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NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20591

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AIRCRAFT ACCIDENT REPORT

TRANS INTERNATIONAL AIRLINES CORP.
FERRY FLIGHT 863, DOUGLAS DC-8-63F, N4863T
J.F. KENNEDY INTERNATIONAL AIRPORT, NEW YORK
SEPTEMBER 8, 1970

ADOPTED: AUGUST 18, 1971

E R R A T U M

Page 5 of the subject report has been revised to reflect additional technical information concerning ground operation of the elevators. Please substitute the attached pages 5 and 6 for those now appearing in the report.

September 15, 1971

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SYNOPSIS

A Trans International Airlines Douglas DC-8-63F, N4863T, Ferry Flight 863 crashed during takeoff at John F. Kennedy International Airport, New York, at 1606, September 8, 1970.

Approximately 1,500 feet from the initiation of the takeoff roll, the aircraft was observed rotating to an excessively nose-high attitude. The aircraft became airborne about 2,800 feet down the runway after which it continued to rotate slowly upward to an attitude estimated to be between 60° and 90° above the horizontal, at an altitude estimated to be between 300 to 500 feet above the ground. The aircraft rolled about 20° to the right, rolled back to the left until it reached approximately a vertical angle of bank, and then fell to the ground in that attitude. The aircraft was destroyed by impact and postimpact fire. All 11 crewmembers, the only occupants of the aircraft, died in the accident.

The Board determines that the probable cause of this accident was a loss of pitch control caused by the entrapment of a pointed, asphalt-covered object between the leading edge of the right elevator and the right horizontal spar web access door in the aft part of the stabilizer. The restriction to elevator movement, caused by a highly unusual and unknown condition, was not detected by the crew in time to reject the takeoff successfully. However, an apparent lack of crew responsiveness to a highly unusual emergency situation, coupled with the captain's failure to monitor adequately the takeoff, contributed to the failure to reject the takeoff.

The Board has recommended to the Federal Aviation Administration that all DC-8 operators be advised of the circumstances of this accident; that takeoffs in DC-8's should be rejected when premature or unacceptable rotation of the aircraft occurs during takeoff; and that provisions for the detection of jammed elevators and determination of elevator position be provided to DC-8 crews.

The FAA replied that engineering evaluations are being completed and they will advise the Board of the results. The FAA also requested further data regarding the recommendation that takeoffs should be aborted when premature or unwanted rotation was experienced in the DC-8.

The Board also recommends that a review should be conducted on the subject of rejected takeoff procedures in air carrier operation with a view to amplifying, clarifying, and standardizing each pilot's role in that procedure. More specific information regarding the dynamics of rejected takeoffs and pre-takeoff briefings should also be considered.

1. INVESTIGATION

1.1 History of the Flight

Trans International Airlines (TIA) Ferry Flight 863, a Douglas DC-8-63F, was engaged in a ferry flight from J. F. Kennedy International Airport to Dulles International Airport, Washington, D. C., where passengers were to board for a flight from Washington to Gatwick International Airport, London, England.

The crew arrived at the TIA operations office about 1410, 1/ and made preparations for the flight to Washington scheduled to depart at 1600. An Instrument Flight Rules clearance was requested at 1526 and was received at 1530. The captain and first officer were observed seated in their respective seats, just prior to receiving taxi instructions to proceed to Runway 13R (Right).

At 1604, Flight 863 was cleared into takeoff position, with instructions to hold and, at 1604:55, the flight was cleared for an immediate takeoff.

Based on information from the Cockpit Voice Recorder (CVR) and the Flight Data Recorder (FDR), the takeoff roll began at 1605:07, and the tail skid began dragging on the runway at 91 knots (the computed rotation speed was 124 knots), 1,550 feet from the takeoff end of the runway, at 1605:26. The tail skid dragged on the runway intermittently for an additional 1,250 feet.

At 1605:35, when the aircraft was about 2,800 feet down the runway, the aircraft became airborne and, according to pilot-qualified witnesses, rotated slowly to an unusually nose-high attitude. Stall warnings (stick shaker) were recorded on the CVR within 1 to 2 seconds after lift-off and continued until 1605:49. Witnesses stated that the aircraft reached a nose-high attitude estimated to be between 60° and 90° at an altitude of 300 to 500 feet above the ground. The aircraft then rolled about 20° to the right, rolled back to the left until the left wing was approximately perpendicular to the ground, and descended in a left-wing-down, nosedown attitude. The aircraft contacted the ground at 1605:52, on its left wing and the nose. The wreckage was immediately engulfed in flames. The crash firefighting crews arrived at the wreckage approximately 30 seconds after the accident, and brought the fire under control in about 5 minutes.

The accident occurred in daylight, at an elevation of 12 feet m.s.l. at latitude 40° 39'N. and longitude 73° 47'W.

1.2 Injuries to Persons

<u>Injuries</u>	<u>Crew</u>	<u>Passengers</u>	<u>Other</u>
Fatal	11	0	0
Nonfatal	0	0	0
None	0	0	

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

1.3 Damage to Aircraft

The aircraft was destroyed by impact and postimpact fire.

1.4 Other Damage

None.

1.5 Crew Information

The flight deck crewmembers were certificated and currently qualified in accordance with the Federal Aviation Administration's (FAA) and TIA's regulatory requirements for flight. The captain had flown 259.3 hours in the DC-8 in the last 90 days. The first officer had flown 276 hours during the same period. (For details, see Appendix B.)

1.6 Aircraft Information

N4863T, was a Douglas Model DC-8-63F, serial No. 45951, with a date of manufacture November 22, 1968. The aircraft had accumulated 7878:05 hours of operating time since new. All four of its Pratt & Whitney JT3D-7 engines had been routinely replaced at appropriate maintenance intervals.

The aircraft and engines had been maintained in accordance with TIA and FAA procedures. Required inspections had been performed at the prescribed time intervals and nonroutine maintenance items had been corrected in accordance with existing policies.

Postaccident examination of all four engines indicated that no prior engine problem existed that could be related to this accident.

Records pertaining to the longitudinal control system of N4863T indicated that the last elevator control maintenance accomplished was the replacement of the pitch trim compensator on November 4, 1969. Only routine greasings were accomplished after that date. Several autopilot writeups were corrected during this period by changing the air data computer.

The takeoff gross weight of N4863T was 203,861 pounds, and the center of gravity was 24.0 percent of the aircraft's mean aerodynamic chord, both within operational limits.

These data included 38,000 pounds of jet kerosene fuel which was loaded according to the normal fuel loading schedule.

The elevator control system of the DC-8 Sixty Series aircraft is actuated mechanically and consists of elevators, control tabs, geared tabs, control columns, a load-feel and centering mechanism, and elevator dampers.

The elevators are operated aerodynamically by the tabs which are controlled by a cable system from the control column. The geared tab on each elevator is linked mechanically to the stabilizer so that as the elevator moves, the geared tab moves in the same direction as the control tab to provide additional aerodynamic control surface. (See Attachment 1.)

The elevators are hinged to brackets attached to the horizontal stabilizer rear spar. Elevator travel is approximately 27° trailing edge up (TEU) and 16-1/2° trailing edge down (TED) from the neutral position. The elevators are interconnected by a torque tube so they can operate in unison. Both elevators are aerodynamically balanced and mass balance weights are installed in the leading edge to minimize flutter. The mass balance causes the elevator to be in the approximate 27° TEU position when no aerodynamic load is applied and the gust locks are disengaged.

