
Landing with gear-up, Eastern Airlines, Boeing 727-25, N8140N, John F. Kennedy International Airport, Jamaica, New York, April 8, 1981

Micro-summary: This Boeing 727-25 intentionally landed with gear up following an inability to confirm gear down and locked.

Event Date: 1981-04-08 at 2003 EST

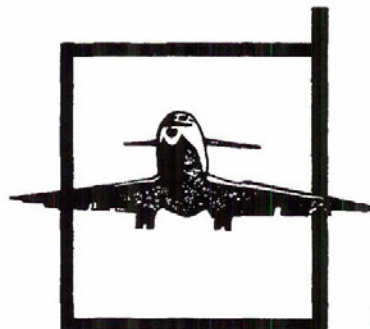
Investigative Body: National Transportation Safety Board (NTSB), USA

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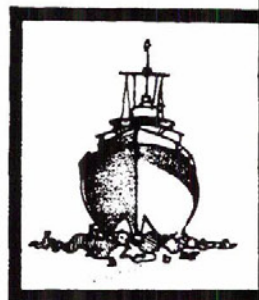
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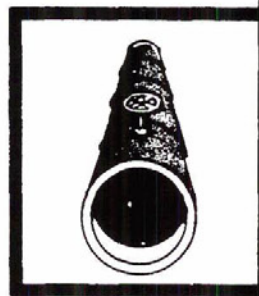
WASHINGTON, D.C. 20594



AIRCRAFT INCIDENT REPORT



**EASTERN AIRLINES
BOEING 727-25, N8140N
JOHN F. KENNEDY INTERNATIONAL AIRPORT
JAMAICA, NEW YORK
APRIL 8, 1981**



NTSB-AAR-81-14



UNITED STATES GOVERNMENT

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**NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594**

AIRCRAFT INCIDENT REPORT

Adopted: September 1, 1981

**EASTERN AIRLINES
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APRIL 8, 1981**

SYNOPSIS

About 2003 e.s.t. on April 8, 1981, Eastern Airlines Flight 60 Boeing 727-25, N8140N, made an intentional gears-up landing on runway 22R at John F. Kennedy International Airport following an uneventful flight from New Orleans, Louisiana. All 67 passengers and 6 crewmembers evacuated the aircraft safely using emergency procedures. There were no injuries.

The National Transportation Safety Board determines that the probable cause of the incident was the failure of the left main landing gear downlock switch which prevented a positive indication that the left main gear was down and locked, and the flightcrew's conviction that the left main gear could not be extended. Contributing to the incident was the inability of the second officer to observe clearly and interpret the left gear position indicator alignment through the viewing port.

FACTUAL INFORMATION

History of the Flight

At 1540 e.s.t., 1/ Eastern Airlines Flight 60, a Boeing 727-25, departed New Orleans, Louisiana, on a regularly scheduled passenger flight to John F. Kennedy International Airport, New York. The flight was on an instrument flight rules (IFR) flight plan with 67 passengers and 6 crewmembers on board. Its estimated time en route was 2 hours 30 minutes, and it carried 33,000 pounds of Jet A-1 fuel. The flight proceeded uneventfully to New York where a normal descent was made, and about 1910, clearance was received for an approach to runway 22 left.

During the approach, with the first officer flying the aircraft from the right seat, the captain moved the landing gear lever to the down position. The nose gear and right main gear green indicator lights illuminated, indicating the gears were down and locked. However, the left main gear green light did not illuminate. The captain retracted and extended the gear again during the final approach with the same result. The first officer initiated a missed approach, while the captain advised the control tower of the problem. After the aircraft was transferred to departure control, the flight was radar vectored to a holding area clear of traffic.

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

The captain and second officer reviewed the flight manual abnormal procedures section for a landing gear unsafe indication. The nose and right main gear green lights were lit, the left main gear green light was not lit, no red lights were illuminated, and the gear unsafe warning horn sounded when the throttle was retarded to idle. When checked by the crew using the test circuit, all red and green lights illuminated, which verified the bulb and circuit integrity. Following the test circuit checks, the second officer went to the cabin to observe the main gear through viewing ports 2/ in the floor. Passengers seated near the location of the viewing ports observed him on the floor pulling up the carpet.

One passenger seated in row 23 stated: "He raised the carpet slightly near my seat; however, he did not appear to be overly concerned in finding what he was looking for and he at no time indicated that he did find what he was looking for. He further did not at any time look through any portion of the floor of the aircraft." Another passenger in that row said "He appeared to be looking for something under the carpet. He did this quickly but did not seem to find what he was looking for." The second officer stated he had some difficulty raising the carpet to expose the viewing port and holding it out of the way so he could use the port. He also stated that he saw the visual "gear down and locked" indicator 3/ in the gear down position on the right main gear. On the left gear, he said he saw only "a lot of metal," but could not see the position indicator aligned in the down and locked position.

