircraft was destroyed in the intense ground fire which developed subsequent to the crash.

There were 219 military passengers (including six dependents) and a crew of 10 aboard the aircraft. Forty-six passengers and one flight attendant received fatal injuries as a result of the post-crash fire.

At the time of the takeoff, a very light freezing drizzle was occurring at the airport. Runway 6R was covered with ice with braking action reported as fair to poor.

Following the accident, tire skid marks, degraded rubber and shredded tire casings were found over most of the length of the runway.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the aircraft to attain the necessary airspeed to effect lift-off during the attempted takeoff. The lack of acceleration, undetected by the crew until after the aircraft reached V_1 speed, was the result of a high frictional drag which was caused by a failure of all main landing gear wheels to rotate. Although it was determined that a braking pressure sufficient to lock all of the wheels was imparted to the brake system, the source of this pressure could not be determined. Possible sources of the unwanted braking pressure were either hydraulic/brake system malfunction or an inadvertently engaged parking brake.

RECOMMENDATIONS

As a result of this investigation, the Safety Board recommended that the Federal Aviation Administration take the following actions:

(a) Determine and implement takeoff procedures that will provide the flightcrew with time or distance reference to appraise the aircraft's acceleration to the V_1 speed.

(b) Initiate action to incorporate in its airworthiness requirements, a provision for fuel system fire safety devices which will be effective in the prevention and control of both in-flight and post-crash fuel system fires and explosions.

The Board further recommends that the Federal Aviation Administration in cooperation with the aircraft manufacturers and the National Aeronautics and Space Agency, utilize the results of extensive research and accident investigation data to develop and implement major improvements in the design of transport aircraft interiors. Of particular concern are the crashworthiness of galley equipment stewardess seats and restraining devices, and the flammability of cabin interior materials.

1. INVESTIGATION

1.1 History of Flight

Capitol International Airways, Inc., Flight C2C3/26, a DC-8-63F, N4909C, was a Military Airlift Command (MAC) contract flight scheduled from McChord Air Force Base, Tacoma, Washington, to Cam Ranh Bay, Republic of South Viet Nam, with en route refueling stops at Anchorage, Alaska, and Yokota, Japan.

The flight departed from McChord AFB at 1204 1/ on November 27, 1970, with 219 passengers and a crew of 10 aboard. It landed on Runway 6L at Anchorage International Airport at 1532. There were no unusual occurrences en route and the flight was described by the crew as routine.

The captain stated that during the landing rollout he used reverse thrust and medium heavy braking to bring the aircraft to a stop on the icy runway. Braking action was fair to poor and only light braking was used while taxiing to the ramp. After the aircraft was parked and chocked at the terminal ramp the parking brakes were released.

A mechanic who guided the aircraft to the ramp conducted a walk-around inspection after it was parked. He visually checked the tires for proper inflation and tread condition and found them completely serviceable. He noted no abnormal amount of heat radiating from the tires or wheel areas.

The only discrepancies noted on the inbound flight were a higher than normal amplitude indication on the No. 1 engine Airborne Vibration Monitor (AVM) instrument and an unreliable Engine Pressure Ratio (EPR) gauge, also on the No. 1 engine.

The No. 1 engine was uncowled and inspected during the refueling operation at Anchorage; however, no discrepancies were found and the engine was recowled.

It was determined that the No. 1 engine EPR system was inoperative but since all of the other engine instruments were operational and within limits, continued operations were permissible under the carrier's operating specifications.

The airplane was refueled with 117,227 pounds of JET-1-A fuel for a computed takeoff gross weight of 349,012 pounds. The allowable takeoff gross weight (structural limitation) was 350,000 pounds.

1/ All times herein are Alaska standrard based on the 24-hour clock.

Because freezing drizzle was falling, the aircraft was deiced just prior to its departure from the ramp. Both wings, the horizontal stabilizers, and all control surfaces were sprayed with a heated ethylene glycol solution.

The flight departed the ramp at approximately 1654 and, upon request, received clearance to Runway 6R. The takeoff checklist was completed except for the transponder and ignition override items, while the aircraft was being taxied to the runway. The flight was cleared to taxi into position to hold on Runway 6R at 1700:25, and was cleared for takeoff at 1702:40.

The captain stated that after the flight had been cleared into position he taxied slowly onto the runway and stopped the aircraft with the nose pointed slightly to the right of the centerline. He also stated he did not set the parking brakes while on the mway awaiting takeoff clearance and, further, that the parking brakes had not been reset at any time subsequent to brake release at the terminal ramp.

The first officer had been previously assigned to make this takeoff and while the aircraft was in position on the runway, the captain briefed the flightcrew that he (the captain) would handle the brakes, set the engine parer, and make the necessary airspeed calls attendant with the takeoff.

The remaining checklist items were completed by the crew and at approximately 1703, the flight was cleared for takeoff.

The captain stated that he advanced the power to 80 percent (N_2 compressor r.p.m.), released the brakes (pedals) and said, "lets go" to the first officer. He then advanced the throttles to the takeoff parer of 1.87 EPR. The No. 1 engine power was set by aligning the N_2 r.p.m., fuel flow, and exhaust gas temperature (EGT) indicators of that engine to correspond with those values obtained on the other three engines.

No movement or sliding of the aircraft was noticed by the crew prior to the brake release.

The reference speeds used for the takeoff were: V_1 - 138 KIAS, 2/ V_R 3/ - 153 KIAS, and V_2 4/ - 163 KIAS.

In regard to the takeoff, the captain testified: "The aircraft appeared normal, up to approximately 130 - 135 knots. The speed did not

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2/ V_1 - critical - engine failure speed; KIAS - knots indicated airspeed.
3/ V_R - rotation speed.
4/ V_2 - takeoff safety speed.

diminish, the acceleration somewhat was decayed or flattened out. I continued to V_1. V_1 was reached and there was no more decay, the acceleration was continuing ... and at 145 knots or ... somewhere within that area, the speed flattened out, the acceleration flattened out. We continued and it appeared that there was sufficient runway to continue the takeoff, rotate, and continue flight ....

"V_R was reached. I called V_R, and this appeared to be approximately ... eighteen to fifteen hundred feet from the end of the runway. The aircraft was rotated. I followed through (on the controls) with Mr. Downs, and the aircraft did not come off.

"At some point after leaving the end of the runway, it appeared to me that the tail was dragging, and I did not see any object in front of me, but it became a little rough, and I felt at this time that I should try to save the aircraft, the passengers, and *my* own self-preservation was on *my* mind, and that it would be better if I came to a stop on the ground rather than becoming airborne ... I reduced the power to off, or pulled the throttles completely off, there seemed to be three different impacts, and at each time I could not control any movement with *my* arms in the cockpit. The last impact the lights went out."

The first officer stated that prior to the start of the takeoff the captain ran the power up to 60 percent, released the brakes and said, "let's go", ... "I think it was simultaneous with his saying, 'let's go' the airplane started to move. I made a slight correction to complete the alignment of the aircraft with the runway, and shortly thereafter made another slight change to the left to get the nose wheel off of the centerline lights.

"It seemed like it took a few moments longer to get to V_1 than normal. With our rate of acceleration we had and the remaining runway, it appeared to me that there was no problem involved.

"Several times during the run to V_1, I checked the engine instruments, they all seemed to be reading properly, and at the 80 knot call, I checked the engine instruments too, and they were all reading normally.

"After V_1 there was a definite lag in the acceleration, but still with the rate it was increasing, it appeared to me there would be plenty of room to reach V_R, rotate, and clear the runway before the end.

"Upon reaching ... V_R ... it still appeared to me that we could rotate and become clear of the airport before the end of the runway. Upon reaching V_R, I rotated the airplane to about 9 degrees, and I believe it was about that time Captain Reid asked for the air foil deice to be turned off .... About that time I felt the airplane should have been airborne and flying, I became aware of a rumbling noise which I attributed to the main trucks running on the ground, on the roughened surface off the end of the mway."

Two passengers, both U. S. Air Force pilots, stated that the initial acceleration of the aircraft on the takeoff roll appeared to be slow and that after they had proceeded about 2,000 to 3,000 feet down the runway they began to hear a series of loud reports which they believed were the aircraft's tires blowing out. It was their consensus that the aircraft lacked the necessary speed for takeoff and that soon after the rotation occurred the ride became extremely rough. At about this point, the first of three impact jolts was felt. The nose of the aircraft came down and the engine noise ceased. They reported that all lights in the passenger cabin went out and that a fire developed on the left side of the aircraft before it came to a stop. Most of the other survivors gave similar accounts of the events that occurred during the takeoff attempt and crash sequence.

Two eyewitnesses to the accident testified that the initial portion of the takeoff run was normal with the exception that rotation occurred further down the runway than would usually be expected. One of these witnesses, who was on a taxiway adjacent to the runway, heard two or three loud reports shortly after the takeoff was initiated. He stated that these noises sounded like tires blaring out.

None of the flight deck crew heard the sounds or reports described by the passengers or witnesses, nor did they feel any unusual vibrations that they associated with blown tires.

The accident occurred at approximately 1705 during the hours of darkness.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other
Fatal	1	46	0
Nonfatal	6	43	0
None	3	130	

1.3 Damage to Aircraft

The airplane structure with the exception of the forward cockpit area and aft fuselage was completely destroyed by fire.

1.4 Other Damage

A wooden fence constructed of 4- by 4-inch timber, located 675 feet beyond the end of the mway was leveled. The ILS localizer support structure, located 1,002 feet from the end of the runway, was struck by the aircraft and received massive damage.

1.5 Crew Information

All crewmembers were certificated and qualified to conduct this flight. (For detailed information, see Appendix B.)

1.6 Aircraft Information

The aircraft, a McDonnell Douglas DC-8-63F, United States Registry, N4909C, was owned by the CIT Corp of New York and was leased to and operated by Capitol International Airways, Inc., a supplemental carrier, with headquarters at Metropolitan Airport, Nashville, Tennessee.

The aircraft was certificated and maintained in accordance with existing requirements. (For detailed information see Appendix C.)

1.7 Meteorological Information

The surface weather observations at Anchorage International Airport for a period prior to and following the accident were, in part, as follows:

1545 - Local, estimated 500 feet broken, 2,500 feet overcast, visibility 5 miles, very light freezing drizzle, fog, wind 060° 9 knots, altimeter setting 30.01 inches.

1555 - Measured 500 feet broken, 2,200 feet overcast, visibility 5 miles, very light freezing drizzle, fog, sea level pressure 1017 millibars, temperature 23° F., dew point 21° F., wind 040° 8 knots, altimeter setting 30.01 inches.