When the control column is moved forward or aft, the cable system and mechanical linkage cause the elevator tabs to move up or down and, during flight, aerodynamic forces on the displaced tabs drive the elevators. As the position of the elevators changes in relation to the horizontal stabilizer, mechanical linkage moves the geared tabs in the same direction as the control tabs, providing additional aerodynamic boost to assist in moving the elevators.

The TIA DC-8 Flight Operation Manual required pilots to test the flight controls to the full limits of their travel prior to takeoff. Movement of the controls was to be accomplished slowly and smoothly to avoid damage to boosted controls (rudder and ailerons). The CVR transcript indicated that the flight controls were checked while the crew was taxiing to the runway.

1.7 Meteorological Information

The weather reported just prior to the accident at 1451:00 was 3,000 feet scattered, estimated 15,000 feet broken, visibility 13 miles, temperature 69° F., dew point 53° F., wind from 150° at 8 knots, and the altimeter setting 30.08. The weather taken just after the accident was the same except that the wind had shifted to 180° and its speed had increased 1 knot.

The accident occurred in bright daylight.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

The communications between TIA Flight 863 and the FAA facilities were routine.

The last communication received from TIA Flight 863 was the word "Right-o" in response to a thank you from departure control, just after the start of the takeoff roll.

1.10 Aerodrome and Ground Facilities

JFK Airport had been undergoing an expansion and modernization program including the relocation of the outer and inner taxiways and ramp expansion. This work required the removal of old paved surfaces and resulted in taxiway and runway contamination.

Introduction of the new large jet aircraft with more than twice the thrust of previous jet (transport) aircraft, caused considerable erosion along most taxiways and runways. According to New York Port Authority personnel, the products of this erosion, pieces of asphaltic material, rocks, etc., were being blown onto taxiways, ramps, and runways, making it difficult to keep these areas clean.

1.11 Flight Recorders

(a) Flight Data Recorder

The aircraft was equipped with a Sundstrand Data Control, Inc., UDC Division, FDR Model F-542B, S/N 3985, located on the right upper side of the rear pressure bulkhead. The recorder was recovered shortly after the accident and, upon disassembly, it was found that the recording medium was not damaged.

Examination of the data graph prepared from the flight data recorder readout indicated that the aircraft accelerated in a normal manner during the first 15 seconds, reaching about 91 knots, at which time the aircraft rotated noseup. Shortly thereafter, the airspeed and altitude traces became aberrant and continued so throughout the recorded time history. About 14 seconds after the indications of rotation, the acceleration trace (g), moved in a positive direction, to a maximum of + 1.5 g in about 5½ seconds, then reversed and reached a value of + 0.5 g in about 4 seconds. The trace remained below the + 1.0 g until electrical power was lost at impact. The heading remained close to the runway heading of 130° until the last 15 seconds of flight when it fluctuated between headings of 070° and 150°.

(b) Cockpit Voice Recorder

The aircraft was equipped with a United Control Voice Recorder, Model V-557, S/N 1917, located on the right upper side of the rear pressure bulkhead.

Pretakeoff conversation indicated that the engine startup, flight control check, stabilizer check, and flap settings were accomplished in

a normal manner. Nothing unusual was noted in the cockpit conversation until the start of the takeoff roll. At 1605:07, the sounds of engines "spool-up" was recorded and, at 1605:21, the order to "set the power" was recorded. An unusual sound, identified as the tail skid dragging, was recorded at 1605:26. It continued for several seconds. Shortly afterward at 1605:35, the captain's words "let's take it off" were recorded. Two and one-half seconds later, at 1605:37.5, the first officer stated, "Can't control this thing, Ron." "Ron" has been identified as the captain by fellow pilots. At 1605:38.6, the sound of the stick shaker began. At 1605:45.6, the sound of the horizontal trim-in-motion buzzer was heard once, followed by the words "What happened" at 1605:47.6. At 1605:49, the stick shaker sound ceased. The last remark recorded was, "Oh gosh," at 1605:50.8, and the recorder ceased operation at 1605:52.

Difficulties were experienced in transcribing the CVR recording because of interference from the cockpit speaker, which was on during taxi and takeoff.

1.12 Wreckage

The wreckage came to rest on a magnetic heading of 094° and was confined to an area approximately 250 feet long and 375 feet wide. The aircraft struck the ground on the left wing and the left side of the nose, fragmenting at impact. Fire broke out almost simultaneously with the impact and consumed approximately 60 percent of the aircraft.

After examination in place, the engines, unburned portions of the right wing, and the empennage were moved to a hangar where detailed tear-down inspections and studies were completed.

Because of the circumstances surrounding this accident, particular attention was paid to those items that would affect the longitudinal control of the aircraft. These items were examined and their positions were:

1. The horizontal stabilizer trim setting was 2° aircraft noseup, approximately the correct setting for takeoff at the calculated weight and center of gravity.
2. The landing flaps were extended to 23°, the takeoff position.
3. The leading edge slots were properly opened on the right wing.
4. No determination of the slot position on the left wing could be made.
5. The pitch trim compensator actuator was in the retracted position, properly positioned for takeoff.

6. The elevator dampers on both elevators were securely mounted and there was no evidence of malfunction observed.
7. The fuse rivets of the elevator load-feel centering spring assembly were sheared in the push (aircraft nosedown) direction.
8. The gust locks showed no evidence of being engaged.
9. Both the flight and ground spoilers were in the retracted position.
10. The landing gear was down and locked.
11. There was no evidence to indicate that the elevator autopilot servo was engaged.
12. No determination regarding the pitch trim servo could be made.

There was no evidence of distress on the elevator torque tube bearings. There was a fresh indentation on the left torque fitting which appeared to have been made by the spar. Calculations based on this mark indicated that it was made when the elevator was approximately 13° trailing edge up.

There was no evidence of distress in the recovered portions of the pilot's control columns, control column torque tube, and associated torque tubes, cranks, and linkage in the empennage. The elevator control cables were properly connected in both the forward and after sections of the aircraft. All the cables examined had either been burned through or showed evidence similar to a tensile failure of the cable.

There were marks on the left side of the fuselage, between fuselage Stations 1890 and 1970, that appeared to have been made by the left elevator at impact. Calculations based on these marks indicated that the elevator was approximately 14° to 16° trailing edge up when the marks were made. The left elevator was fixed in position approximately 15° trailing edge up. The elevator was held in this position by the surrounding structure.

During the examination of the right horizontal stabilizer, a hole was found in a rear spar web access door at approximately stabilizer Station 32. This hole appeared to have been punched in the access door by a foreign object. On that portion of the leading edge of the right elevator that faced the hole, an area of scratches and gouges was found. There were scratches adjacent to and below the hole in the access door and a smear of asphaltic material adhered to the metal near the hole. (See Attachment No. 2.)

No foreign object was found in the stabilizer or in the area between the elevator and the stabilizer. However, several tar-covered stones, 1-1/2 to 2 inches in diameter, were found in the vicinity of the empennage.

1.13 Fire

No in-flight fire was reported other than that seen coming from the inlets and exhaust ducts of the engines when the aircraft was in an unusually nose-high attitude.

The postimpact fire broke out almost simultaneously with the impact and consumed approximately 60 percent of the aircraft structure. The airport firefighting equipment arrived at the accident site approximately 30 seconds after the impact and controlled the fire in approximately 5 minutes.