The captain and second officer tried to extend the left main gear by using the manual release system but encountered a stiff resistance to rotation of the handcrank in the uplock release direction. Both crewmembers said that they never attempted to rotate it in the downlock direction. After several unsuccessful attempts, the captain called a representative of the Technical Service Section of Eastern Airlines in Miami, Florida. The captain and the technical services representative reviewed the abnormal procedures checklist, and the captain agreed to try both the hydraulic and manual methods again. The flightcrew attempted repeatedly to lower the left main gear both manually and hydraulically; however, the left gear green light did not illuminate while the other lights illuminated each time. The crew did not see or could not remember if the red lights functioned during the cycles. Although the second officer returned to the cabin to observe the top of the wing for evidence of landing gear structural damage or failure, he did not attempt to observe the wheel well again.

The crew then discussed the possibility of having to land with the gears retracted. About 1940, at the captain's direction, the first officer requested information from Approach Control on the amount of time necessary to foam the runway. Approach Control advised the aircraft that the Port Authority Crash Fire unit had stated 1 1/2 to 2 hours would be necessary to foam 4,000 feet of runway. The captain determined that the remaining fuel would not permit holding for that length of time. A discussion with the technical service representative in Miami indicated that landing on foam was considered by the company to be at the captain's option.

The captain briefed the flight attendants and passengers, and the flight attendants prepared the cabin for a gears-up landing and emergency evacuation. About 2000, with 7,500 pounds of fuel remaining, the captain flew the final approach with 30° of flaps at a reference speed of 107 +5 knots.

2/ One direct vision viewing port on each side of the cabin in the floor between seat rows 21 and 22 permit observation of the main gear side struts, visual downlock indicator, and the wheel well area.

3/ Red index marks on a white background affixed to separate parts of the side strut and the downlock mechanism are aligned when the gear is down and the downlock is engaged.

The aircraft touched down at about 115 knots 85 feet from the displaced threshold slightly to the right of the centerline on runway 22. It slid 2,602 feet from that point where it yawed left and came to rest on the runway centerline. The crew shut down the engines and secured the cockpit. In the cabin, the flight attendants and passengers opened the doors and overwing emergency exits and inflated the evacuation slides.

By 2004, the passengers and crew had evacuated the aircraft safely using all exits, including the aft ventral airstair door.

Injuries to Persons

<u>Injuries</u>	<u>Crew</u>	<u>Passengers</u>	<u>Other</u>	<u>Total</u>
Fatal	0	0	0	0
Serious	0	0	0	0
Minor/None	6	67	0	73

Damage to Aircraft

Damage was confined to the lower fuselage skin, formers, keel beam, inboard landing gear doors, and flap trailing edges.

Personnel Information

The crewmembers were properly certificated and trained in accordance with current regulations. (See appendix B.)

Aircraft Information

The aircraft, a Boeing 727-25, was manufactured by the Boeing Company and delivered to Eastern Airlines on December 10, 1965. At the time of the accident, it had accumulated 47,651 hours. It was certificated and maintained in accordance with current regulations under the Eastern Airlines continuous airworthiness program.

The following inspections had been conducted on the aircraft.

<u>Inspection</u>	<u>Date</u>
A-Check - Segment - 1	4-4-81
C-Check - C-1	2-7-81
D-Check - D-2	2-7-81

During the C- and D-checks, considerable work was performed on the landing gear retraction/extension systems and gear doors. This work involved the replacement of certain parts in the landing gear uplock system, inspection of other parts, and rigging checks, all in compliance with a Federal Aviation Administration airworthiness directive and Boeing service bulletins. Functional tests of the normal and manual extension were performed following completion of the work. In addition, a flight test was conducted after the inspections were completed and the manual extension system was functionally tested in flight.

At the time of the accident, the aircraft had been operated 540 hours since its last inspection with no reported discrepancies on the landing gear retraction/extension systems.

Meteorological Information

The National Weather Service (NWS) reported the following weather observations at JFK at 2110: estimated ceiling -- 25,000 feet thin, scattered; visibility -- 12 miles; temperature -- 52° F; dew point -- 44° F; wind -- 190° at 20 knots; altimeter setting -- 30.19 inHg.

Communications

There were no reported communications difficulties between the aircraft and air traffic control or the Eastern Airlines technical services representative.

Aerodrome Information

John F. Kennedy International Airport, located in Jamaica, New York, is about 12 miles southeast of midtown Manhattan, about 9 miles south-southeast of LaGuardia Airport, and about 18 miles east-southeast of Newark International Airport, New Jersey. Two sets of parallel runways are available -- 4-22 and 13-31, left and right. The runways are equipped with instrument landing system (ILS) facilities; however, under IFR weather conditions, only one runway can be used at a time for instrument approaches. A short runway, 14-32, is available for general aviation and short takeoff-and-land aircraft. Elevation at the airport is 12 feet. Although the Port of New York Authority crash fire and rescue section has capability for foaming a runway and will provide the service on request, there are no requirements or standards for such service in the Airport Certification regulations, 14 CFR 139.