1655 - Record Special, measured 400 feet broken, 1,700 feet overcast, visibility 5 miles, very light freezing drizzle, fog, sea level pressure 1016.1 millibars, temperature 23° F., dew point 22° F., wind 050° 8 knots, altimeter setting 29.98 inches.

1707 - Special, measured 300 feet broken, 1,600 feet overcast, visibility 5 miles, very light freezing drizzle, fog, temperature 24° F., dew point 23° F., wind 060° 6 knots, altimeter setting 29.97 inches.

The record of surface weather observations for Anchorage showed that the freezing drizzle began at 1449 and ended at 2035. The wind velocity record showed approximately 6 knots at 1705.

There were no pilot weather reports available via teletype pertinent to the time and place of the accident. At 1508, the pilot of a Boeing 727 reported that braking action was fair on Runway 6R.

Sunset at Anchorage on November 27, 1970, was at 1459.

1.8 Aids to Navigation

Navigational aids were not involved in this accident.

1.9 Communications

There were no communication difficulties associated with this accident.

The flight had established normal communications with the Anchorage Control Tower. At 1700:25, Anchorage Tower cleared N4909C to taxi into position and hold on Runway 6R. Takeoff clearance was transmitted at 1702:40.

1.10 Aerodrome and Ground Facilities

Runway 6R is 10,900 feet long and 150 feet wide and has a paved asphalt surface. It has a gradient of -0.28 percent. The runway is equipped with high intensity mway edge lights, a high intensity approach light system with sequenced flashing lights, centerline lights, and touchdown zone lights.

All runway lights were on at the time of the accident. The terrain between the end of the mway and a drainage ditch located 2,620 feet from the runway is primarily a flat, plowed surface. The ditch, which is approximately 12 feet deep, is oriented perpendicular to the extended centerline of the runway. Beyond the ditch, the terrain is generally irregular, especially at the site where the aircraft came to rest.

A small barrier 3 feet high constructed of 4- by 4-inch wooden columns crossed the extended runway centerline 675 feet from the end of the runway. An ILS localizer facility and supporting structure was located at a point 1,002 feet from the end of the runway end on the approximate runway centerline.

An examination of runway conditions was made about 15 minutes after the accident. At that time a 1/16- to 1/8-inch glaze of relatively soft, moist, clear ice covered the surface.

1.11 Flight Recorders

N4909C was equipped with a Fairchild Model F2424 Flight Data Recorder (FDR) and a United Control V-557 Model Cockpit Voice Recorder (CVR).

The CVR tape had been exposed to excessive heat and no readout could be obtained.

The foil medium of the FDR was recovered relatively free of damage; all recorded parameter traces had been active and were readable.

The flight record was read out from a point coincident with the final turn to the takeoff runway to the end of the recorded traces. A datagraph plotted for this period covered a total time of 3:20 minutes. Because of large spikes or aberrations found in the indicated airspeed trace, a fairing wits made through the trace commencing with the maximum airspeed attained and working back to a resultant start of takeoff.

The readout shows that after the turn onto the runway the aircraft remained stationary on a heading of 064" (slightly to the right of runway heading) for a period of approximately 1 minute and 34 seconds. At this point, the trace indicates aircraft movement and a left turn to 058° followed by a slight right turn stabilizing between 060° and 062°. Coincident with the left turn the airspeed trace began to oscillate upwards from a below zero point to a median of approximately 50 knots as the heading became stabilized at about 062°. The maximum speed attained during the takeoff was 152 KIAS which wits reached approximately 72 seconds after the start of the takeoff. At this point the speed dropped off radically, and the altitude and the vertical acceleration traces began to show large excursions.

A comparison of various selected airspeeds versus time in seconds from the start of the takeoff showed the following:

KIAS	Elapsed Time from Start of Takeoff (seconds)
80	25 seconds
100	35 "
120	45 "
139 (V_1)	59 "
152	72

1.12 Wreckage

Evidence found on Runway 6R showed progressive deterioration of the airplane's tires during the takeoff run. The aircraft ran off the end of the runway and continued down the extended centerline of the runway, through the ILS localizer facility, and struck the far side of a deep drainage ditch. It came to rest in an upright position approximately 3,400 feet beyond the end of Runway 6R on a heading of about 020°. (See Appendix D.) The fuselage sustained a circumferential fracture near Fuselage Station (FS) 1320. The tail section came to rest about 30 feet from the main fuselage section and rotated 10° counterclockwise from it. The ensuing ground fire destroyed most of the fuselage and much of the wing structure.

Documentation of the evidence on the runway was made during the period November 29 to December 1. Prior to that time, the runway surface had been treated to remove the ice accumulation, therefore, some of the imprints left by the aircraft were partially obliterated before they could be documented.

Visible wheel tracks were made by the left main landing gear truck as it progressed from the taxiway onto the runway. This truck left a well-defined static footprint melted through the ice. The center of this footprint was located 100 feet from the threshold lights and 115 feet from the right (south) edge of the runway. The Tour tire prints in the ice were uniform in size. There was no evidence of skidding in the left wheel tracks leading to this footprint; however, skid marks extended in the direction of the takeoff roll (eastward) from the tire prints. Other skid marks were observed in the yellow paint of the runway identification marking "6R." The left inboard wheel tracks scrubbed through the ice and left scoring in the paint marking along the upright part of the numeral "6," and the right inboard track left similar marks along the front of the letter "R."

A piece of degraded rubber was observed 560 feet from the footprint of the left-hand truck, and similar pieces were scattered for 5,000 to 6,000 feet down the runway. These pieces had the appearance of rubber which had been partially melted, and then resolidified. Most of the degraded rubber was found to the right of the runway centerline. Two pieces of the rubber, one located 2,000 feet, and the other 2,500 feet east of the left-hand truck footprint, exhibited raised grooves similar to those in the tire tread. The tire pieces found in the first 2,700 feet from the footprint contained only tread rubber. Beyond that point, bits of tire cord were visible in the rubber, and by 3,200 feet, bits of loose fiber were struck in the runway surface.

At 3,480 feet beyond the static footprint, the left-hand inboard track became dark and well defined, with a narrow dark black band down its left edge. The wide band ceased after approximately 250 feet, but the narrow dark band and accompanying scores in the runway surface continued to the end of the runway.

By 4,300 feet, each left-hand track was reduced to two narrow bands (each approximately 2 inches in width) on the outside edges of the track. In this same area were found the first pieces of normal rubber. Parts of both tire caps and carcasses were identified.

The right-hand tracks were also reduced to narrow bands, similar to those described above, at a point approximately 8,700 feet beyond the static footprint. In that same area, a piece of tire bead from a right-hand inboard tire was found wedged into a centerline runway light.

As the aircraft ran off the runway, *only* tire tracks from the main landing gear were evident. The left outboard track was just to the right of the runway centerline at that point. Beyond the runmy, tracks in the snow were continuous until they intersected the drainage ditch 2,620 feet from the end of the runway.

A 71-foot long score in the ground began 545 feet beyond the end of the runway. This score, located between the wheel tracks, was made by the tail skid of the aircraft.

Six hundred seventy five feet beyond the runway, the aircraft passed through a wooden fence constructed of 4- by 4-inch timber and 1,002 feet from the end of the runway, the aircraft contacted the structure supporting the ILS localizer facility. The left inboard track passed directly through a stanchion which supported a 4- by 4-inch wood column. The first ground imprint of the nose landing gear began approximately 370 feet beyond the ILS localizer, and continued from that point to the drainage ditch.

Two small fragments of an aircraft wheel were found in the area traversed by the aircraft just before it struck the ILS structure. Both fragments exhibited areas which were ground flat. A number of parts including pieces of main landing gear wheels and tires, a cowling, landing gear doors, and pieces of wing flaps were found in the area of the ILS localizer and between that facility and the drainage ditch located approximately 1,600 feet beyond. The No. 2 engine, pieces of cowling, and landing gear parts were located in the area of the ditch, and numerous small pieces of fuselage structure, aircraft control surfaces, systems components, and engine cowling were located between the ditch and the sire of the main wreckage. Among these components was an intact brake assembly. This assembly had melted through the snow (1 to 3 inches), but it had not scorched the straw-colored grass under the snow. A nearly-complete wheel and tire assembly found nearby did not melt through the snow.

The 12-foot deep ditch which crossed the extended centerline widened to become a deep swale at the point where the centerline crossed it. The landing gear tracks terminated at the western edge of this swale. Five shallow depressions in the ground originated in the swale, approximately 2,700 feet from the end of the runway, and continued for various distances toward the main wreckage site. The spacing between these scores would correspond approximately with the respective distances between the four engines and the aircraft fuselage. A narrow trail of ground fire, which originated at the eastern edge of the swale between the depressions left by the right-hand engines, continued from the swale to the main wreckage site which was located approximately 700 feet east of the drainage ditch. A similar trail of ground fire originated on the left side of the aircraft approximately 300 feet east of the ditch and continued to the main wreckage site area.

The main landing gear assemblies were found, detached from the aircraft, in the vicinity of the primary wreckage area.

The left forward outboard wheel was found just beyond the ILS structure. The wheel had been forced off its axle and was fractured. There was evidence of parallel milling of both inboard and outboard flanges in one spot.

The left forward inboard wheel was recovered in several pieces along the overrun track. Fusable plugs from this wheel, which are designed to melt at highly elevated temperatures, were missing because of the location of the fractures. Segments of rims from this wheel exhibited milling in one spot.

The right forward inboard wheel was severely damaged by fire. Only the tube well surface and a portion of outboard tire rim about 12 inches in length remained. The wheel was deformed.

The right forward outboard wheel was almost totally consumed by the fire. The hub, segments of spokes, and tire well, and an inboard section of rim approximately 11 inches in length, remained. The left aft outboard wheel was reduced to the tire well surface and a portion of the rim. The edge of the remaining outboard wheel segment displayed an angular milling area.

The left aft inboard wheel was severely damaged by fire. Some spoke segments and seven tie bolts remained with the tire well. The right aft inboard wheel was almost totally consumed by fire. A section of the outboard flange, which was recovered separately, exhibited a milled spot approximately 3/8-inch deep. The right aft outboard wheel was also burned and only sections of the inboard flange remained.

The fusable plugs in the intact wheel rims were found in place. Most of these fuses had been burned to ash residue but had not blown.