1.14 Survival Aspects

This was a nonsurvivable accident. The medical records of the pilots reflected no conditions which should have affected the normal operation of the aircraft. Post-mortem examinations of the crewmembers revealed no condition which could be related to accident causation. The results of toxicological studies performed were negative. The injuries suffered by the crew were consistent with impact forces imposed from the left side of the aircraft. The damage of the aircraft seats was also consistent with impact forces imposed from the left side and nose section of the aircraft. No evidence of seatbelt failure was found.

The captain's right hand and forearm had sustained fractures which have previously been observed in aircraft accident victims and which have been associated with handling the flight controls at impact. The copilot's forearms and hands did not demonstrate these typical fractures although hand fractures were noted.

The New York Port Authority Police Emergency crews from both the main and satellite garages on the airport fought the fire. The main garage was located approximately 300 yards from the crash site. The crew at this station were securing from a previous emergency call and their response time was less than 30 seconds after impact. The response time from the satellite garage was approximately 2 minutes. A special rescue squad from the New York City Fire Department supplied portable saws to cut some of the wreckage in the forward section of the aircraft.

1.15 Tests and Research

The principal recovered pitch control system components were taken to the manufacturer for detailed examination and study. In addition,

aerodynamic studies were conducted to determine the aircraft performance capabilities based on the information developed regarding elevator jamming at various trailing-edge-up positions. The manufacturer conducted these studies and examinations at the request of the Board and NTSB investigators observed the work. Based on these studies the manufacturer postulated that:

1. The 1-1/4 inch scratch below the tear in the access door was caused by initial binding with the elevator in approximately a 12° to 15° trailing-edge-up position. This initial binding was followed by continued movement in an elevator leading-edge-up direction.
2. The puncture in the access door occurred with an elevator deflection of between 8° and 11° trailing edge up. The tearing above the puncture indicated that the elevator moved to a trailing-edge-up angle of between 5° and 8° .

The aerodynamic studies indicated that the recorded performance of the aircraft was within its performance capabilities at the takeoff configuration, weight, and balance.

Using the tail section of another DC-8, 60 series, the Board conducted a series of tests to determine what effect the introduction of foreign objects into the space between the elevator and the horizontal stabilizer would have on the operation of the elevator. In addition, examination of another DC-8 was made with particular reference to the pitch control system.

Under static conditions, the elevators were balanced so that the normal position was full trailing edge up, about 24° above the horizontal. In this condition, the pilot's control column was at or near the neutral position. When the control column was moved to the apparent forward limit of travel, the gust lock could be engaged, locking the elevators. With the elevators locked, the control column moved aft to a neutral position, and the elevator angle was measured to be 0° .

With the gust lock off, the control column was moved to the forward column stop, 4 inches forward of the neutral position, and the aft column stop, 10 inches aft of the neutral position. With the column full forward, the elevator angle was 9° trailing edge down, and with the column full aft, the elevator was $27\text{-}1/4^{\circ}$ trailing edge up.

With the gust lock off, the elevator was blocked in five different trailing-edge-up positions and an attempt was made to move the control column forward from its static position. It was noted that as soon as a

forward force was applied to the column, a resistance to movement was felt. The results of this test are shown below:

<u>Control Column Position</u>	<u>Blocked Elevator Position</u>
1-1/2 inches aft of neutral	27° trailing edge up
1/4 inch aft of neutral	22° trailing edge up
Neutral position	17° trailing edge up
1 inch forward of neutral	12° trailing edge up
1-1/2 inches forward of neutral	8° trailing edge up

Another test was performed with the gust lock off. The elevator motion was blocked with a piece of 3/4-inch plywood approximately 1-1/2 by 2 inches, placed in the same location as the damaged area of the accident aircraft. In this test, the static column position was recorded, then an 80-pound push force was applied to the column, and the column position was recorded. The web of the horizontal stabilizer rear spar "oil canned" when the push force was applied to the control column.

With the elevator blocked in the 15° trailing-edge-up position, the control column was 1-1/8 inches aft of the neutral position. When the 80-pound push force was applied to the control column, the column was moved to a position 1-3/8 inches forward of the neutral position. There was no change noted in the position of the control tab or the elevator.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

The circumstances surrounding this accident immediately directed the thrust of the investigation to those conditions that could affect abnormally the pitch control of the aircraft.

The flightcrew and the aircraft were properly certificated and capable of performing the intended flight.

The weight and balance were within the established limits.

The autopsies and toxicological studies of the flightcrew indicated that there was no preexisting disease or disability that would have affected their performance. There was no evidence of in-flight incapacitation of or interference with the pilots.

Examination of the horizontal stabilizer established that it was in a position appropriate for the takeoff conditions. The landing flaps were positioned properly at the takeoff setting. There was no evidence of structural or system malfunction of the pitch control system. The elevator torque tube bearings and elevator hinges that were examined showed no evidence of prior distress.

Calculations performed by NTSB and the manufacturer indicate that, given the takeoff conditions, 16° of elevator trailing-edge-up deflection (aircraft noseup) would have been sufficient to perform the initial rotation at an airspeed of approximately 80 knots. The correlation of the cockpit voice recorder record, the flight data recorder record, and the witness observations indicated that the aircraft had rotated to an excessively nose-high attitude at an indicated airspeed of approximately 91 knots at a point approximately 1,500 feet past the beginning of the takeoff roll. The initial elevator deflection was not maintained throughout the flight. These studies also indicated that the aircraft was capable of performing the maneuvers described by the witnesses but that the elevator angle would have gradually decreased throughout portions of the flight.

Physical evidence that could be associated with a pitch system problem was the position of the elevator, the discovery of the hole punched in the right horizontal spar web access door, the scarring of the opposite, corresponding area on the leading edge of the right elevator, and traces of asphaltic materials found around the periphery of the hole in the access door. This evidence, coupled with the discovery of several large, asphalt-covered stones in the area of the recovered tail section, led the Board to test the effect of lodging a similar size stone in the area between the leading edge of the elevator and the trailing edge of the stabilizer. When a stone was so placed in this area and the elevator moved to the aircraft noseup position, the stone followed the leading edge of the elevator down into the space between the elevator and the stabilizer. When force was applied to the elevator to return it to the level position, the stone jammed into the space and kept the elevator from moving. (See Attachment 2a.) As more force was applied to move the elevator down, the metal was seen flexing and buckling where the stone pressed on it.

Calculations based on an ultimate shear failure mode were provided by the manufacturer. These calculations indicated that the loads required to fail the material in the access door varied according to the length of the contact line between the foreign object and the door. For example, if the contact line were 1 inch long, 1,720 pounds would have been required to achieve the ultimate shear value of 43,000 p.s.i.; however, if the contact line were only .5-inch long, the load would be reduced to 860 pounds to achieve the same ultimate shear value.

Examination of the leading edge of the right elevator and the trailing face of the right stabilizer indicated that an irregular shaped, asphalt-covered, hard object was lodged between the two surfaces. Calculations based on the fresh scars and marks in this area indicated that the elevator was approximately 12° trailing edge up when sufficient force was applied to cause the foreign object to scar and pit the metal. Scrape marks on the access door indicated that the object skidded or slid, under pressure, up the face of the door. Finally, the object punched an irregular hole in the door and then fell free, probably upon impact. (See Attachment 2.)