Flight Recorders

N8140N was equipped with a Sundstrand model FA-542 flight data recorder (FDR), serial No. 2161, and a Fairchild model A-100 cockpit voice recorder (CVR), serial No. 2287.

When investigators opened the FDR cannister to remove the recorder, they discovered that the static line connection was loose. When the foil was removed, it had been torn. The airspeed and altitude parameters had not been recorded because of the static pressure leak. Therefore, no FDR readout was made.

All channels of the CVR tape were recorded clearly. The 30-minute recording began during a discussion between the captain and Eastern Airlines Technical Services, reviewing the abnormal procedures checklist for manual gear extension. In the discussion the captain stated that the gear door would not open. The captain agreed to try both normal and manual methods again. Referring to the manual release crank, the captain stated: "...clockwise position at least three times. We can't get more than about two turns with two people on it."

The recording contained sounds of the gear handle being lowered again normally, cockpit air noises indicating that the nose gear had extended, and crew conversation confirming that the left gear green light had not illuminated. The gear warning horn sounded for about 1/2 second.

The captain and first officer attempted again to lower the left main gear manually and could not turn the crank more than two turns. Again, the captain reviewed the abnormal procedures checklist and confirmed the recommendation to land with all gear retracted. The remaining portion of the recording contained conversation regarding the

passenger briefing, discussion of flap setting for landing, and the captain's crew briefing concerning the procedures after landing. There was no discussion on the indications given by the landing gear indicator lights during extension and retraction.

The recording ended after the aircraft had landed when the crew had secured the engines and electrical power in the cockpit.

Flightcrew Interview

The flightcrew stated that they did not see the sequence of the gear red and green indicating lights during the initial lowering of the gear. During later recycling, they saw no red or green lights on the left gear indicator when the other gears were down, nor did they monitor the action of the red lights during the operating cycle.

The captain stated that he considered requesting a fly-by for visual observation of landing gear position by ground or control tower observers. However, he decided against this action because he considered a low fly-by at night over the relatively dark airport to be hazardous considering the amount of traffic and the lack of sufficient illumination to observe the landing gear adequately.

The second officer stated that when he checked the gear position, he turned on the wheel well lights and it functioned normally. He had difficulty lifting the carpet and holding it out of the way to look through the ports. On the right gear, he saw the red marks of the visual indicator aligned; however, in the left wheel well he could not see the indicator, but saw only "a lot of metal." He stated it was light colored and he did not see the tire and assumed that the gear had not extended and the door remained closed. He further stated that following the initial attempts to lower the gear manually, he returned to the cabin to examine the upper wing for evidence of a "walking beam" failure, as required by the abnormal procedures section of the flight manual. However, he did not attempt to observe the wheel well again.

The captain stated that they had made five landings during that day in N8140N and the gear and indicating system had functioned normally each time.

Impact Information

Runway 22 right is 11,352 feet long and 200 feet wide. The aircraft initial impact point was 85 feet from the displaced approach threshold lights and 23 feet right of the runway centerline. Metallic scrape marks, began a short distance from the initial impact point, continued 2,602 feet down the runway, and stopped 43 feet from the right edge of the runway. A second set of metallic scrape marks, which was about 2 feet left of the runway centerline, was found about 2,074 feet downstream from the displaced runway lights. The scrape marks continued 528 feet down the runway and stopped almost parallel to the first scrape mark.

The first set of scrape marks varied in width from a few inches at the initial impact point to 73 inches where it stopped. The 73-inch scrape marks matched abrasion marks found on the belly of the aircraft. The second set of scrape marks varied between 1 and 3 feet wide.

The aircraft stopped beyond the end of the metallic scrape marks on the runway centerline with the nose of the aircraft pointed about 23° left of the runway centerline.

The fuselage was structurally intact although it had sustained abrasion damage in certain areas. The lower surface of the air-conditioning bay between body stations (B.S.) 640 and B.S. 870 displayed abrasion damage. The damage started at the splitter of the ram air inlet and fanned out 36.5 inches to the right butt line and 36.5 inches to the left butt line for a total damage area width of 73 inches at B.S. 700.

Both main landing gear inboard doors showed heavy exterior skin abrasion and were worn through at the door hinges. The keel beam between B.S. 870 and B.S. 950 had sustained abrasion damage through the lower chord and skin panel. The abrasion mark continued on the lower fuselage skin from a position aft of the main landing gear wheel well from B.S. 950 to B.S. 1066. The drain masts located in the abraded area were worn and bent. The very high frequency (VHF) antenna at B.S. 1010 had been severed or ground off. The aft lavatory drain mast at B.S. 1150 was cracked and scraped. No other damage was noted on the fuselage or the attached components.

The left and right inboard and outboard trailing edge flaps were attached to the wing. The left inboard trailing edge flap showed abrasion and wear damage for 130 inches. The right inboard trailing edge flap, aft section, sustained similar abrasion and wear damage along the inboard section for 120 inches. The left outboard trailing edge flap, aft section, showed 3 inches of abrasion damage on the inboard. The left "elephant ear" fairing on the outboard trailing edge flap showed a small scrape mark at the lower edge. Both inboard flap aft fairings were slightly bent and scraped. No other damage was noted on the left and right wing trailing edge flaps and fairings.