Microscopic examination of the wheel bearings disclosed no evidence of scoring, flattening, or overheating. No deformations or discoloration were found on any of these bearings.

Seven of the eight main landing gear tires were recovered from the wreckage area and were examined by the Board at the tire manufacturer's laboratory. The eighth tire was destroyed in the fire. Five of these tires exhibited a milled "x" blowout pattern. X-ray examination of all seven tires revealed that they had blown out from friction milling and that none of the tires rotated after it had gone flat.

All wheel brakes were recovered and were examined in detail by the Board at the manufacturer's facility.

The No. 1 brake unit, which had been thrown clear of the aircraft in the vicinity of the ILS localizer structure, was generally intact and was functionally tested under pressure. All of the other brake units had received considerable damage during the impact sequence and could not be tested under pressure.

Minute inspection and disassembly of all brake assemblies revealed no evidence of overheating, abrasions, welding, or hard spots. All of the assemblies appeared capable of normal operation other than for the damage received during breakup.

Stators and rotors were measured for thickness and were found to be within operational limits. Other components of the brake system, i.e., hydraulic lines, valves, restrictor lines, etc., were severely damaged during the impact and fire. A few antiskid valves were recovered but were so badly burned that they could not be functionally tested. The brake control Valves were not recovered because of the total fire destruction in the wheel wells.

The cabling from the footbrake pedal torque tube mechanism aft to the normal vicinity of the main brake valves was severed and burned.

The parking brake handle was in the "off" position. There was no evidence of any failure or malfunction of the parking brake mechanism located under the floorboard beneath the captain's rudder pedals.

Because of the destruction in the wheel well areas, no integrity existed between the brake valves and pedals or airbrake handle, and the associated rigging and plunbing.

Empennage control surfaces were intact, however, all control cables from the cockpit were either severed or burned away.

The spoiler control lever was found in the stowed position. The control gust lock was in the "off" position.

The main hydraulic reservoir, return manifold and all other plumbing to the reservoir were destroyed in the fire. The hydraulic by-pass lever was in the "normal" position.

The wing flap actuators were positioned for an approximate 23° flap setting (takeoff position). Measurement of the horizontal stabilizer jackscrew assembly corresponded to a stabilizer setting of 4.2° aircraft noseup.

The landing gear lever was in the down and locked position.

The Pitot probes, together with both airspeed indicators, were functionally checked and found to be operational and within allowable tolerances. The Pitot tube heat switch in the cockpit was found in the "on" position.

1.13 Fire

The interior of the fuselage forward of the rear pressure bulkhead was totally gutted by fire. The major portion of the left wing and the inboard end of the right wing were also consumed by fire.

There was no evidence that a fire existed before the aircraft struck the ILS structure.

A dry chemical unit of the airport fire department arrived on the scene within 3 minutes after the crash occurred and initiated the fire-fighting and rescue activities. All airport fire units were operating at the scene within 5 minutes after the alert. Several minutes after the accident occurred, two fairly large explosions were observed emanating from the left side of the aircraft. Subsequent explosions occurred and hampered firefighting and rescue operations.

Fire/rescue units from the Air National Guard, Borough Fire Department, Anchorage Fire Department, and Elmendorf Air Force Base also responded and assisted in the firefighting and rescue activities.

1.14 Survival Aspects

Impact conditions were survivable, as the occupied area of the aircraft remained relatively intact and decelerative forces were not of a magnitude to cause incapacitating trauma that would have prevented escape. However, postcrash fire and explosions caused intolerable conditions which prevented the escape of some of the nonincapacitated occupants.

Pathological examination of the deceased disclosed that all of the fatalities, 46 passengers and one flight attendant, were caused by fire or by the inhalation of the products of combustion. There were no traumatic injuries found that would have caused death. In only one fatality was there *any* finding that would indicate a possible degree of incapacitation due to decelerative forces.

The aircraft carried a full load of 219 passengers. Of these passengers, 213 were active duty military personnel and six were military dependents. All of the dependents survived the accident.

The normal passenger load for the commercial Capitol International Airways DC-8-63F aircraft is 250 passengers with a 31-inch minimum seat pitch (fore and aft distance allowed for one row of seats). In the military (MAC Contract) configuration of 219 passengers the minimum seat pitch is 38 inches.

Most of the survivors stated that as the aircraft proceeded down the runway during the takeoff, they heard loud sounds described as tires blowing out. Following rotation, the aircraft ran off the runway and, according to the survivors, the ride became extremely rough and "bumpy." Three distinct impact jolts were felt, the last of which was described as extremely severe. At this time all lights in the passenger cabin went out

The first impact was with the ILS structure at which point structural damage was incurred in the left wing area. As the aircraft continued in the same direction, it traversed the 12-foot deep drainage ditch which initiated gross structural breakup and caused the most severe jolt felt by the passengers. An additional decelerative force was felt as the aircraft came to stop.

Survivors reported that fire broke out on the left side of the aircraft following the first impact and continued throughout the crash sequence. While the aircraft was still moving forward a passenger opened the left hand overwing exit and fire came into the cabin for a short period of time.

Major structural damage occurred on the second impact, at which time the aft section of the cabin broke open and the right wing tore loose spilling the fuel contained therein. A large fire then erupted on the right side of the aircraft. Some of the passengers seated in this area removed their seatbelts and attempted to move away from the fire. The third and final decelerative jolt caught them en route and threw them forward, injuring some.

Thousands of gallons of raw fuel which were released when the wing broke loose accumulated in one big pool, reportedly 6 to 8 inches deep, in and around the aircraft.

Also, during the impact sequence, numerous interior fixtures including galley equipment, overhead racks, and liferafts tore loose from their attachments and obstructed aisles and exits in the passenger cabin. The forward galley exit was completely blocked by loose galley equipment and the ceiling panel which prevented the use of this exit in the evacuation.

Flight attendants reported difficulty in remaining in their fold-down jmpseats during the crash sequence. One forward-facing double seat unit folded from under the attendant while the aircraft bounced Over the rough terrain. An attendant who was seated at a rear galley exit stated that during the crash the galley equipment began to come loose and in order to hold it secure she had to loosen her seatbelt and manually hold this equipment in place. Because of the loosened seatbelt she was thrown from her seat and, in fact, knocked unconscious so that she had to be carried from the aircraft by one of the passengers during the evacuation.

Survivors reported that an intense fire had developed along the left side of the aircraft before it came to a stop. Also, large amounts of raw fuel were observed in the aft cabin areas and on the ground adjacent to the aircraft during the evacuation.

Except for the forward galley door, which was blocked by galley equipment, all exits in the forward part of the cabin were opened and used for evacuation. Three of the four over-wing window exits were also opened and used

The majority of the fatalities had been occupying seats located in an area aft of the wing and forward of the main break in the rear passenger cabin. This area predominantly encompassed seating Rows 26 through 35. There are two jet escape doors located in this area (Row 33); however, according to a survivor seated next to the door on the right side, he was unable to open either of them. He exited through the break in the fuselage (near Row 36). The other survivors from this area, as well as all of the survivors in the forward cabin areas, used the over-wing exit, forward jet escape doors and forward entry door. It should also be noted that the fatally injured flight attendant was seated at Row 33 on the aisle seat near the left side jet escape door.

The remaining survivors in the aft cabin area either found themselves outside of the aircraft after it stopped or exited through the break in the fuselage. A few survivors used the aft galley exit which could only be partially opened as it was lodged next to a small embankment. The aft entry door was jammed and could not be opened by the flight attendant assigned to that station.

The cabin crew consisted of six flight attendants who were seated at their assigned stations for the takeoff. The six assigned stations were located at the forward and aft entry doors, the forward and aft galley doors, a passenger seat on the right side of the aisle near the forward jet escape exit, (Row 9), and a passenger seat on the left side of the aisle near the aft jet escape exit (Row 33). The flight attendants at the four door stations were using the fold-up type jmpseats located at the door entryways.

The captain stated that after the aircraft stopped he opened his cockpit window and yelled to the passengers who were leaving through the forward entry door to leave the area. He attempted to go back into the cabin through the cockpit/cabin door but it was blocked. He then exited through the left side cockpit window, went back to the main entry door and assisted passengers to get out of the aircraft through this exit. When no other passengers appeared at this door, he proceeded to the right side cockpit window and assisted the copilot in evacuating the flight engineer and the navigator who had been injured in the crash.

1.15 Tests and Research

Aircraft Acceleration

Normal takeoff acceleration data for the DC-8-63F, under conditions similar to those experienced by N4909C, on the Anchorage takeoff were computed as follows:

Conditions: Takeoff Gross Weight, 349,012 pounds; flaps 23°; Runway Gradient -0.28; Barometric Pressure 29.97 in./Hg.; Wind 060°, 6 knots; Temperature 24° F.; EPR 1.86.

Speed	Time	Distance
139 KIAS (V_1)	39.2 Seconds	4,500 Feet
153.5 KIAS (V_R)	44.5 "	5,700 "
163 KIAS (V_{LO})	48.0 "	6,600 "

Distance	Time	Speed
1,000 Feet	18.0 Seconds	72.4 KIAS
2,000 "	25.7 "	98.3 "
3,000 "	31.7 "	117.2 "
4,000 "	36.9 "	132.4 "
5,000 "	41.5 "	145.4 "
6,000 "	45.6 "	156.8 "
7,000 "	49.5 "	167.3

Friction Tests

At the request of the National Transportation Safety Board, the National Aeronautics and Space Administration (NASA) participated in the investigation and conducted tests relating to the rolling and sliding friction forces generated by aircraft tires at low groundspeeds.

NASA, in considering the various aspects and circumstances involved in the accident, noted that N4909C taxied for approximately 2 miles under heavy load to the end of Runway 6R, and then stood for approximately 1 minute and 30 seconds with brakes held awaiting takeoff clearance. During this time, the tires on the left main gear, which had been heated to some extent because of tire flexing during the long taxi run, melted the thin coating of ice and came to rest directly on top of painted markings on the end of the runway. As the airplane started to move on the takeoff run, skid marks were left in the parking footprints, thus indicating that the tires were sliding under the influence of take-off thrust. Thus, consideration wits given as to whether a tire which was skidded momentarily could then develop skidding friction coefficients on ice sufficiently low so that it would not begin to roll when the brakes were released. Low speed friction tests were made at the NASA test track to investigate this point.