The Board believes that this foreign object was a stone similar to the ones found in the accident area. Similar stones were also found on nearly all the taxiways and aprons used by Flight 863 prior to takeoff. These stones were lying loose on the surface of the airport during the resurfacing program in progress at the time of the accident. While the Port Authority continuously swept the taxiways and runways, they were unable to keep up with the requirements for removal of debris from all the paved areas. Jet blasts associated with normal operations, particularly those generated by aircraft with more than average thrust, were observed blowing similar stones over the surface of the airport.

In this accident, the time and place of the introduction of a foreign object onto the tail section of N4863T could not be determined.

After reviewing the evidence, the Board believes that the loss of pitch control was caused by a foreign object lodged between the right horizontal stabilizer and the leading edge of the right elevator. The object could have been thrown into that position by jet wake during taxiing or runup. With the object lying in the area between the surfaces, displacement of the elevator to the trailing-edge-up position would have allowed the object to fall between the two surfaces. In view of the static deflection of the elevator in this type of aircraft, trailing edge up, any time the flight controls were unlocked the elevator would assume that position and create a gap between the elevator and the stabilizer. A large deflection of the elevator was also observed during the initial take-off roll of other DC-8's in normal operation.

As the takeoff of N4863T was initiated, the airload on the deflected elevator would have built up, increasing the pressure on the object by attempting to streamline the elevator. The compression of the object between the surfaces could have caused the pitting and scarring of the surfaces that was found.

At approximately 80 knots, an abnormally low airspeed, the aircraft began to rotate, and at approximately 91 knots, the tail skid struck the runway. As the airspeed increased and the pilots increased the nosedown input, the load on the object caused it to move toward the top of the

control surfaces and caused the scratches observed on the access door below the puncture. At the same time, the elevator angle was decreasing toward the 12° position. At approximately that point, a sharp edge or point of the object penetrated the skin of the access door and jammed the elevator in that position. As the load on the elevator increased, the elevator up angle was further reduced to an estimated value of 5° to 8° . The restriction to elevator movement was not detected by the crew in time to successfully reject the takeoff.

In view of the circumstances surrounding this accident, the Board has attempted to analyze the crew's activities during the takeoff in an effort to determine why the pilots did not detect the abnormal situation, assess its implications, and respond to the situation by rejecting the takeoff.

Examination of the evidence, including the voice and flight recorders, witness statements, and the wreckage, made it possible to reconstruct many of the aspects of the flight and portions of the crew's activities. However, during this brief time period, all of the actions of the crew are not known.

The evidence indicates that a strong push force was applied to the control column. Additionally, a relatively small amount of forward trim, aircraft nosedown, was used. The amount of trim was only about one-half of a degree, however. Finally, there was a recorded verbal indication by the first officer that he could no longer control the aircraft. This statement was not made until after the aircraft had left the ground.

As the aircraft began to rotate at a speed of approximately 80 knots, this should have been the first indication to the crew of an abnormal condition. About 4 seconds later, at 91 knots, the tail skid began to drag on the runway and continued to do so for approximately 9 seconds. The aircraft subsequently became airborne at an airspeed of approximately 117 knots and immediately resumed its upward rotation. At this point, there was no other reasonable alternative available to the crew than to continue the takeoff; and the accident became inevitable.

There should have been ample time for the pilots to recognize the abnormal behavior of the aircraft, i.e., early rotation and dragging of the tail skid, and under such circumstances the takeoff should have been rejected. The captain, even though he was outside the control loop, should have immediately recognized an abnormal condition and, without having to know the precise reason for the abnormality, should have either taken control or ordered the takeoff rejected. The first officer, being part of the control loop, should have recognized an abnormal condition when appropriate control inputs did not correct the premature rotation of the aircraft.

It is evident, therefore, that a critical link in this set of circumstances was the failure of the pilots to take the only appropriate action available to them by rejecting the takeoff: In analyzing this failure, the Board has attempted to identify the conditioning factors which led to this critical event and these factors are discussed below in the order of their importance:

1. A study of rejected takeoff procedures contained in various aircraft flight manuals and flight operation handbooks revealed two significant statements regarding this procedure:
 - a. The primary reason for initiating a rejected takeoff is an engine failure or loss of power at or before reaching V_1 . ^{2/}
 - b. Rejecting takeoffs at high speeds is potentially dangerous and should not be attempted unless an actual engine failure has occurred.

In this connection, the Board's records indicate that between January 1964 and January 1970, there were 21 accidents or incidents involving rejected takeoffs in air carrier operations resulting in the destruction of six aircraft, substantial damage to nine aircraft, and minor damage to four aircraft. Only two of the 21 occurrences were initiated by a powerplant failure or loss of power. Fifteen of these 21 occurrences were reported to the Board as accidents and, in eight of these 15, the Board found that pilot technique, supervision, or preflight preparations were cause factors.

In contrast, the Flight Safety Foundation recently reported an analysis of 200 successfully rejected takeoffs. The frequency of such rejects was reported to be about once in every 3,000 takeoff attempts. Powerplant problems were the over-riding reasons with 64 occurrences including 26 occurrences of low power and nine occurrences of actual engine failure.

In view of the variety of rejected takeoff initiating factors recorded and the fact that engine failure or loss of power does not appear to be the primary reason in unsuccessful rejected takeoffs, the Board believes that the previously mentioned emphasis in flight manuals and training procedures on engine failure is misleading and that the emphasis on the dangers of rejected takeoffs tends to prejudice the pilot against the use of that procedure.

^{2/} V_1 is defined by 14 CFR 1.2 as critical engine speed. From this point, takeoff can be continued or stopped safely on a smooth, hard-surfaced runway (14 CFR 25.109 and .111).

2. A review of the TIA Flight Operations Manual showed that it was not precise in specifying the rejected takeoff procedure to be followed by the crew, particularly when the copilot is flying the aircraft and the captain was performing some of the duties of the copilot. The manual did state that the captain would keep his hand on the power levers during a normal takeoff until the aircraft reached V_1 ; "... the captain always retains the decision regarding the discontinuance of the takeoff ..." and "... if he is not handling the controls himself, he [the captain] must take over."

Thirteen seconds passed between the onset of the early rotation at approximately 80 knots and the captain's order to takeoff. This appears to have been an adequate amount of time to verify the rotation, determine that the first officer did not cause the rotation, and initiate a rejected takeoff before the aircraft became uncontrollable or reached an excessively high speed. All of the information required for this decision was available in the cockpit.

However, if the captain was not monitoring the takeoff, it would take him more time to get oriented, scan the instruments, check the trim and flap settings, question the first officer, and make a decision. In this connection, we note that there is no record that the captain questioned the first officer, nor did the first officer volunteer any information to the captain until the first officer found he could not control the aircraft after lift-off.

If a captain allows a first officer to fly the aircraft but retains the command prerogatives including all decisionmaking, the captain must keep himself completely aware of what is happening to his aircraft at all times. This is particularly important during critical phases of flight such as takeoff, approach, and landing. The captain must also be in position to assume control of the aircraft at any time. To do less is to restrict his ability to make sound decisions and take timely, appropriate corrective action.

In this case, it appears that the captain may not have been completely aware that the aircraft was performing abnormally and therefore was unable to take timely corrective action.

3. Human behavior in a particular situation is never completely independent of surrounding events and prior experiences. In this case, the events prior to takeoff were conducive to de-emphasizing the rejected takeoff alternative as a planned procedure in the pilot's mind. The usually crowded traffic conditions at this airport; the need to expedite the takeoff at the tower's request ("---be prepared for an immediate takeoff ---"); the knowledge that there was traffic behind them on final

approach ("---Traffic's turning base"); and the fact that the first 15 seconds of takeoff roll were entirely normal, all combined to suppress the rejected takeoff procedure as a means of responding to an emergency.