Because of the intentional gears-up landing, the nose gear and the left and right main landing gears were in the stowed position in the wheel wells. Examination of the left main landing gear revealed no evidence of damage to the piston cylinder, side brace (upper and lower segments), drag brace, actuator support beam, wheels, brakes, tires, or wing gear door assemblies.

The aircraft was lifted off the runway by cranes. Both inboard main landing gear doors were hanging by the attached actuators and sequencing push-pull rods. After the loose doors had been cleared, the nose and both main gears were extended manually by a Safety Board investigator and pinned in the down and locked position. (See figure 1.)

In normal manual operation, the handcrank must be rotated 3 turns clockwise (CW) to release the door uplock and gear uplock. When the door and gear fall free, the crank must be rotated 6 turns counterclockwise (CCW) to lock the gear down. When the aircraft was lifted from the runway, the Safety Board investigator rotated the left main gear manual extension handcrank in a clockwise direction to release the gear uplocks. The investigator said that he felt increasing resistance to rotation after about one turn, and after about 1 3/4 turns, he heard a "thud," the resistance eased, and the gear fell free from the retracted position. The crank rotated counterclockwise six turns without any resistance and the gear locked down normally.

After the aircraft had been towed to a hangar, several tests and examinations were conducted by Safety Board investigators. The rigging of the manual gear extension system was checked in accordance with the Boeing Company maintenance manual. The clearances were within tolerance and the positions of the cams and operating arms were correct. The rigging of the left main gear door sequence valve was correct.

After the aircraft had been placed on jacks, the left main gear was raised hydraulically using the landing gear control handle on the flight deck. The gear door actuator retracted and extended normally. The actuator was free at its door attachment end because the door had been removed. During the test, the gear door sequencing valve