It was noted that N4909C was equipped with Type VII, 44.5 x 16.5 -18, 30-ply rating, 225 m.p.h. tires, each under a vertical loading of 40,000 pounds. Since the equipment necessary for mounting a tire of that size to the carriage test fixture was not readily available, a Type VII, 49 x 17-ply rating tire was substituted. It had been determined under previous test conditions that the 49 x 17 tire provided a good substitute for the aircraft tire and that under identical vertical loading and inflation conditions only minor differences occurred in the footprints of the two tires.

NASA also conducted tests to determine whether viscous skidding of an unbraked wheel could be sustained on ice following brake release under skidding conditions on ice. It was determined, in all cases, that the tire spun up and rotated following brake release. Tire inflation pressures for these tests were varied from 200 p.s.i. to 50 p.s.i. in 25-pound increments, while the vertical load was maintained at 40,000 pounds.

The breakaway starting friction coefficient on frosted ice and on glazed ice was measured at 0.16 and 0.14, respectively. NASA thus noted that as long as the initial aircraft thrust-to-weight ratio exceeded these values the aircraft would have moved forward with brakes on and wheels locked. It was found that immediately upon sliding, because of water melting in the footprint from friction heating, the average sliding friction (0.025) dropped to a value which wis of the same order as the normal rolling friction (0.019). Thus, it was indicated that a takeoff could be continued under these conditions with little effect on the aircraft's acceleration, but with catastrophic effect on the tires due to degradation and loss of tread rubber.

Brake System Failure/Malfunction Inquiry

As part of the investigation inquiries were directed to 12 U. S. air carriers and one foreign air carrier operating Douglas DC-8 (60 series) equipment. The inquiries were directed toward determining instances of brake system malfunctions or failures which have occurred in the DC-8 fleets. Specific questions were posed regarding failure of brakes to release, abnormally high hydraulic system back pressures, hydraulic system contamination, and antiskid system malfunction.

While the majority of the operators had experienced no "major" brake system problems, several reported cases of either slow and/or incomplete brake releases because of either hydraulic system back pressure, suspected malfunction of an antiskid control valve, or suspected air locks in the brake system. Some of these cases involved all of the brakes and others involved one main landing gear only.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

The evidence developed during the investigation of this accident showed that the main landing gear wheels were not rotating during the takeoff run. As a result, the aircraft, operating within 988 pounds of its maximum structural weight limit of 350,000 pounds, failed to attain the computed lift-off speed of 163 KIAS. The entire usable length of Runway 6R, which was coated with ice, had been used in attaining the highest speed recorded of 152 knots. Considerable testing and analytical studies were conducted to determine the cause of the locked wheels as well as the operational consequences relating to the performance of the aircraft.

It was noted that after the aircraft taxied into position on Runway 6R, it remained there for approximately 1 minute and 30 seconds before the takeoff was commenced. This position on the runway was marked by a static footprint of the left main landing gear tires. These tires, which left clear tracks from the taxiway onto the runway, appeared to have rolled into the position marked by the static footprint, and, as evidenced by skid marks on the runway, apparently all four of these tires skidded out of that position.

The static footprint was caused when the heat of the tires melted through the ice covering on the runway. The heat necessary to melt the ice was most likely generated as a result of the long taxi run from the terminal to the runway (approximately 2 miles) at a very heavy gross weight. According to one study concerning heat generation for rolling tires, taxiing 1 mile at this aircraft's gross weight would have heated the air inside the tire to 160° F. It then follows, that a 2-mile taxi run would heat the tires to an even greater degree and, considering the time that the aircraft was in position on the runway, they would have melted through the ice as exhibited by the footprint.

The Board is unable to determine *why* there was no footprint from the right main landing gear. However, it is possible that the ice on the runway was not of uniform thickness so that there was little or no ice on the runway surface under the right main landing gear.

As was noted, evidence of skidding in the direction of takeoff was observed at each of the four tire prints made by the left truck. Skid marks from the right-hand inboard truck were observed just a short distance from the left gear static footprint. Progressive deterioration of all main landing gear tires began at the initiation of the takeoff and continued the entire length of the runway. The first scrap of reverted rubber was located only 560 feet from the start of the takeoff and by 2,700 feet from the starting point, the amount of fiber in the rubber scraps indicates that some or all of the tires were ground down to their carcass reinforcing cords.

It was determined that by 4,300 feet from the start of the takeoff, all of the left-hand tires were flat and by 8,700 feet all of the right-hand ties were flat.

Examination of the tires and wheels which were not extensively fire-damaged revealed that all were ground down in one contact area only, with no evidence to suggest that they had ever rotated during the attempted takeoff. The type of tire damage and blowout patterns appeared typical of that caused by locked-wheel skids. X-ray examination of all tires, except the No. 8 tire which was destroyed by fire, showed that none of the tires had rolled after it had gone flat.

In view of the above, it is concluded by the Board that all of the main landing gear wheels of N4909C rolled as the aircraft was taxied onto the mway and that they never rolled thereafter.

The crew stated that the initial acceleration or movement of the aircraft appeared quite normal following the application of takeoff power and brake release. The reason the crew did not detect the fact that the initial movement of the aircraft was a skid becomes easily comprehensible if considered in terms of the NASA runway friction data.

Assuming a total weight on the landing gear of approximately 349,000 pounds and a breakaway coefficient of friction of 0.14, only 48,900 pounds of friction drag could be created. With a total. engine thrust at 1.86 EPI (N4909C's takeoff EPR) equal to 74,600 pounds, only 65 percent thrust woul have been required to cause the aircraft to skid even with brakes on and wheels locked. Since the sliding coefficient of friction (0.025) is almo a full order of magnitude lower than the breakaway coefficient of frictio (0.14), a surge of acceleration possibly similar to a normal takeoff brak release would have been felt when the aircraft first started to move. Mo over, the sliding coefficient of friction was found to have been just slightly higher than the normal rolling coefficient of friction So that th initial acceleration would not have differed appreciably from that of a normal takeoff.

However, the effect on the tires due to degradation and loss of trea rubber was catastrophic. As the airspeed increased, the sliding coeffici of friction probably increased to values nearly double its low speed valu and as the degradation of the tires progressed to blowout, friction value must have risen significantly, probably to values near 0.2 to 0.3. The acceleration of the aircraft would, therefore, have deteriorated from the normal. takeoff acceleration at an increasing rate throughout the attempte takeoff, particularly during the latter stages.

A comparison of the McDonnell Douglas computations of distance versu time for a normal takeoff with similar computations obtained from integrat-ing the time/velocity data from the accident flight data recorder readout graphically demonstrated the results of this degradation:

Normal Takeoff Performance			Accident Takeoff Performance			Differential	
Distance (Feet)	Time (Sec)	Speed (KIAS)	Speed (KIAS)	Time (Sec)	Distance	Time (Sec)	Distance (Feet)
1000	18	72.4	72.4	22	1250	- 4	+ 250
2000	25.7	98.3	98.3	33	2650	- 8.3	+ 650
3000	31.7	117.2	117.2	45	4700	-13.3	+1700
4000	36.9	132.4	132.4	55	6600	-18.1	+2600
4500	39.2	139 (V_1)	139 (V_1)	60	7700	-20.8	+3200
5000	41.5	145.4	145.4	65	8800	-23.5	+3800
5584	44	152	*152	72	10,400	-28	+4816
5700	44.5	153.5(V_R)					

* Max KIAS attained.

The above comparison confirms the coefficient of friction tests applicable to the initial phase of the takeoff wherein the aircraft performance up to a speed of approximately 100 KIAS was just slightly below the normal expected performance.

Thus, detection by the crew that the wheels were not rotating and the attendant progressive performance degradation would have been difficult, if not impossible, during the early stages of the takeoff. Perhaps the only cue could have been an unusual feel of the aircraft at the initial breakaway. This thought was negated by the crew in their statements that the sensation of brake release was felt at the outset of the takeoff run.

From the foregoing discussion it is obvious, then, that the primary causal area concerns the reason, or reasons the main landing gear wheels failed to rotate during the takeoff. The possibilities for this unwanted condition are many, however, the evidence available in this case clearly indicates that a sustained braking torque, which was somehow applied to all of the main landing gear wheels subsequent to alignment on the runway, prevented *any* further rotation of them. There was no evidence found, or supportive data developed, which would indicate that a phenomenon such as hydroplaning had inhibited the wheel rotation.

In considering the conditions under which an equal braking torque, sufficient to lock all wheels, could have been applied, the following possibilities were raised:

- A malfunction occurred in the brake system or hydraulic system which either applied an unwanted brake pressure or prevented complete release of the brakes.

- High frictional forces developed by improperly installed wheels created sufficient resistance so as to prevent wheel rotation.

- The brakes were applied by the crew while in position on the runway and were unintentionally not released prior to the takeoff attempt.

Extensive examination of the brake assemblies revealed no indications of any failure or malfunction to these components. The parking brake mechanism was intact and operational and was in the released position. All clearances between the brake plates were normal and the discs showed no evidence of overheat, binding, welding, or any other abnormality that could have been associated with a braking torque problem.

The air brake lever was found in the "Off" and safetied position evidencing that no intentional application of the air brake occurred. Because the air brake cylinder was not recovered there was no way of determining if there had been an inadvertent application of air to this system which activated the brakes. However, this possibility is also rather remote in that a leaking air valve is designed to vent overboard and not into the system, thereby preventing the application of brakes.

The possibility of a malfunction within the hydraulic system leading to an unwanted brake application was also examined. Various system failure mode conditions were postulated and examined as to their effect on the brake system. It was found that under certain, albeit remote, conditions a flow of hydraulic fluid in excess of normal quantity could raise the pressure on the brake supply lines, through the return system, and apply brakes. For this situation to occur there would have to be failures to several of the cylinders which return fluid into the brake manifold in common with the fluid from the brake return lines. Excess pressure could then be transmitted from the brake manifold through the return system.

Along these same lines, if a restrictor check valve in the return system were to stick open, an abnormal pressure on the return side of the affected check valve could block the returning pressure of the brake return fluid and, thereby, delay the release of brakes previously applied. Similarly, if a one-way check valve in the return system to the reservoir became blocked the resultant pressure in this line could build up and hold the brakes on.

Because most of the hydraulic and brake system components such as valves, accumulators, and associated plumbing were virtually destroyed in the fire, no information could be derived concerning the system's preimpact condition. Therefore, from the evidence available no conclusions can be established as to the possible relationship between a hydraulic System malfunction and the locked brakes.