Additionally, this crew had extensive experience in this type of aircraft. This familiarity, combined with the highly unusual nature of the emergency and reinforced by the knowledge of a normal trim setting, a light gross weight, an empty aircraft, and more than ample engine power would predispose the crew towards electing to fly out of any difficulty rather than to reject the takeoff. In that regard, it must be borne in mind that the crew had no method of assessing this jammed elevator problem other than the abnormal aircraft behavior. Thus, the indications of a critical malfunction were subtle and ambiguous in the minds of the crew during the takeoff roll, and did not become obvious and absolute to them until the aircraft became airborne and recovery by any procedure became impossible.

4. The Flight Safety Foundation recently printed a comment on teamwork in their April 1971 Accident Prevention Bulletin which, because of its applicability to this accident, is quoted in part below:

"The best fail-safe provision in the cockpit is proper teamwork. Optimum teamwork however, is always preceded by a thorough (not a lengthy) briefing by the pilot-in-command and possibly the copilot when acting as flying pilot. It is the solid basis of teamwork, from which mutual confidence and assistance develop into mutual cross-monitoring and cross-checking, without hesitation to call the other crew members' attention to any performance which is outside of given tolerances. This habit of mutual help, of early detection and elimination to each other's mistakes and errors, makes for the highest safety factor of a multiple crew."

The Board believes that the rejected takeoff procedure is the most appropriate emergency procedure to be chosen during the takeoff roll before flying speed is reached, and for a variety of emergency events. This then, would seem to be the event to plan for. The Military Airlift Command recognizes the value of proper communications and preparation for contingencies, in that aircraft commanders are required to brief their crew on takeoff procedures, possible emergencies, etc., as part of an item on the before-takeoff checklist. The value of this procedure is found in the fact that each crewmember is mentally prepared for any eventuality each time a flight is commenced.

The infrequent occurrence of emergencies in modern jet aircraft has made air carrier operations quite routine. Because of this, a crewmember can become so familiar with his task that his actions are not

influenced by conscious thought but rather by patterned response, devoid of emotion and motivation. When this patterned response is broken because of an irregular input into the expected routine, a completely new response pattern must be set up, consisting of: recognition of the problem; analyzing its effect on the task outcome; recalling a remedial procedure; and executing the procedure. The time element which is involved here may be reduced considerably by anticipating certain events which are most likely to be disruptive in the sequence and by knowing the appropriate remedial procedures.

In the case at hand, the fact that neither pilot responded with the one appropriate action to the abnormal indications during the takeoff roll suggests that the rejected takeoff alternative was not sufficiently prominent among other options to be readily selected in this developing emergency situation. However, it would seem to be a reasonable conclusion that, had the crew been required to discuss the takeoff contingencies as an item on their checklist, they would have been better prepared to cope with this highly unusual emergency situation.

2.2 Conclusions

(a) Findings

1. The flightcrew and the aircraft were properly certificated and capable of performing the flight.
2. The weight and balance were within limits.
3. There was no evidence of flightcrew incapacitation from any cause.
4. The aircraft was properly trimmed for takeoff and the flaps were set at the takeoff position.
5. There was no evidence of a structural or system failure in the pitch control system other than the damage to the right horizontal stabilizer leading edge and the access door on the right horizontal stabilizer rear spar.
6. The airspeed, at the time the tail skid struck the runway, was approximately 91 knots, 33 knots lower than the planned rotation velocity. However, the rotation began at approximately 80 knots at a point approximately 1,500 feet after beginning the takeoff roll.
7. An elevator trailing-edge-up (aircraft noseup) deflection of approximately 16° was required to rotate the aircraft at 91 knots.

8. Scratches and gouges were found on the surface of a right horizontal spar web access door and on the leading edge of the right horizontal stabilizer immediately opposite the scarred area. There were smears of asphaltic material on the surface of the access door in the area of the scars.
9. It was calculated that the elevator was in a 12° to 15° trailing-edge-up position when the initial scratches were made. A short distance above the scratches on the access door, a hole was punched in the skin of the door. It was calculated that the elevator was approximately 8° to 11° trailing edge up when the hole was punched in the door.
10. The construction of the empennage of this aircraft is such that when a foreign object is placed on top of the horizontal tail, it tends to slide inboard and toward the area between the stabilizer and elevator. If the object is too large to pass between these two components, it will remain in this area. When an elevator trailing-edge-up condition exists, the object drops down into the gap and will resist a return of the elevator to the level position.
11. An object with a contact line of 2 inches or less could have punched through the access door and no restriction to elevator motion would have occurred. An object with a greater contact line than specified would distribute the forces over a greater area and would not penetrate the skin, under the elevator loads existing at takeoff.
12. In this case, the object had an irregular surface and eventually the imposed forces were concentrated on a point or sharp edge causing the puncture, but the object was too large to pass through the hole in the door.
13. The object stayed between the elevator and the stabilizer, holding the elevator in an approximate 5° to 8° trailing-edge-up position until initial aircraft impact.
14. With the elevator jammed in this position, there was not adequate pitch control available to the pilots to correct the attitude of the aircraft after it became airborne.
15. The captain was responsible, by TIA standards, for any initiation of rejected takeoff procedures.

16. The captain made the decision to continue the takeoff, as indicated by his command "Lets take it off" during the takeoff roll. He made that decision, however, without aircraft control inputs upon which to determine the cause of the abnormal aircraft behavior.
17. Before the crew fully realized the criticalness of their situation, the takeoff had progressed to a point where they had little or no time to reject the takeoff successfully. This was caused by a combination of factors including inadequate explanation of the rejected takeoff procedures in the handbooks, de-emphasizing of rejected takeoff procedures because of environmental pressures, and the lack of planning for such events before takeoff.

(b) Probable Cause

The Board determines that the probable cause of this accident was a loss of pitch control caused by the entrapment of a pointed, asphalt-covered object between the leading edge of the right elevator and the right horizontal spar web access door in the aft part of the stabilizer. The restriction to elevator movement, caused by a highly unusual and unknown condition, was not detected by the crew in time to reject the takeoff successfully. However, an apparent lack of crew responsiveness to a highly unusual emergency situation, coupled with the captain's failure to monitor adequately the takeoff, contributed to the failure to reject the takeoff.

3. RECOMMENDATIONS

Based on the results of the investigation of this accident, the Board recommended to the Administrator, Federal Aviation Administration, that (1) all DC-8 operators be advised of the hazardous condition that can be created by foreign objects jamming the aircraft's elevators; (2) all DC-8 operators should be advised that takeoffs should be rejected when premature or unacceptable rotation occurs during takeoff until adequate procedures are developed for a positive check of elevator position; (3) the DC-8 flight control system should be evaluated by the FAA with a view to establishing a standard procedure for checking the system from the cockpit. This procedure should provide for positive detection of a jammed elevator; and (4) consideration be given for a requirement to install an elevator position indicator in the cockpit of all DC-8 aircraft.

The Administrator replied November 20, 1970, that engineering evaluations were being completed at Douglas Aircraft Company. He stated that additional time was required to complete these evaluations and he would advise the Board of any action taken as soon as the evaluations

were completed. The Administrator also stated that he needed additional clarification regarding Recommendation No. 2.