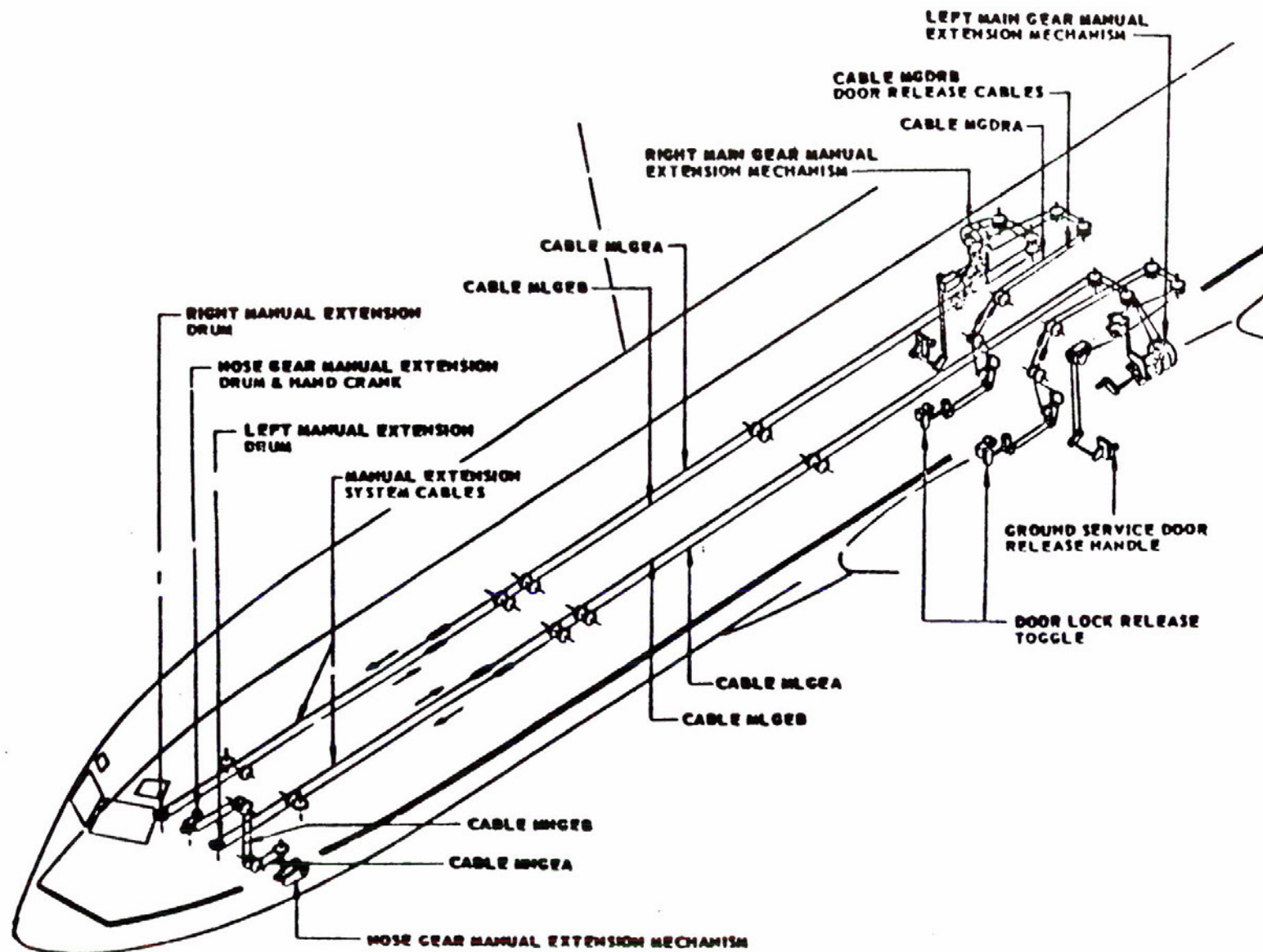


Figure 1.—Manual gear extension system.

was positioned manually and the nose wheel and right main gear were pinned to remain down and locked. The left main gear lights were operated normally. The left main gear was lowered hydraulically and all action was normal.

After the left main gear was raised again hydraulically, the gear was lowered using the manual system. No resistance to the operation of the manual release system was noted.

All three landing gears were retracted and extended hydraulically, and all were normal. The right main gear was lowered manually without difficulty.

Following temporary repair of the fuselage and wing flap damage, the aircraft was flown with the gear down to Eastern Airlines' Miami facility, where the Safety Board conducted further testing and a complete examination of the main landing gear extension and retraction system.

Gear System Components Examination

The left main gear door actuator was tested in accordance with the manufacturer's maintenance manual and functioned normally. It was disassembled and no evidence of malfunction or up lock damage was found.

The door lock operated sequence valve was functionally tested and operated normally. It was disassembled and no evidence of malfunction or damage was found.

The door ground safety valve, gear sequence valve, and left door valve were functionally tested and all functioned normally.

Left Main Landing Gear Manual Extension System

After the aircraft was flown to Miami, the left main gear manual release system was functionally tested with the aircraft on jacks. It functioned normally with no unusual resistance to crank rotation. During the test, a scored and rubbed notch was found between two cable grooves on the cable drum. A worn and scored flat spot was found on the cylindrical cable guard above the drum. Based on the findings, tests were conducted to determine if the cable could move out of the groove and jam under the guard.

The tests were conducted with the gear down and locked and the inboard gear door removed. The gear uplock hook was placed in the locked position. The manual extension crank was rotated clockwise about 3 turns to unlock the hook, and force was continued in the same direction. The cable exiting the bottom side of the drum slackened slightly but not enough to allow it to move out of the groove.

The handcrank was rotated counterclockwise about 1 1/2 to 2 turns until the manual extension gearbox crank roller contacted the side strut cam. Resistance to the rotation of the handcrank increased, accompanied by slackening of the cable on the upper side of the drum, sufficiently to allow the cable to move out the groove and ride between the drum lands and the cable guard. When force on the handcrank was reduced, the cable tension caused the crank to spring back.

At the request of the Safety Board, the Boeing Company performed a similar test on a new aircraft in the factory with similar results.

Left Main Landing Gear Downlock Indicating System

The left main landing gear downlock-actuated switch assembly, the landing gear accessory unit, and the indicator light assembly were removed from the aircraft.

The gear accessory unit was functionally tested in the manufacturer's Miami facility; all circuit parameters measured within Boeing's specified values.

The indicator light assembly was functionally checked. All red and green bulbs functioned normally, and all diodes in the unit were checked and found to be serviceable.

The down lock switch assembly was removed from the landing gear and checked on the bench. When the operating lever was moved through the normal stroke to the down and locked position, electrical measurement through the switch indicated intermittent, erratic operation.

Further tests were made at the manufacturer's facility where the switch was wired into a circuit simulating the aircraft circuit and using the indicator lights and light relays from the aircraft. The circuit functioned normally. The switch was then cold-soaked in an altitude chamber under conditions simulating 35,000 feet for 1 hour 40 minutes, and then brought to a simulated 5,000 feet, where it functioned intermittently.

The chamber was brought to sea level, and the switch cycled several times during which it functioned normally only once. It was then checked on a bench. During several cycles the resistance across the switch was measured as high as four times the maximum specified by the manufacturer.

Disassembly of the switch revealed a black coating on the contacts which was identified by laboratory analysis as predominantly silicone. A silicone compound is used as a lubricant on the switch case cover seal and electrical connector seals.

Evacuation Slide Lighting Tests

During the evacuation, it was reported that the galley door slide did not illuminate. Eastern Airlines examined the galley door slide and determined that the lighting failed because the battery had discharged. The battery had been installed in April 1980 and was due for replacement in February 1984. It was not possible to determine if the battery had been discharged before or after the slide was deployed. When a test battery was installed, all lights on the slide functioned normally.