One chronic complaint noted in the maintenance records of this aircraft concerned a pull to the left during taxi operations. This frequently logged complaint was treated as a nosewheel steering discrepancy but it was not positively determined if this was, in fact, the actual problem causing the complaint, or if it had been satisfactorily corrected. It was theorized that the pull to the left may have been caused by a dragging brake rather than a nosewheel steering fault. If this were the case, it would seem reasonable that the problem would have noticeably manifested itself both through routine brake inspections or, possibly, through slower than normal takeoff acceleration during the course of actual line operation. However, no such documentation was found in log sheets or maintenance records to substantiate this possibility or any other theory pertaining to a brake system malfunction. (See Appendix C .)

The maintenance records indicated that six of the eight wheels had been changed at the company's maintenance base in Wilmington, Delaware, prior to the aircraft's departure for this flight. All of the main landing gear wheels and related wheel bearings were examined by the Board for evidence of high friction forces that possibly could have impeded free wheel rotation. All of the wheel bearings were in operational condition and there were no unusual surface markings or discolorations to indicate high frictional activity. Similarly, the bearing cups were in good order and showed no evidence of scoring or overheating.

Under the category of an unintentional and unwanted brake application, consideration was given to the possibility of an inadvertent foot pressure on the brake pedals during the takeoff by either the captain or first officer. The captain stated that he held the brakes with his instep on the rudder bar and his toes on the brake pedals while the engine power was being stabilized. Then, simultaneous with the throttle advance to takeoff parer he released the pressure on the brake pedals keeping his feet on the rudder pedals. The first officer stated that during the takeoff his feet were placed on the rudder pedals with his heels on the floor and that all steering was accomplished in this manner. He stated that he did not feel the brake pedals being depressed at any time during the takeoff.

With the existing slippery conditions of the runway and corresponding sliding coefficient of friction, only slight braking pressures would have been required to allow the aircraft to begin its initial slide from the takeoff position and to continue to the point where catastrophic degradation of the tires was in effect.

However, when the aircraft began to slide the rise in the coefficient of friction most certainly would have been sufficient to overcome dragging brakes, if in fact, the came of the condition was due to an inadvertent and slight braking pressure being applied to the pedals by one of the crewmembers. In that case, some indication of wheel rotation would have been evidenced either on the tires or the runway. In addition to the fact that no such evidence was found, it is also difficult to believe that the brakes could be applied and maintained equally in this manner without a conscious effort on the pibot's part to do so. It is, therefore, highly improbable that this possibility was responsible for the locked wheels.

The remaining possibility involves an unremembered act on the part of the crew, of setting the parking brakes while holding on the mway awaiting takeoff clearance and then failing to release the brakes prior to commencing the takeoff. Notwithstanding the fact that both the captain and first officer testified that the parking brakes were not applied at any time subsequent to departure from the terminal ramp, it is known that this type of situation has happened in the past and, therefore, the possibility of a similar occurrence in this case was closely analyzed by the Board.

In most cases where flightcrews have overlooked checklist items, or have failed to configure an aircraft properly for a particular flight regime, one of two factors, or a combination thereof, have intervened to cause a memory lapse. These factors are a time interval between actions/activities, and an occurrence of a significant distraction prior to the required function. Working in concert, these factors appear to be complementary; i.e., the longer the time interval the lesser distraction level required, and vice versa.

To some extent, it can be theorized that the operational situation for this flight could have presented the proper circumstances for these factors to exist. That is, after taking the runway, the flight held for approximately 1 minute and 30 seconds before the takeoff was initiated. During this interval of time, the crew was involved in completing the remaining takeoff checklist items, monitoring the engine instruments, and setting the proper engine parer for takeoff.

Because of the inoperative No. 1 engine EPR gauge, the captain had instructed the crew that he would set the takeoff power and handle the brakes, although the first officer would be making the takeoff. To obtain the desired EPR for the No. 1 engine, the fuel flow, N2 compressor r.p.m. and EGT, indications for this engine were aligned with the corresponding indications of the other engines as obtained through the targeted EPR setting. Normal takeoff procedures call for the pilot making the takeoff to advance all thrust levers to obtain the approximate takeoff EPR with the other pilot making the final minute thrust lever adjustments necessary to obtain this setting.

When the takeoff clearance was received, the captain's attention was drawn to the engine instruments, first, to set power at 80 percent and monitor engine stabilization and, then, to align the No. 1 engine settings with those of the other engines to effect the proper takeoff EPR.

Thus, if the parking brake had been engaged when the aircraft was positioned on the runway, the intervening period of time between the receipt of the takeoff clearance in consonance with whatever distraction was caused by monitoring and aligning the engine instruments might have been sufficient to cause the crew to overlook parking brake release.

If this theory is to be accepted, then, the fact that the captain, first officer, and flight engineer failed to notice the antiskid "not armed" warning light must also be accepted. This warning light is located on the upper right-hand corner of the captain's instrument panel within the field of vision of the captain, first officer, and the flight engineer. It is illuminated whenever the antiskid system is not armed (switch-off) or at any time that the antiskid switch is in the "on" (armed) position and the parking brake is engaged.

The flightcrew testified that the amber antiskid "not armed" light was properly illuminated during the taxi to the runway and that when the system was armed, in accordance with the takeoff checklist, just prior to taking the runway, the light went out. They stated that this light did not come on again at any time prior to, or during the takeoff run.

It is difficult to conceive that this light, if it were illuminated during the takeoff, could have been overlooked by all crewmembers in the cockpit. This is particularly true considering the darkened cockpit conditions of a night operation where a bright amber light would, indeed, be conspicuous to the flightcrew. Although this light has a dimming circuit the crew testified that it was not dimmed.

Again, in consonance with the testimony of the crew that the brakes had not been set, the logic of this situation would also indicate that the antiskid light was not on during the takeoff and, therefore, the parking brakes were not engaged.

This reasoning precludes the remote possibility of a failure in the antiskid warning light circuitry after the crew engaged the antiskid switch and observed the warning light go out.

Unfortunately, in this case there was no remaining physical evidence to verify any of the foregoing possibilities. In fact, because of the unusual and coincidental circumstances of the locked wheels; i.e., that an equal braking torque was applied to all eight wheels, and, that the braking torque apparently was not initiated until the aircraft was positioned on the runway for takeoff, the Board cannot dismiss either the possibility of a hydraulic/brake system malfunction or the possibility that the parking brake was engaged. Similarly, neither of these possibilities can be supported in its entirety.

Although the combination of elements which prevented wheel rotation while still permitting the aircraft to move down the runway is certainly the prime causal factor, the crew response to the problem cannot be ignored. As has been pointed out, the initial portion of the takeoff might have seemed quite normal, however, it must be concluded that the ever-increasing lack of acceleration had reached noticeable limits by about 100 knots. By the time the aircraft reached V_1 it had consumed 60 seconds and had traveled 71 percent farther than it should have.

The captain stated that the acceleration felt "normal" up to approximately 135 knots. However, he did note some "slugging" or a momentary deceleration at about 100 knots which might have, in his mind, masked the magnitude of performance degradation which should have been apparent from this point on. Although the captain realized that the acceleration was slower than normal after attaining V_1 speed, his decision to continue the takeoff under the existing conditions is understandable. The accelerate/stop concept (V_1) would automatically preclude a takeoff rejection after attaining V_1 except for the occurrence of a catastrophic emergency considered by the captain to require this action. It is apparent that the insidious nature of the performance degradation made recognition and assessment of the situation very difficult, and once the aircraft had accelerated to the V_1 speed, the only viable option was to continue the takeoff and hopefully attain lift-off.

Under these conditions, perhaps the only means by which the accident could have been avoided, once the takeoff was commenced, would have been the crew's early recognition of the lack of proper acceleration followed immediately by a rejected takeoff. This could only have been achieved if there had been some procedure available to the crew by which they could determine if the required acceleration over a given time or distance had been achieved. The captain's decision to discontinue the takeoff under the existing circumstances was valid.

The total loss of life in this accident, 47 fatalities, was directly attributable to the post-crash fire. In fact, had this not been a military contract flight with a high ratio of healthy, well disciplined military personnel and only a few dependents, the loss of life, most certainly, would have been much higher.

This type of "survivable" accident demonstrates clearly the need for the development of fuel system safety devices, explosion suppression systems, or other related equipment that will be capable of minimizing the hazards of post-crash fire and explosions. At present no certificated air carrier transports are so equipped.

Cabin interior design features were directly involved in injuries and incapacitation of flight cabin attendants and in some instances these features restricted the evacuation routes within the cabin. The Board is aware of research now in progress that is aimed at improving the crash-worthiness of cabin interiors. Of particular interest are the galley equipment restraining devices, cabin attendant seating arrangements, and overhead storage rack security. The Board is extremely concerned that these areas be improved. Strong emphasis must be placed on the fact that the cabin attendants, who are depended upon, are responsible for emergency assistance to passengers, were either partially or totally incapacitated during this accident. Only because of alert, responsive, and orderly conduct of these military passengers, many of whom took charge during the emergency, was an even greater disaster averted.

2.2 Conclusions

(a) Findings

1. The aircraft was certificated and maintained in accordance with existing regulations.

2. The pilots were certificated and qualified for the flight.

3. The aircraft was within certified weight and balance limitations for the takeoff.

4. The aircraft rolled into position on Runway 6R and held for approximately 1 minute 30 seconds before the takeoff was initiated.

5. A thin layer of ice covered the runway surface.

6. A braking torque of unknown source was imparted to all eight main landing gear wheels.

7. The main landing gear wheels did not rotate during the attempted takeoff.

8. The fact that the initial sliding coefficient of friction on the runway surface was only slightly higher than the normal rolling coefficient of friction of the wheels masked the detection of the locked wheels.

9. Because of the frictional drag created by the rubber degradation, tire failure, and abrasive milling of wheel rims, the acceleration was adversely affected and the aircraft did not attain the necessary lift-off speed.

10. The slower than normal acceleration of the aircraft was not evident to the pilots until such time that a successful rejected takeoff was virtually impossible.

11. The impact conditions were classified as survivable with all fatalities resulting from the post-impact fire.

12. Some flight attendants were incapacitated as a result of body restraint system, and galley equipment security deficiencies. Their incapacitation precluded their effective assistance in passenger evacuation.

(b) Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the aircraft to attain the necessary airspeed to effect lift-off during the attempted takeoff. The lack of acceleration, undetected by the crew until after the aircraft reached V_1 speed, was the result of a high frictional drag which was caused by a failure of all main landing gear wheels to rotate. Although it was determined that a braking pressure sufficient to lock all of the wheels was imparted to the brake system, the source of this pressure could not be determined. Possible sources of the unwanted braking pressure were either a hydraulic/brake system malfunction or an inadvertently engaged parking brake.