The Administrator, on March 8, 1971, reported that he had completed his review and investigation of our recommendations. He stated that the manufacturer had developed a procedure to check for elevator movement and jamming prior to takeoff and that the FAA had issued an operations alert December 1, 1970, requesting that this procedure be brought to the attention of all DC-8 operators. He further stated that the usefulness and value of an elevator position indicator would not justify the large cost and complexity of the installation due to the design of the elevator control system. (See Attachment 3.)

Since a rejected takeoff is a normal response to an emergency event which occurs before flying speed is reached, this would appear to be an event that should be preplanned by flightcrews. Some flight operations recognize the value of proper communication and preparation for contingencies and require flightcrew briefings on takeoff procedures, possible emergencies, and duty assignments dependent on which pilot is handling the flight controls. The value of such a procedure is that each crew-member is mentally prepared for such eventualities each time a flight is commenced.

Our review of flight manuals and operations manuals indicates that the procedures contained in these manuals could be improved by being more specific in duty assignments and functions during a rejected takeoff, particularly by clarifying each pilot's duties in cases where the copilot is handling the flight controls and a rejected takeoff is required. In this connection, the Board believes that the history of rejected takeoff accidents and incidents indicates that additional emphasis is needed on factors other than engine failure that might require the initiation of a rejected takeoff procedure.

Therefore, the Board recommends that:

The Federal Aviation Administration review the subject of rejected takeoff procedures in air carrier operations with a view to: amplifying and clarifying these procedures; standardizing operation and flight manual procedures for each aircraft; reviewing the role each pilot plays in accomplishing a rejected takeoff; exploring the requirements for rejected takeoff training; providing flightcrews with more specific information regarding the dynamics of rejected takeoff conditions for the specific aircraft; and, requiring a pretakeoff briefing of rejected takeoff and other emergency procedures that the crew may have to employ.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

Oscar M. Laurel, Member, was absent, not voting.

August 18, 1971

INVESTIGATION

1. Investigation

The Board received official notification of the accident at approximately 1630 e.d.t. on September 8, 1970. An investigation team was dispatched from Washington, D. C. and arrived in New York in the early evening hours of September 8, 1970. Upon arrival, working groups were established for Human Factors, Structures, Powerplants, Systems, Maintenance Records, Cockpit Voice Recorder, Flight Recorder, and a combined group consisting of Operations, Weather and Air Traffic Control.

Interested Parties participating in the investigation included the Federal Aviation Administration, Trans International Airlines, Douglas Aircraft Company, International Brotherhood of Teamsters, Pratt & Whitney Division of United Aircraft Corporation, Port Authority of New York, and the Air Line Pilots Association.

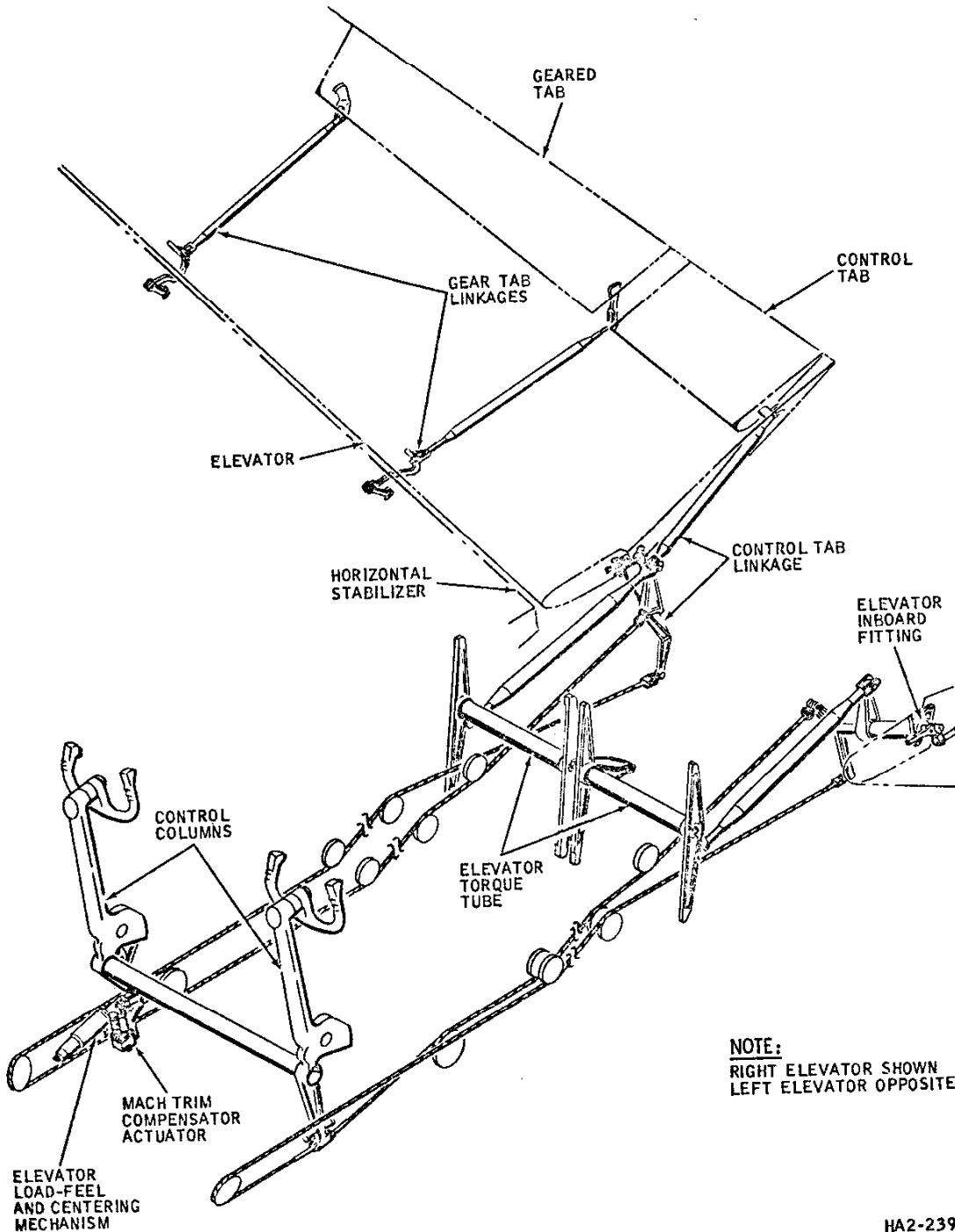
2. Hearing

A public hearing was not held concerning this accident and no preliminary report was issued.