Landing Gear Indicating System

The gear downlock switch is a two-position microswitch mounted on and actuated by the downlock mechanism in the main landing gear side strut. When the gear is in the retracted position, the switch is positioned to complete a circuit which will permit the red unsafe light to illuminate if the landing gear control handle position and the actual landing gear position are not the same. The switch remains in the position while the gear is in transit to the down and locked position. As the gear is downlocked, it actuates the microswitch to a position which opens the "unsafe" light circuit and completes the circuit to illuminate the green "gear down and locked" light. This action also energizes the warning horn relay to prevent the horn from sounding when throttles are retarded.

The horn and lights are intended to be different warnings for different conditions and are not considered to be redundant, independent warnings for the same condition. The

horn provides a warning if the throttles are retarded and the aircraft is not in a landing configuration.

The individual red and green lights are intended to indicate the position of each landing gear with respect to the position selected by the gear lever. Redundancy for the gear position lights is provided by the visual indicator mounted on each landing gear mechanism, to be observed through a viewing port for each gear.

Gear Downlock Switch Mechanical Reliability Reports

Before the incident, several Eastern Boeing 727-25 aircraft flightcrews had reported unsafe gear warning occurrences. In the 2 weeks following the incident, six occurrences of unsafe gear warnings were reported. Most involved failure of the gear down and locked indicator light to illuminate. All were corrected by replacing the gear downlock switch assembly.

At the time of the incident, Eastern Airlines Technical Services personnel were not aware of the previous switch malfunction reports and did not present the malfunction to the crew as a possible source of the problem. Eastern's systems engineering department had only begun to recognize the relatively high malfunction rate during the same week and had not yet established a corrective action.

Aircraft Flight Manual - Abnormal Procedures

Section A-10, page 6 of the Eastern B-727 Flight Manual contains the following procedure:

Landing Gear Unsafe Indication

When hydraulic system "A" is normal and the landing gear lever is in the DN (down) position, three green GEAR lights should illuminate, indicating that gear is "down and locked." If one or more green lights do not come on, or if one or more red lights do not go out, the following procedures, as appropriate, can be used to verify that the gear is "down and locked" or is in fact, UNSAFE.

1. GEAR Warning Lights TEST
- Verifies light bulb and circuit integrity.
2. Any Throttle RETARD TO IDLE
3. Visually check the gear "down and locked" position indicators through the appropriate viewers.

If these checks indicate an UNSAFE gear, accomplish the appropriate manual gear extension procedure to lock down the landing gear in question.

MAIN GEAR UNSAFE INDICATION

If a main gear indicates UNSAFE upon retraction or extension, THE GEAR SHOULD NOT BE RE-CYCLED UNTIL THE FOLLOWING IS ACCOMPLISHED; particularly if a heavy MLG thumping noise or loss of hydraulic fluid were noted:

1. Observe top of wings over MLG struts from cabin windows:
 - Check skin for hole or damage which could be caused by a failed "walking beam."
 - If wing skin is damaged or the other signs of this abnormality exist (thumping noise, etc.), DO NOT RE-CYCLE gear as further damage may be incurred. Refer to MANUAL GEAR EXTENSION procedure.
2. If wing skin is undamaged and other signs of abnormality are not apparent, the gear can be re-cycled without the probability of further damage.

The manual gear extension is given on page 7:

The following procedure is to be used when manually extending any gear to the down and locked position.

1. System "A" Pumps OFF
2. Landing Gear Lever OFF
3. Appropriate Gear Extension Access Door(s) (cockpit floor) OPEN
4. Follow instructions on upturned door(s) to extend and lock gear.
 - Nose gear extension can be monitored by noting the changes in noise level as the doors open and the gear drops into place.
5. Hand Crank REMOVE

All landing gear should now be "down and locked."

6. System "A" Pumps ON
7. Landing Gear Lever DOWN
8. Visually check that appropriate gear(s) are "down and locked."

NOTE: Accomplish appropriate normal check lists.

On page 8 the following guidance is provided:

LANDING WITH INOPERATIVE GEAR

Should it become unavoidable to land with one or more gears not fully down and locked, the following recommendations should be considered:

1. Should the choice be between landing with one main gear and the nose gear extended, or a landing with all gears up: - land with all gears up.

Instructions for manual extension of the gears are located inside each respective crank receptacle access door on the cockpit floor. The section is accompanied by illustrations and placards of the crank receptacles.

No illustrations are shown in the section which indicate the location of the viewing ports or depict the gear down and locked indicator in the wheel well.

Manual Gear Extension System

The manual gear extension system is cable-operated from the cockpit by means of a handcrank. The cables drive a reduction gearbox, located in the wheel well, which through a series of cables, cams, and levers, operates the inboard door uplock, the gear uplock, and the gear downlock. When the gear is lowered manually, the inboard door remains open.