3. RECOMMENDATIONS

As a result of this investigation the Safety Board recommended that the Federal Aviation Administration take the following actions.

(a) Determine and implement takeoff procedures that will provide the flightcrew with time or distance reference to appraise the aircraft's acceleration to the V_1 speed. (See Appendix D.)

(b) Initiate action to incorporate in its airworthiness requirements, a provision for fuel system fire safety devices which will be effective in the prevention and control of both in-flight and post-crash fuel system fires and explosions. (See Appendix E.)

The Board further recommends that:

The Federal Aviation Administration, in cooperation with the aircraft manufacturers and the National Aeronautics and Space Administration, utilize the results of already extensive research and accident investigation data to develop and implement major improvements in the design of transport aircraft interiors. Of particular concern are improvements in the crashworthiness of galley equipment, stewardess seats and restraining devices, and the flammability cabin interior materials.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ OSCAR M. LAUREL
Member

/s/ FRANCIS H. MCADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

March 29, 1972

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Board received notification of the accident from the Federal Aviation Administration at approximately 2224 on November 27, 1970. An investigating team was immediately dispatched to the scene of the accident. Working groups were established for Operations, Weather, Human Factors, Systems, Structures, Powerplants, Flight Recorder, and Maintenance Records. Interested parties included the Federal Aviation Administration, Capitol International Airways, Air Line Pilots Association, McDonnell Douglas Corporation, Pratt and Whitney Division, United Aircraft Corporation, Bendix Corporation, and Hydro-Aire Corporation. The on-scene investigation was completed by December 4, 1970.

2. Hearing

A public hearing was held at Anchorage, Alaska, on February 16-18, 1971. Parties to the Investigation included: the Federal Aviation Administration, Capitol International Airways, Air Line Pilots Association, McDonnell Douglas Corporation, and the Bendix Corporation.

Additional depositions were taken by the Board on March 23, 1971.

3. Preliminary Reports

A preliminary factual report of the investigation was released by the Board on January 28, 1971. A summary of the testimony taken at the public hearing was released on March 23, 1971.

APPENDIX B

CREW INFORMATION

Captain William G. Reid, aged 48, was employed by Capitol International Airways, Inc., on January 1, 1955. He held airline transport certificate No. 609934 with ratings in Lockheed Constellation, C-46, DC-8 aircraft and commercial privileges in single-engine land aircraft. He had accumulated approximately 14,650 total flying hours, including 5,740 hours in E-8 aircraft. His last FAA first-class medical certificate was issued on June 19, 1970, with the limitation that the holder shall wear correcting lenses while exercising the privileges of the certificate.

He completed his Last proficiency check on June 11, 1970, and his last line check on December 10, 1969. He completed recurrent ground training on February 19, 1970, and emergency procedures training February 16, 1970. He had flown 257 hours in the previous 90 days, and 87 hours in the last 30 days.

The captain stated that he had flown into Anchorage International Airport approximately 10 times in the last 60 days previous to the accident, all in DC-8-63 type aircraft-

First Officer James A. Downs, aged 55, was employed by Capitol International Airways, Inc., on May 28, 1962. He held airline transport certificate No. 523111, with ratings in E-3, E-4, and Lockheed Constellation type aircraft and commercial privileges in single-engine land aircraft. He had accumulated approximately 13,500 total flying hours, including 2,057 hours in DC-8 aircraft. His last first-class FAA medical certificate was issued on January 2, 1970, with the limitation that the holder shall wear corrective lenses while exercising the privileges of the certificate.

He completed his last proficiency check on June 8, 1970. He had. flown 227 hours in the previous 90 days, and 83 hours in the last 30 days. He completed recurrent ground training on May 6, 1970, and emergency procedure training on April 24, 1970.

First Officer Downs had started pilot in command upgrade training in May 1970. He had completed six DC-8 simulator training flights when this training was discontinued. Instructor comments on these flights indicated that his progress was slow, and more training would be required. The upgrade training was discontinued by the company for the reason, "Training discontinued - lack of aircraft." He was returned to the line as a first officer on June 9, 1970.

Flight Engineer Edward W. Fink, age 41, was employed by Capitol International Airways, Inc., on May 12, 1964. He held flight engineer license No. 1298319 with reciprocating and turbojet engine ratings. He had accumulated approximately 10,000 total flying hours, including 2,000 hours in DC-8 aircraft.

His last FAA first-class medical certificate was issued without waivers on May 12, 1970.

His last flight check was completed on December 3, 1969, and he had completed recurrency and emergency training on December 12, and 23, 1969, respectively. He had flown 69 hours in the previous 30 days.

Flight Navigator Robert D. Leonard, aged 53, was employed by Capitol International Airways, Inc., on February 28, 1966. He held flight navigator certificate No. 1679321. He had accumulated approximately 14,000 total flying hours, including 2,500 hours in DC-8 aircraft.

His last FAA first-class medical certificate was issued on May 15, 1970, with the limitation that the holder shall wear correcting lenses while exercising the privileges of the certificate. His last flight check was completed on February 15, 1970. He completed recurrent ground training on December 30, 1969, and emergency procedures training on March 16, 1970.

All of the flightcrew members had been on duty for 7 hours and 20 minutes, including the 3 hours and 45 minutes of flight time when the accident occurred. They had received 24 duty-free hours prior to reporting for this flight.

Stewardess Marlene Faistauer was employed by Capitol International Airways, Inc., on June 11, 1968. Her last recurrent training was completed on April 15, 1970.

Stewardess Alexandra Plommer was employed by Capitol International Airways, Inc., on June 11, 1968. Her last recurrent training was completed on April 15, 1970.

Stewardess Barbara M. Ogden was employed by Capitol International Airways, Inc., on June 9, 1969. Her last recurrent training was completed on April 15, 1970.

Stewardess Alice B. Mendez was employed by Capitol International Airways, Inc., on June 9, 1969. Her last recurrent training was completed on April 15, 1970.

Stewardess Britta E. Thomsen was employed by Capitol International Airways, Inc., on May 23, 1970. Her initial training was started on April 27, 1970, and was completed on May 23, 1970.

Stewardess Birgitta I. Ekelund was employed by Capitol International Airways, Inc., on May 23, 1970. Her initial training was started on April 27, 1970, and was completed on May 23, 1970. (Miss Ekelund was fatally injured in the accident.)

AIRCRAFT INFORMATION

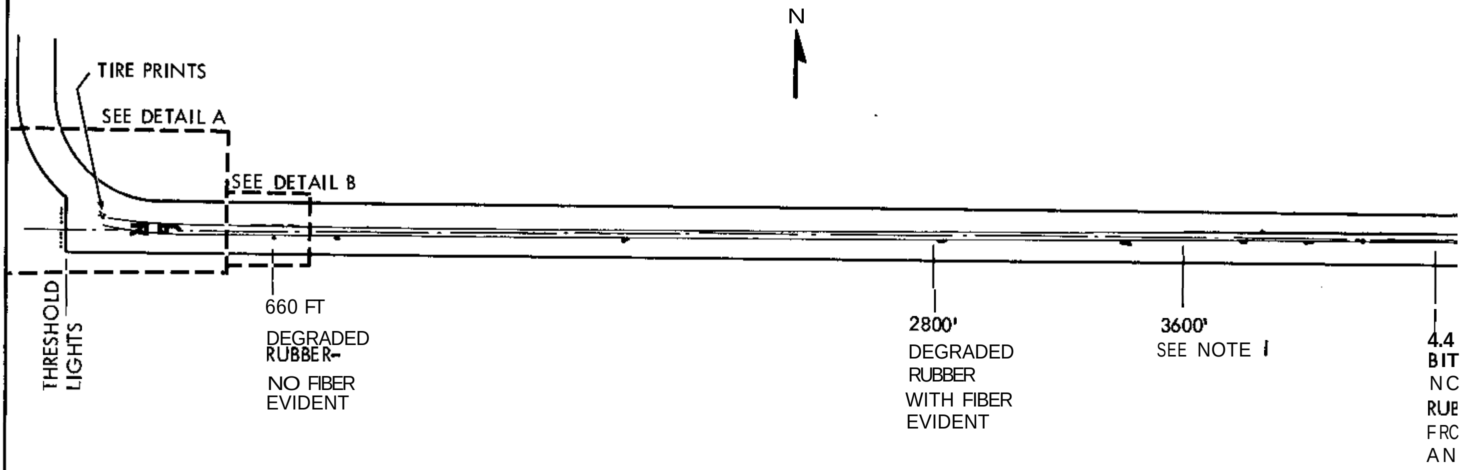
The aircraft, a McDonnell Douglas DC-8-63F, N4909C, was issued a Standard Airworthiness Certificate, Transport Category, dated July 2, 1969. It was purchased by the C.I.T. Corporation on July 2, 1969, and was leased to Capitol International Airways, Inc., on that date.