CREW INFORMATION

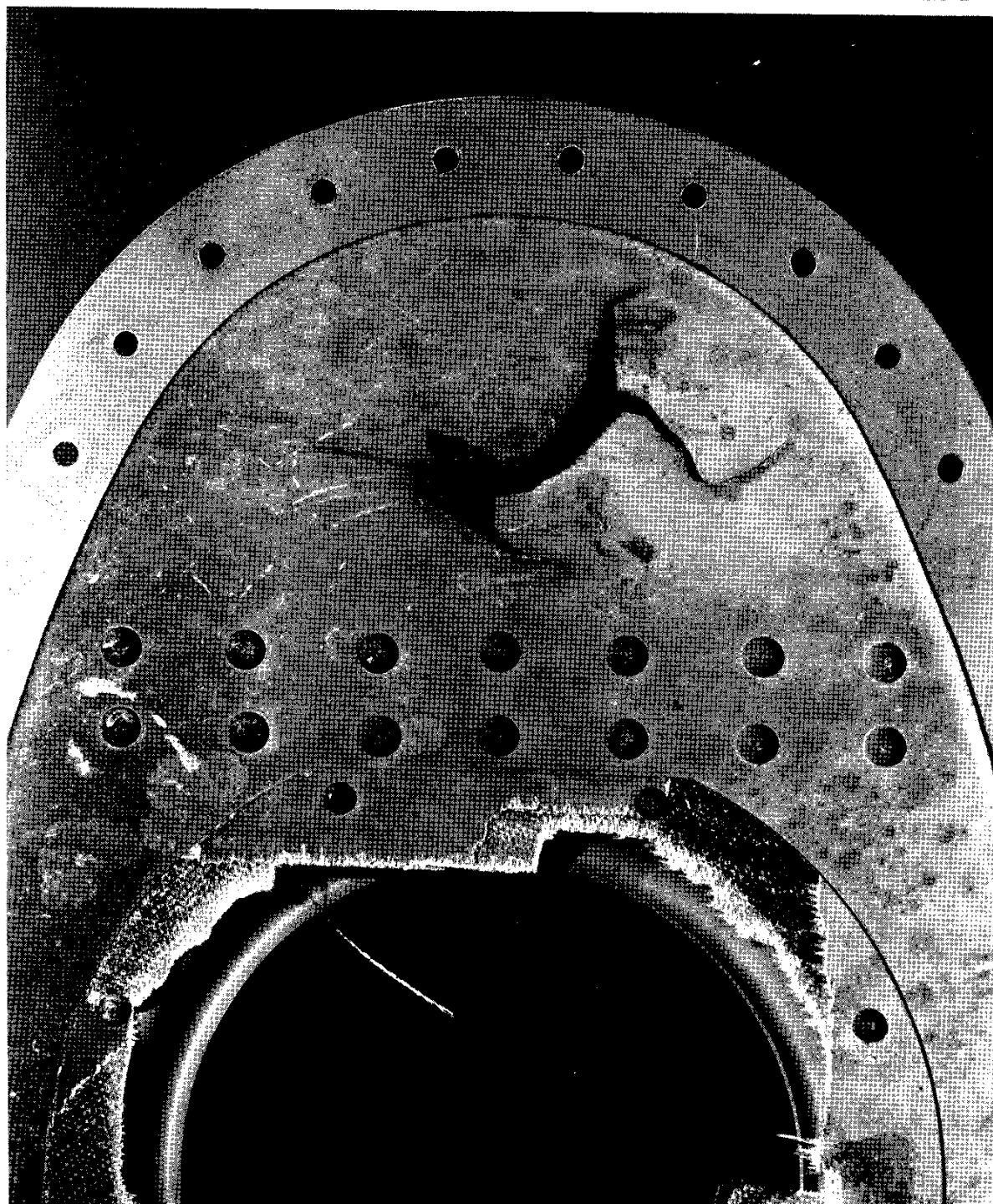
	Captain	First Officer	Second Officer
Address :	Joseph John May 203 Via Monte Walnut Creek, Calif.	John Donald Loeffler 12295 Woodside Drive Saratoga, Calif. 95070	Donald Kenneth Neal 7432 Hansen Drive Dublin, Calif. 94566
Age :	49	47	42
Certificates Held :	Airline trans- port rating 371061, Class I Medical Dated 4/28/70	Airline trans- port rating 1489067, Class II Medical Dated 9/23/69	Flight Engineer 1423858 Class II Medical Dated 7/1/70
Limitations :	Holder shall wear correcting glasses for near vision while ex- ercising the privi- leges of his air- man certificate	None	None
Pilot Ratings :	Aircraft multi- engine land, Instrument DC-3, DC-4, DC-6 DC-7, DC-8, L1049 Commercial Aircraft single-engine land	Aircraft multi- engine land, and Instrument T1049	Flight Engineer
Total Time (TT) :	22,300 hours	15,775 hours	10,000 hours
TT in Type :	7,100 hours	4,750 hours	3,500 hours
TT last 90 days in type :	259.3 hours	276 hours	205 hours
Rest period 24 hours prior to accident :	14 hours	14 hours	14 hours

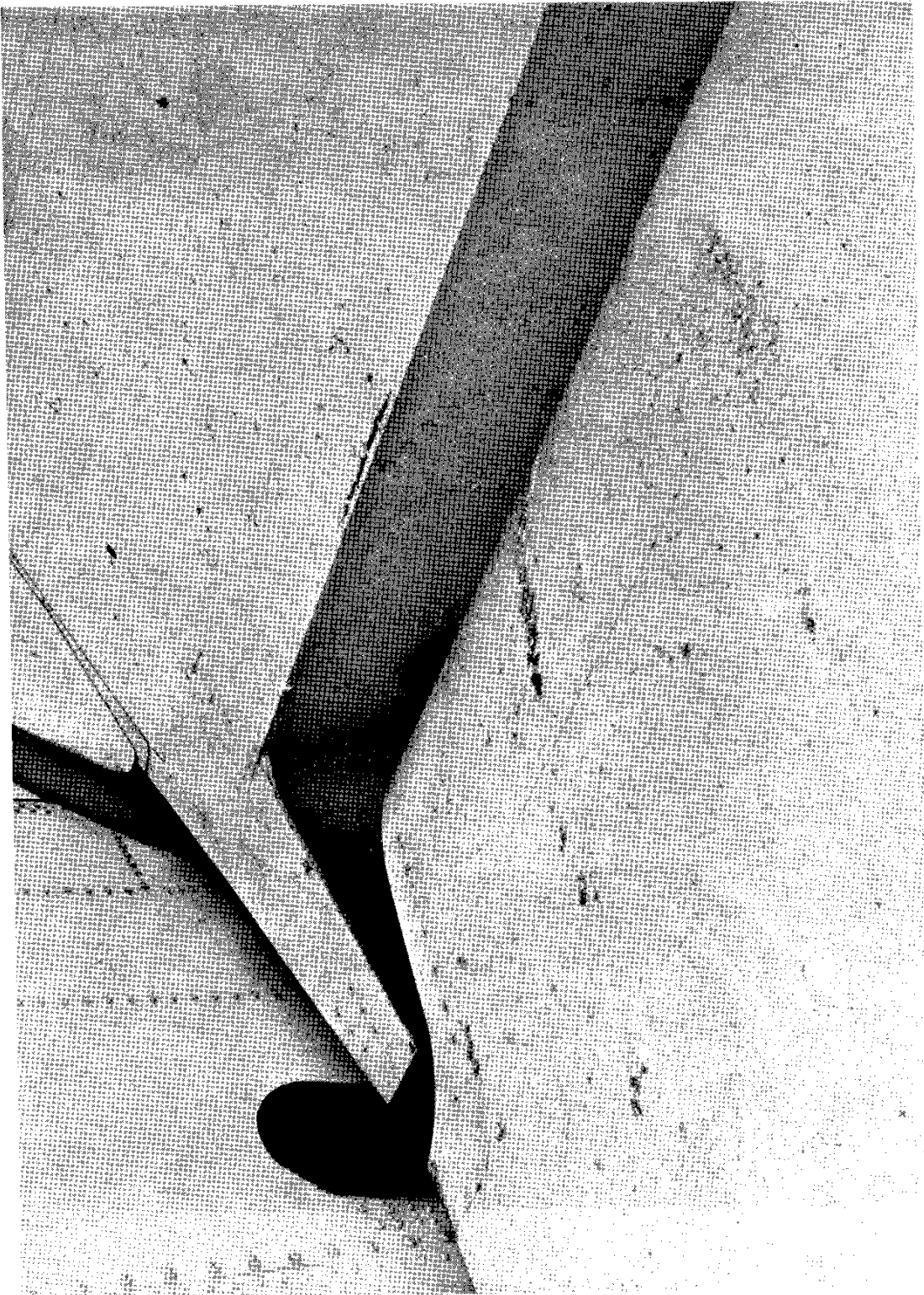
	Captain	First Officer	Second Officer
Duty time 24 hours prior to accident	: 10 hours	10 hours	10 hours
Time this Flight	: Not Applicable	Not Applicable	Not Applicable