Visual Observation of Gear Position Indicators

A visual "down and locked" position indicator is incorporated in the gear mechanism in the wheel well. This consists of a metal tab which is attached to and moves with the downlock mechanism. A red mark on the tab aligns with a corresponding red mark on the face of the side strut cam when the gear is down and locked. Both red marks are surrounded by a white background.

A direct vision observation port is located in the cabin floor above each main gear well between seat rows 21 and 22. It does not provide a view of the entire wheel well area but is oriented such that when the gear is down and locked the visual indicator red index marks are visible at the upper end of the side strut. A portion of the outboard section of the main landing gear door is also visible. When the gear is retracted, only the tire and a part of the wheel rim are visible through the viewing port. The wheel well can be illuminated by a light located in the upper inboard corner near the viewing port. The light is controlled by a switch located at the second officer's station.

Examination of the visual indicator when the aircraft was in the hangar on jacks revealed that the red marks were aligned properly and the red paint was in good condition, but grease and dirt deposits were on the white background. The deposits were visible through the viewer in the bright lighting conditions existing in the hangar. No attempt was made to duplicate the illumination existing at the time the incident although the wheel well lights were turned on and operated normally.

Crew Training

Crew training on the location of the landing gear viewing ports and visual gear down indicators is provided during initial qualification training when crewmembers are shown how to locate the ports and observe the indicators through the ports with gears down and locked. They do not observe the wheel well with the gears up and locked.

During recurrent training in the B727 simulator flight, crewmembers are usually required to demonstrate manual gear extension; however, this does not include viewing the wheel well through the port.

ANALYSIS

The Flightcrew

The captain, first officer, and second officer were properly certificated and qualified in accordance with FAA and company requirements and regulations.

The Aircraft

The aircraft was certificated and maintained in accordance with applicable regulations. There was no evidence of landing gear system failure, malfunction, or abnormality before the incident.

Flightcrew Actions

The flightcrew's first indication of a landing gear problem was the absence of an illuminated green left landing gear indicator light. When, the landing gear had been recycled and the indicator light remained unlit, the flightcrew followed the flight manual procedures for a landing gear unsafe condition. They had to rely on the only indications available to them, namely the unlit green light, the warning horn when the throttle was retarded, and the visual observation of the wheel well. With two conditions indicating that the gear was not down, the visual observation then became the final means of confirming actual gear position. Although the statements of two passengers tend to imply that the second officer did not find "what he was looking for" with respect to checking the viewing ports, it is more likely his actions were misinterpreted or misunderstood by these passengers not knowledgeable of the aircraft. There is no doubt that the second officer uncovered both right and left ports and viewed both wheel wells. Further, there is no doubt that he knew how the visual down and locked indication should look and that he observed that indication in the right wheel well. However, he could not specifically identify the same indication in the left wheel well. His description of having observed "a lot of metal" indicates that the gear was out of the up and locked position because only the tire and a part of the wheel are visible when the gear is up and locked. He stated that he had never observed the wheel well with the gear up and did not know what could be seen through the port with the gear up. Thus, in the absence of a positive identification of the down and locked indication, the second officer believed he was viewing the gear door and that the gear had not extended. This information and the cockpit indications confirmed to the crewmembers that the left main gear was not extended.

When the flightcrew encountered resistance to rotation of the manual system handcrank, they assumed they could not unlock the door and lower the gear. Throughout their attempts to lower the gear by recycling the normal system and cranking manually, they relied entirely on their original conviction and the cockpit indications which were their only source of information. Because they did not view the wheel well a second time and never attempted to rotate the crank in the opposite direction, they assumed the gear could not be lowered. Based on this assumption, the captain then followed the flight manual recommendation and landed with all gear retracted.

Manual Release System

Functional tests and rigging checks revealed no discrepancies or misrigging of the manual release system. However, it was determined that the forces on the crank as described by the crew could be duplicated when the handcrank was rotated counter-clockwise in the downlock direction with the gear down and locked. The tests also confirmed that such action would allow sufficient slack in the cable so that it could move out of the drum groove and ride between the drum and a cable guard. The marks on the cable drum and cable guard indicate that at some time the cable was out of the groove on the drum. If it was out during the landing, then the manual extension of the gear during the recovery operation would have likely forced the cable back into the groove. This assumption is supported by the reported resistance of the crank and then sudden release and normal operations when the gear was lowered during aircraft recovery. However, if the cable moved out of the drum during the incident, it could only have done so if the crank was rotated in the wrong direction with the gear down and locked. The second officer, however, stated that he followed the placard and flight manual directions and never rotated the crank in the downlock direction. Therefore, the Safety Board was not able to determine if the manual system functioned abnormally or if the cable moved out of the drum during the attempts to lower the gear.

Gear Downlock Switch Malfunction

Testing and examination of the downlock microswitch at the manufacturer's facility confirmed that the switch operated intermittently and unreliably after cold-soaking at altitude. The high resistance across the switch contacts caused by the silicone deposits would prevent current flow through the switch, thus preventing operation of the indicator lights and horn relay. Therefore, if the gear operated normally, the left gear red and green indicator lights would not have illuminated and the horn relay would not have functioned to open the horn circuit.