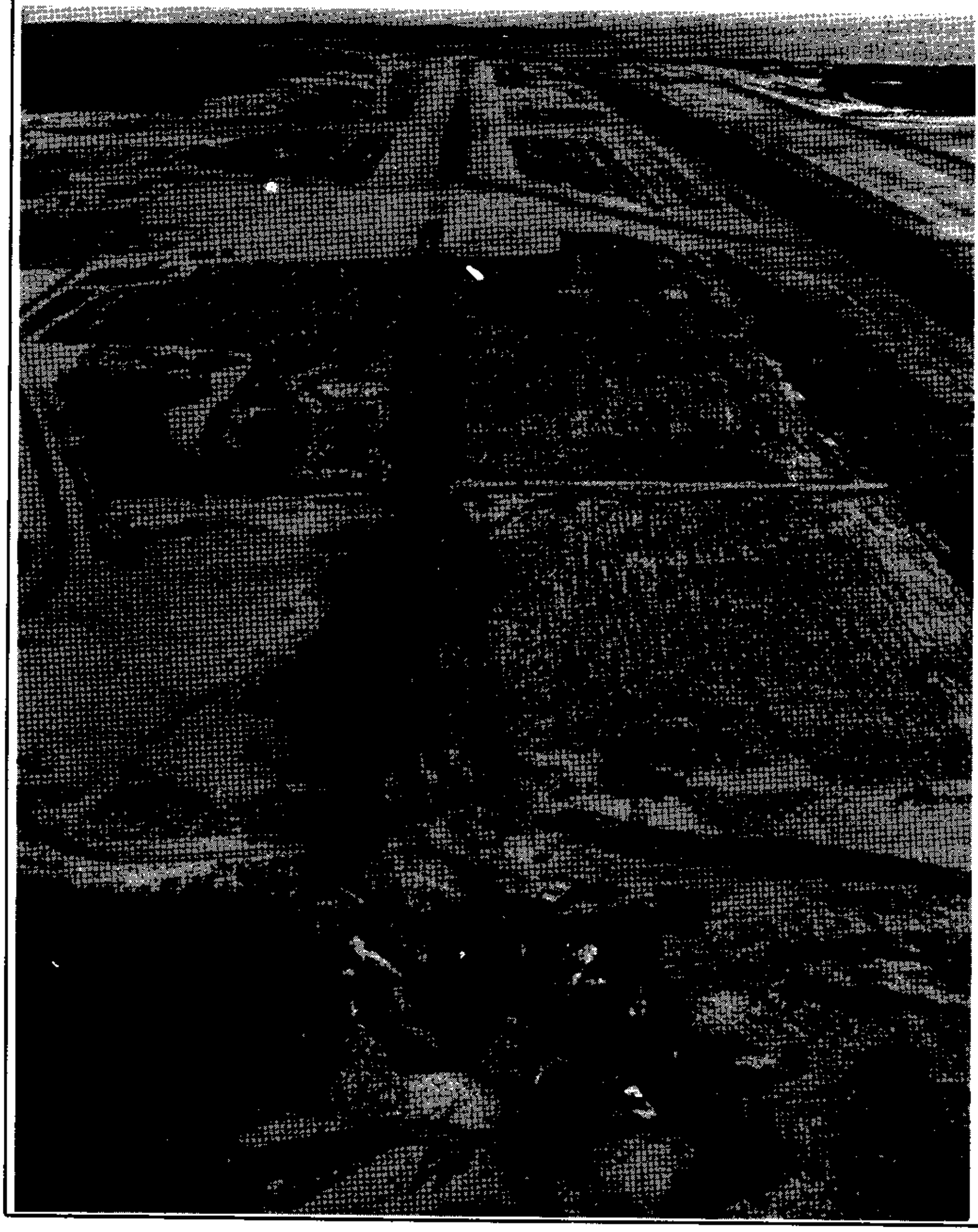
At the time of the accident N4909C had accumulated a total of 4944:49 flight hours of which 11:11 hours were accumulated since completion of the last required line service check at the company's maintenance base at Wilmington, Delaware, on November 26, 1970. During this check the wheel and tire assemblies for wheel positions 1, 2, 4, 6, 7, and 8 were changed. The No. 3 brake asembly was replaced. All other brake assemblies were recorded as checked within limits. Subsequent to the check the aircraft departed for the subject flight and had accumulated four landings and four takeoffs, not including the attempted takeoff which terminated in this accident. A review of the aircraft logbook entries subsequent to its departure from Wilmington on November 26, 1970, disclosed no discrepancies pertaining to the tires, wheels, brakes or hydraulic system.

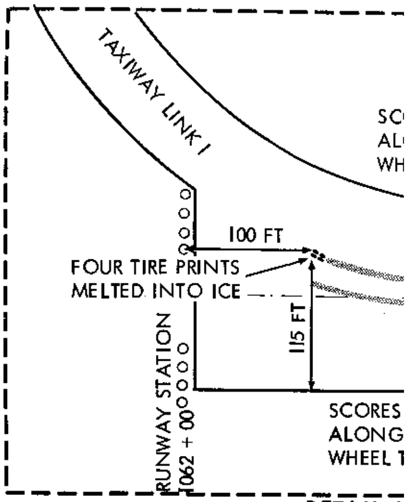
A review of the aircraft records for the preceding year showed no recorded instances of recurring landing gear (tires, wheels, brakes) or hydraulic discrepancies, other than replacements for normal wear.

The only recorded discrepancy of a recurring nature noted in the aircraft logs pertained to the nosewheel steering. During the period from September 4, 1970, to November 26, 1970, there were eight complaints concerning various difficulties with the nose steering. Most of the remarks were to the effect that the aircraft pulled to the left while taxiing, that it was difficult to turn to the right, or that the aircraft steered hard while taxiing. Corrective action performed for these complaints ranged from replacing the left-hand nosewheel tire, greasing the nose steering collar, adjusting rudder trim, to replacing both the left and right-hand steering cylinders. The last discrepancy for the nose steering, "hard to turn right" was on November 24, 1970, at which time the left-hand steering cylinder was replaced.

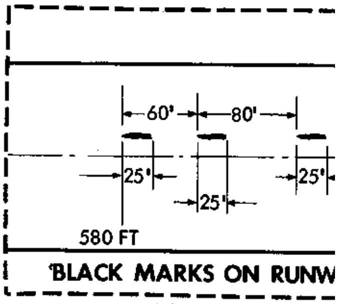
According to the records reviewed, the aircraft was maintained in accordance with all applicable FAA and company procedures and regulations.



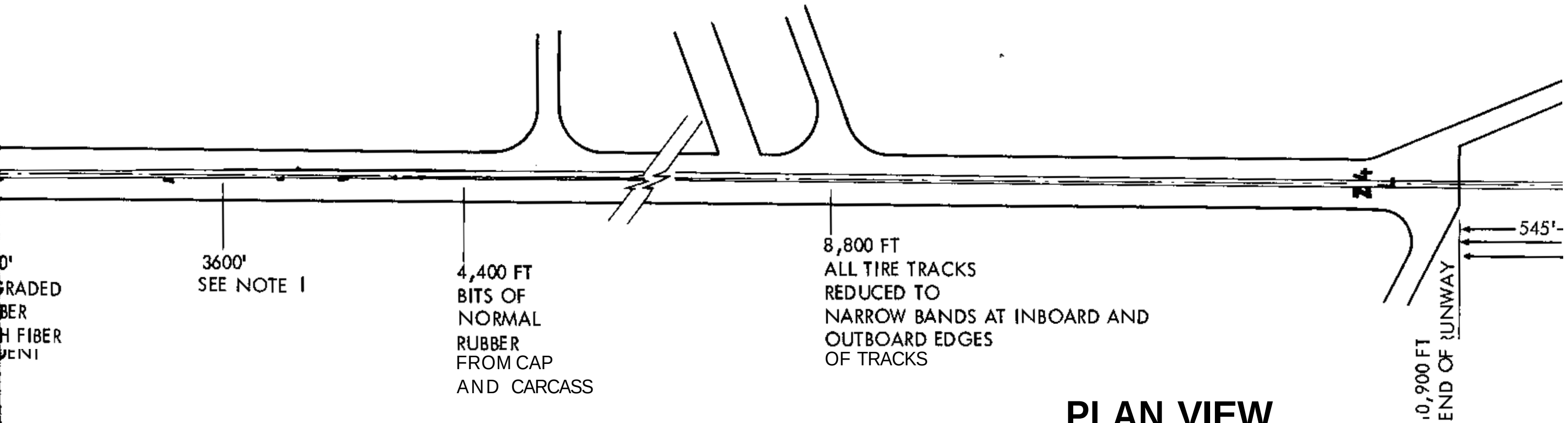




DETAIL A

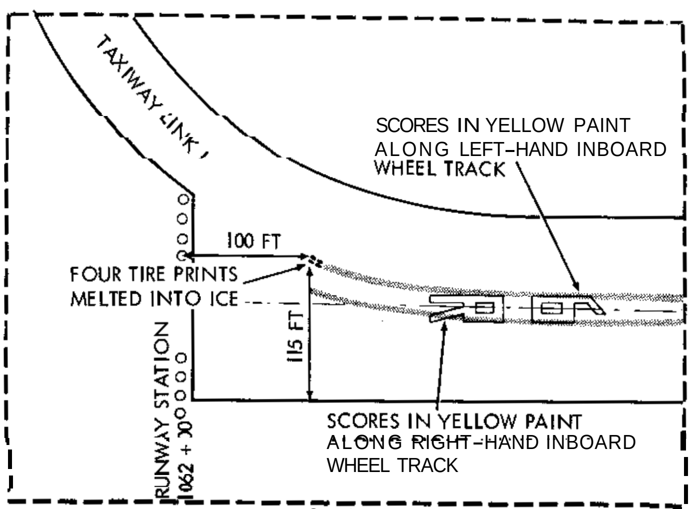


DETAIL B

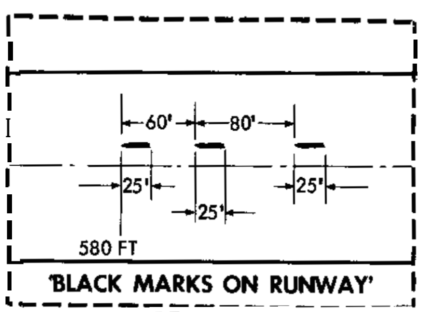


PLAN VIEW

SCALE: 0 500'