HA2-239

Elevator Control System -- Schematic
Figure 1







DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

October 28, 1970

C
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Y

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

Dear Mr. Shaffer:

During the National Transportation Safety Board's investigation of the Trans International Airlines DC-8-63F accident at the J. F. Kennedy Airport on September 8, 1970, it was discovered that the movement of a DC-8 elevator can readily be restricted by the entrapment of a foreign object between the aft part of the stabilizer and the leading edge of the elevator.

The design static position of the DC-8 elevator (gust lock off) is in the trailing-edge up position. With the elevator in this position, a large trough-like opening is formed on the top side of the horizontal tail surface just aft of the rear edge of the stabilizer and extending the entire length of the elevator. An object cast upon the top side of the horizontal tail surfaces when the elevator is in the up position will easily find its way into this opening. If the object is larger than five-eighths of an inch in diameter, it cannot pass through to the ground, and the object becomes trapped in the trough.

Tests conducted with objects varying in diameter between $1\frac{1}{2}$ to 3 inches show that when they are placed or dropped into this trough, they become wedged between the leading edge of the elevator and the vertical metal closure webbing at the rear of the stabilizer. If the object is a solid hard substance, it can effectively restrict movement of the elevator and prevent it from moving to a faired position with the stabilizer.

An analysis of the relationship between the forces about the elevator hinge line and the potential size of foreign objects at the stabilizer/elevator interface discloses that the elevator may be rather

Honorable John H. Shaffer

- 2 -

easily jammed at speeds in the takeoff regime. A punching out of the stabilizer web would, of course, be required in order to alleviate such a constraint but is unlikely unless the entrapped object is very small. At 90 knots, for example, an object with a contact perimeter exceeding 2 inches (a flat bearing surface with an area of perhaps one-fourth of a square inch) would be too large to exceed the shear stress capability of the web.

The Board considers this particular situation to be quite hazardous, especially in view of the DC-8's lack of an elevator position indicator in the cockpit to show the actual position of this control surface. Due to the design of the DC-8 control system and existing procedures utilized by the crew to check flight control movements, it is very possible that an elevator jammed by a foreign object would not be detected by the crew.

The Board is also concerned that today's operations of modern, large jet aircraft on our airports, coupled with the vast amount of new construction work in progress at these facilities, increase the chances that a foreign object can become a hazard in the manner described above.

In view of the above considerations, the Board recommends that:

1. All DC-8 operators be advised of the hazardous condition that can be created by foreign object jamming of the aircraft's elevators.
2. Until adequate procedures are developed for positive check of elevator position, all DC-8 operators be advised that takeoff should be aborted whenever premature or unacceptable rotation of the aircraft occurs during takeoff.
3. The DC-8 flight control system be evaluated by the FAA in the interest of developing a standard procedure for checking the system from the cockpit. The procedure should provide for positive detection of a jammed elevator.
4. Consideration be given for a requirement to install an elevator position indicator in the cockpit of all DC-8 aircraft.

Honorable John H. Shaffer

- 3 -

In accordance with established procedures, this letter will be placed in our public docket at the end of the five working-day period commencing 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,

/s/ John H. Reed
Chairman

Department of Transportation
FEDERAL AVIATION ADMINISTRATION

Washington, D. C. 20590

COPY

20 NOV 1970

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

Dear Mr. Chairman:

This is in reply to your letter dated 28 October 1970 regarding recommendations which are based on the results of your investigation of the Trans International Airlines DC-8-63F at John F. Kennedy on 8 September 1970. The investigation disclosed that the movement of a DC-8 elevator can readily be restricted by the entrapment of a foreign object between the aft part of the stabilizer and the leading edge of the elevator.

As you know, there have been several elevator travel tests run at the Douglas Aircraft Company. Additional time is needed to complete the engineering evaluation and we will advise you relative to action taken as soon as these evaluations are complete.

There is one point in your letter on which we need additional clarification, i.e., recommendation 2 on page 2. As you know, the decision to abort is a complex one with many variables and to arbitrarily say "abort" could lead to further serious difficulties. First, that takeoff should be aborted whenever premature or unacceptable rotation of the aircraft occurs during takeoff and, second, applying this philosophy only to DC-8 operators, needs some clarification and we would appreciate having the benefit of your thinking as to how this can be applied.

Sincerely,

(signed) J. H. Shaffer
Administrator

WASHINGTON, D.C. 20590



OFFICE OF
THE ADMINISTRATOR

8 MAR 1971

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

Dear Mr.  Chairman:

We have completed our review and investigation of the recommendations provided to us in your 28 October 1970 letter which were based on the results of your investigation of the Trans International Airlines DC-8-63F at John F. Kennedy Airport on 8 September 1970. In this letter you have advised us of a possibility of elevator control movement restrictions caused by the entrapment of a foreign object between the aft part of the stabilizer and the leading edge of the elevator.

In an interim reply to you dated 20 November 1970, we have requested clarification in regard to the Board's recommendation concerning the pilot's decision to abort a takeoff whenever premature or unacceptable rotation occurs during takeoff. Many such aborts, in the opinion of FAA specialists, are considered extremely hazardous in view of the complexities involved in an abort.

Following our request for the above clarification NTSB and FAA representatives met on 18 December 1970 to discuss the intent of the NTSB recommendation. NTSB personnel indicated that in their judgment it was advisable to inform and caution the pilot of a potential hazard but it was not intended to request the pilot to abort whenever premature or unacceptable rotation of the aircraft occurs during takeoff. NTSB personnel fully concurred with FAA representatives that the decisions to abort should be left to the judgment of the pilot.

Douglas has developed check procedures involving control yoke movement to check for elevator movement and jamming prior to takeoff. FAA issued an operations alert on 1 December 1970 outlining this check procedure and requested all principal inspectors to bring this to the

2

attention of all operators utilizing DC-8 aircraft. This pre-takeoff check made by the pilot in accordance with the operations alert will provide adequate assurance to the pilot that there is proper elevator control for flight.

Compliance with the operations alert, we believe, will be consonant with your first three recommendations made in your 28 October 1970 letter. In regard to your fourth recommendation for the installation of an elevator position indicator in the cockpit, we believe that due to the design of the aircraft's elevator controls, the usefulness and value of such a position indicator would not justify the large cost and complexities of this installation. The information provided by the elevator position indicator during the pre-takeoff check specified in the operations alert would, at best, only duplicate the information the pilot obtains by moving the control yoke between full forward and full aft.

With regard to other makes of transports, we have found they are not critical in this area. These designs have been re-evaluated and we can not conceive of them jamming due to external foreign objects.

We understand the overall investigation of this accident has not yet been completed. Based upon your findings and any additional information and recommendations, action will be taken as appropriate.

Sincerely,



J. H. Shaffer
Administrator