During the investigation, it was disclosed that other Eastern Boeing 727-25 aircraft flightcrews had reported similar instances of gear downlock switch malfunctions. Therefore, the Safety Board believes that in this incident the left gear downlock switch on N8140N malfunctioned and caused the loss of gear status indications.

The testing and examination of the landing gear after the incident revealed no damage or malfunction in the system, except for the gear downlock switch which provides for the operation of the indicator lights and horn. If this were the only malfunction, then it is likely that the gear was properly down and locked during the final approach. Since the second officer failed to observe the alignment of the visual indicators, his failures must be attributed to the difficult viewing position, dirt on the indicators, and the possibility of glare and reflection in the viewing port, as well as his lack of knowledge of what can be seen when the gear is in the up and locked position.

The Safety Board believes that the left main gear was properly down and locked although the malfunctioning switch permitted loss of proper gear indications. The inability of the second officer to determine the visual indicator position and the difficulty with the manual system led the flightcrew to conclude the gear was not down and locked and could not be lowered which in turn led to the decision to make a gears-up landing.

CONCLUSIONS

Findings

1. The crewmembers were properly certificated and qualified.
2. The aircraft was properly certificated and maintained.
3. There was no evidence of landing gear failure, malfunction, or abnormality before the incident.
4. The crew followed the flight manual abnormal procedure for landing gear unsafe indication.
5. The second officer did not verify the position of the visual indicator and, based on his observation, the flightcrew was convinced the gear remained retracted.
6. After visually checking the gear position once, the crew relied solely on the horn and light indications in the cockpit to determine the status of the landing gear.
7. Based on the evidence available to them, the crew concluded the left main gear remained retracted.

8. No evidence was found to indicate the landing gear had not operated normally during the final approach.
9. The gear downlock microswitch contacts had high electrical resistance caused by a silicone deposit which prevented normal functioning of the gear indicator circuits.
10. The left main gear was down and locked when the crew attempted to use the manual release system.
11. Based on his earlier conclusions from the evidence available, the captain made a proper decision to land with the gears up.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the incident was the failure of the left main landing gear downlock switch which prevented a positive indication that the left main gear was down and locked, and the flightcrew's conviction that the left main gear could not be extended. Contributing to the incident was the inability of the second officer to observe clearly and interpret the left gear position indicator alignment through the viewing port.

RECOMMENDATIONS

As a result of the investigation, the Safety Board issued the following recommendations to the Federal Aviation Administration:

Require the revision of air carrier operator flight manuals for the Boeing 727, as needed, to illustrate the location of the landing gear position indicator viewing ports in the passenger cabin, and to provide a pictorial presentation of the gear in the fully retracted position and the indicator in and out of the "down-and-locked" position when viewed through the port. (Class II, Priority Action) (A-81-97)

Require the revision of the abnormal procedures section of Boeing 727 air carrier operator flight manuals, as needed, regarding the landing gear unsafe indication, to include additional information relevant to the gear position indicator lights and the landing gear warning horn system, and the fact that they are not independent and are not redundant landing gear position indicating systems. (Class II, Priority Action) (A-81-98)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK BURSLEY
Member

ELWOOD T. DRIVER, Vice Chairman, and FRANCIS H. McADAMS, Member, did not participate.

September 1, 1981

APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Safety Board was notified of the incident about 2000 on April 8, 1981. An investigator from the Safety Board's New York office was dispatched immediately to the scene and an investigation team from the Washington, D.C., headquarters was dispatched at 0700 on April 9, 1981, to New York. Working groups were established for systems, structures, and human factors.

Participation in the on-scene investigation included representatives of Eastern Airlines, The Boeing Company, the Federal Aviation Administration, and the Air Line Pilot's Association. ,

2. Public Hearing

No public hearing was held and no depositions were taken.

APPENDIX B

PERSONNEL INFORMATION

Captain Arthur Glowka

Captain Arthur Glowka holds Airline Transport Pilot Certificate No. 1291398, issued on May 11, 1970, with type ratings in the Boeing 727 and Douglas DC-9. At the time of the incident, he held a current first-class medical certificate, issued on December 16, 1980.

First Officer Forrest E. Roberts

First Officer Forrest E. Roberts holds Airline Transport Pilot Certificate No. 1434902, issued on December 31, 1976, with a type rating in the Cessna 500. At the time of the incident, he held a current first-class medical certificate, issued on October 8, 1980.

Second Officer Gary L. Finley

Second Officer Gary L. Finley holds Airline Transport Pilot Certificate No. 1957676 and Flight Engineer Certificate No. 277-44-0347, issued on July 17, 1979. At the time of the incident, he held a current second class medical certificate, issued on August 7, 1980. He received his initial Boeing 727 training from Braniff International Airlines in July 1979. After furlough from Braniff, he was hired by Eastern Airlines and received a modified initial Boeing 727 training in November 1979.