DETAIL A



DETAIL B

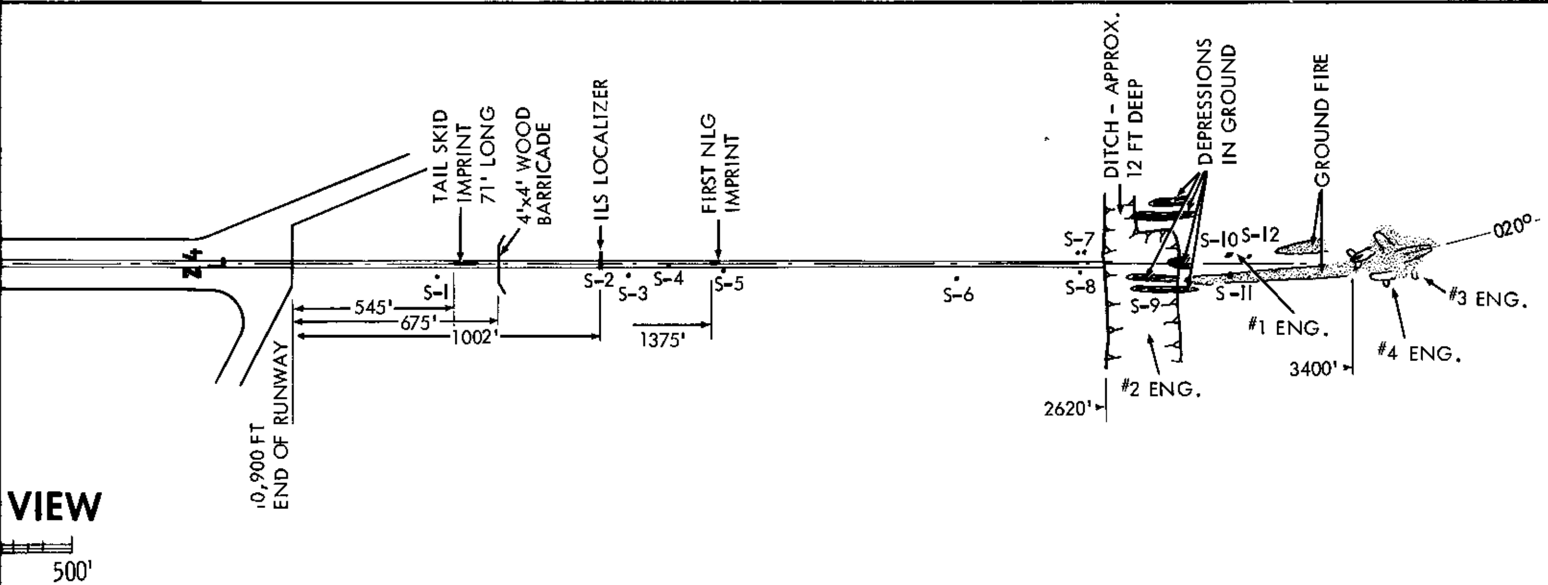
NOTE 1

LH INBD WHEEL TRACK LEAVING DARK TRACK WITH DARK BAND (1/2" TO 2") ON LH EDGE. TRACK CEASED AT 4400', BUT NARROW BAND AND SCORING OF RUNWAY CONTINUED TO END OF RUNWAY

NOTE 2

APPROX. WIDTHS OF TIRE TRACKS

	LHOB	LHIB	RHIB	RHOB
LINE-UP	12"	12"	13"	12"
1000 FT.	12"	13"	16"	14 1/2"
300 FT.	12"	-	18"	14"
4400 FT.	BEAD MARKS		-	-
8800 FT.	BEAD MARKS a RIM MARK ON ℄ LIGHTS			



S-1 FRAGMENTS OF A WHEEL WHICH EXHIBITED GROUND SURFACES
S-2 PIECES OF WHEELS, AIRCRAFT FAIRINGS, ETC. SCATTERED AROUND LOCALIZER
S-3 PIECE OF WING FLAP
S-4 ENGINE COWLING
S-5 LANDING GEAR DOOR
S-6 MAIN LANDING GEAR WHEEL
S-7 MAIN LANDING GEAR TIRES NOS 2 AND NO 6
S-8 PIECE OF MAIN LANDING GEAR WHEEL NO 7
S-9 NO 2 ENGINE, LANDING GEAR PARTS, ENGINE COWLINGS, ETC., SCATTERED ABOUT AREA
5-10 PIECE OF LEFT-HAND OUTBOARD FLAP
5-11 NO I WHEEL AND TIRE
5-12 BRAKE ASSEMBLY

NOTE 1

LH INBD WHEEL TRACK LEAVING DARK TRACK WITH DARK BAND (1/2" TO 2") ON LH EDGE. TRACK CEASED AT 4400', BUT NARROW BAND AND SCORING OF RUNWAY CONTINUED TO END OF RUNWAY

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4400 FT.	BEAD MARKS	-		-
8800 FT.	BEAD MARKS & RIM MARK ON ℄ LIGHTS			

NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C.

WRECKAGE DISTRIBUTION CHART
CAPITOL INTERNATIONAL AIRWAYS, INC.
DOUGLAS DC-8-63, N 4909C

ANCHORAGE INTERNATIONAL AIRPORT
ANCHORAGE, ALASKA
27 November, 1970

71790

APPENDIX E

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

January 20, 1971

Honorable John H. Shaffer
Administrator
Federal Aviation Administration
Washington, D. C. 20590

Dear Mr. Shaffer:

We are currently investigating the accident involving the Capitol International Airways McDonnell-Douglas DC-8-63F, which occurred during an attempted takeoff from Anchorage, Alaska, on November 27, 1970.

The facts thus far developed provide evidence that the aircraft failed to accelerate at a normal rate during the takeoff roll. Although lack of proper rotation of the main landing gear wheels on an icy runway has been established as a prime factor in slow acceleration of the aircraft, the mechanism initiating this condition has as yet not been isolated or identified. Investigation in this area is continuing.

Regardless of the cause for the slow acceleration of the airplane, we feel that a timely takeoff abort might have been Initiated and effected in this case if the crew had been able to determine the acceleration rate of the airplane under the given operating conditions. We feel that procedures enabling flightcrews to make this evaluation must be developed and furnished to all users.

In view of the facts, conditions, and circumstances of this accident, the National Transportation Safety Board recommends that:

> The Federal Aviation Administration determine and implement takeoff procedures that will provide the flightcrew with time or distance reference to enable him to make an appropriate judgement with regard to the airplane's acceleration rate to the V_1 speed, particularly for critical length runways, and for runway surface conditions that may impede acceleration.

Mr. John H. Shaffer (2) January 20, 1971

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

In accordance with established procedures, this letter will be placed in our public docket at the end of the five working-day period comencing the day after the date of this letter. It is understood, therefore, that there will be no public dissemination of this letter until that time.

Sincerely yours,

John H. Reed

John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

4 FEB 1971

Honorable John H. Reed
Chairman, National Transportation
Safety Board
Department of Transportation
Washington. D.C. 20590

Dear Mr. Chairman:

This is in reply to your letter of 20 January 1971 recommending that procedures be implemented to provide acceleration rate information to V_1 speed to the flight crew on takeoff.

We share your concern. As you may recall, time to 100 knots was widely used by operators when turbojets were first introduced. It was not required by regulation and has since been discontinued as ineffective. As a matter of fact, the Air Force, who also used the time or distance against airspeed for checking acceleration, has also discontinued its use except for a very limited number of aircraft which have generally slower acceleration rates than the type equipment being used by the airlines.

Since inertial navigation systems are being installed on an increasing number of large air carrier aircraft, we plan to explore the possibility of the additional use of this equipment to provide takeoff performance information. This subject was discussed at our meeting with the Operations Committee of the Air Transport Association on 19 January 1971. Air Carrier representatives who operate aircraft with inertial systems agreed to explore the problem with their technical people. The Air Transport Association will be asked to provide us with the results of their investigation.

Sincerely,

J. H. Shaffer
Administrator

UNITED STATES OF 'AMERICA
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: November 12, 1971

Adopted by the NATIONAL TRANSPORTATION SAFETY BOARD
at its office in Washington, D. C.
on the 3rd day of November 1971

FORWARDED TO:
Honorable John H. Shaffer
Administrator
Federal Aviation Administration
Washington, D. C. 20591.

SAFETY RECOMMENDATION A-71-59

During public hearings which were convened in the matter of the Allegheny Airlines and Capitol International. Airways accidents, the National Transportation Safety Board obtained extensive expert testimony from the Federal Aviation Administration and from the U.S. Army Mobility Research Laboratory Staff pertaining to the technological advances in the field of in-flight and postcrash fuel system fire safety. The Board is most encourged by these advances and the capability of industry to apply this technology to present and future aircraft.

Technology available today provides a wide scope of improvements in the fuel system fire safety field. Some systems, oriented primarily toward prevention of postcrash fires, are in successful use by the U.S. Army and have saved untold numbers of lives, Other systems such as the Parker liquid nitrogen fuel tank inerting system is most effective in preventing fuel system vapor explosions with the fuel tank system relatively intact.

The Safety Board is aware of the concerted efforts and programs that the Federal Aviation Administration has been engaged in over the past 8 years to promote the development of various explosion and fire prevention systems. The Board has on a regular basis observed, and highly commends the activities of the Advisory Committee on Fuel System Fire Safety which is operating under the chairmanship of Mr. Robert Auburn of your Flight Standards Service. We feel that significant advances in the field of both in-flight and postcrash fuel system fire safety have been made as a result of this committee's work as well as the research and experience gained by the U.S. Army. Particularly encouraging is the operation of your E-9 aircraft with an operationally functional explosion/fire suppression system.

Our current investigation of an accident involving an Allegheny Airlines Convair 580, N5832, which occurred at New Haven, Connecticut, on June 7, 1971, produced evidence that possibly as many as 27 of the 28 persons fatally injured survived the initial crash impact. We have witness reports and corroborative medical data to show that time for a successful evacuation of survivors was drastically limited by fire and smoke as well as by explosions which rapidly expanded the fire.

A similar obstacle to survival was found to be present in the case of a takeoff accident involving Capitol International Airways, Douglas DC-8-63, N4909C, at Anchorage, Alaska, on November 27, 1970. Forty-seven of the 229 persons aboard this aircraft perished. Again in this case, initial crash injuries were of a survivable nature, but the inability to escape the rapidly propagating fire proved fatal.

The Board, therefore, recommends that:

> The Federal Aviation Administration initiate action to incorporate in its airworthiness requirements, a provision for fuel system fire safety devices which will be effective in the prevention and control of both in-flight and postcrash fuel system fires and explosions. It is further recommended that rulemaking action in this matter specifically apply to future passenger-carrying aircraft in the transport category, and that consideration be given to an adaptation to all other passenger-carrying aircraft now in service.

This recommendation will be released to the public on the issue date shown above. No public dissemination of the contents of this document should be made prior to that date.

Reed, Chairman; Laurel, Thayer, and Burgess, Members, concurred in the above recommendation; McAdams, Member, dissented.

John H. Reed

By: **John H.** Reed
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

12 November 1971

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

Dear Mr. Chairman:

This will respond to your Safety Recommendation A-71-59 adopted 3 November 1971 concerning safety devices for enhancing survivability during in-flight and postcrash fires.

Your recommendation deals with the specific goal of preventing and controlling fuel system fires and explosions. We have been working toward this safety objective, recognizing that protection against the occurrence of fire and explosion, whatever the ignition source, would be an important safety improvement.

A key element in our program is the operational evaluation of a protective system in our DC-9 aircraft being utilized for pilot training. Shortly after 1 January 1972, it is anticipated that the accumulated data and information on system reliability, maintainability, and operating costs will be reviewed and discussed with interested industry segments under the auspices of the Advisory Committee on Fuel System Fire Safety. We welcome participation by members of your staff.

Following these coordinating actions, we will develop a course of action regarding rule promulgation, both with respect to new transport category aircraft and passenger-carrying aircraft in service.

Sincerely,

K M Smith

K. M. Smith
Acting Administrator