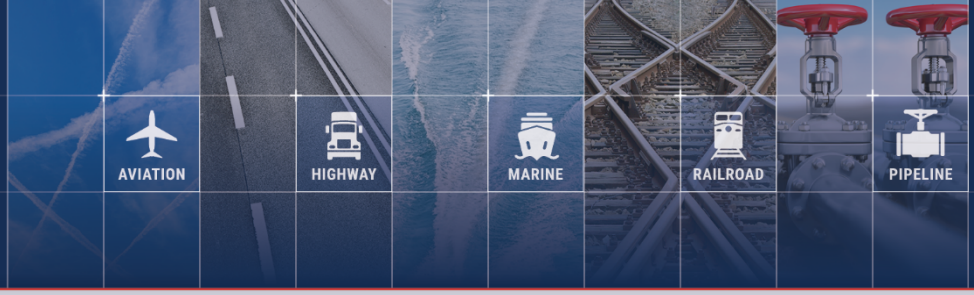

Aviation Investigation Final Report

Location:	Los Angeles, California	**Accident Number:**	DCA20LA138
Date & Time:	August 19, 2020, 04:47 Local	**Registration:**	N146FE
Aircraft:	Boeing 767	**Aircraft Damage:**	Substantial
Defining Event:	Sys/Comp malf/fail (non-power)	**Injuries:**	1 Serious, 1 None
Flight Conducted Under:	Part 121: Air carrier - Non-scheduled		

Analysis

In preparation for landing, LAX air traffic control cleared FedEx flight 1026 for an instrument landing system (ILS) approach to runway 24R. When the airplane descended to an altitude of about 1,800 ft, the flight crew moved the landing gear handle to lower the landing gear. The crew then received a “GEAR DISAGREE” message from the engine indicating and crew alerting system. The crew discontinued the approach and climbed the airplane to 5,000 ft to perform the quick reference handbook Gear Disagree checklist procedure. The checklist directed the crew to lower the landing gear using the alternate gear extension system, but the left main landing gear (MLG) still did not extend.

The flight crew then flew a low approach to the runway so that the tower controller could try to see if the left MLG was extended. The airplane descended to an altitude of about 500 ft above ground level, but the tower controller could not tell whether the left MLG was extended. The crew then declared an emergency and flew another low approach—this time at an altitude of about 200 to 300 ft above ground level and with airport operations personnel positioned along the runway to get a better view of the airplane. The second low approach determined that the left MLG was retracted.

The captain stated that, once the fuel was at an appropriate point to execute the gear-up approach and landing, air traffic control vectored the airplane for an ILS approach to the longest runway at the airport. The captain also stated the airplane made a “normal landing touchdown” and that, after the left engine contacted the runway, he maintained directional control with the ailerons, rudder, and right wheel braking. After the captain manually deployed the speedbrakes, the airplane came to a stop on the runway centerline about 2,000 to 3,000 ft from the end of the runway.

A brake rod, which is installed between each brake assembly housing and the shock strut, transfers the torque generated by the brake to the MLG. Each brake rod is connected to the torque arm on the brake assembly housing using, among other things, a pin that is secured by a retaining bolt. Postaccident examination of the left MLG assembly revealed that the No. 6 brake rod (corresponding to the aft inboard wheel) was connected at the shock strut end but was not connected to the torque arm on the brake assembly housing. The brake rod pin was likely in place during the accident flight takeoff given that no scrape marks or gouging were found on the brake rod, indicating that the brake rod had not contacted the runway while the airplane was moving, which would likely have happened if the brake rod was connected only at the shock strut end while the left MLG was in its extended position. The flight crew was unable to extend the left MLG during the approach because the pin had come loose during the flight, which allowed the brake rod to move out of its normal position and become hung up on the landing gear upstop.

The airplane had accumulated 73 flight cycles since the last No. 6 brake assembly change, which would have been the last time that the No. 6 brake rod was removed and reinstalled. The maintenance personnel who performed the No. 6 brake assembly change did not recall anything unusual or concerning about the installation of the brake assembly or brake rod.

The No. 6 brake rod attaching hardware components from the accident airplane were not located after the accident, precluding a determination of why the pin was in place for the takeoff but not when the crew tried to lower the landing gear. As a result, on the basis of the available evidence for this accident, the investigation was unable to determine the reason that the brake rod pin came loose during the accident flight.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The left main landing gear's failure to extend due to the separation of the brake rod retaining hardware from the aft inboard wheel for reasons that could not be determined based on the available evidence.

Findings

Aircraft	Gear extension and retract sys - Malfunction

Factual Information

History of Flight

Approach	Sys/Comp malf/fail (non-power) (Defining event)
Landing-landing roll	Landing gear collapse

On August 19, 2020, about 0447 Pacific daylight time, Federal Express (FedEx) flight 1026, a Boeing 767-300, N146FE, was substantially damaged after the airplane's left main landing gear (MLG) failed to extend at Los Angeles International Airport (LAX), Los Angeles, California. The first officer sustained a serious injury while exiting the airplane using the cockpit emergency escape rope; the captain was not injured. The flight was operating under Title 14 *Code of Federal Regulations* Part 121 as a domestic cargo flight from Newark Liberty International Airport (EWR), Newark, New Jersey, to LAX.

The captain and the first officer provided statements to the National Transportation Safety Board about the circumstances leading to the accident. The captain stated that the preflight and the departure and en route portions of the flight were uneventful. During those flight portions, the first officer was the pilot flying, and the captain was the pilot monitoring.

In preparation for landing, Los Angeles approach control cleared the airplane for the ILS approach to runway 24R. When the airplane had descended to an altitude of about 1,800 ft, the landing gear handle was activated to lower the landing gear. The crew then received a "GEAR DISAGREE" message from the engine indicating and crew alerting system; the message illuminates when the gear position disagrees with the landing gear lever position.

The captain stated that he and the first officer elected to discontinue the approach and climbed the airplane to 5,000 ft to perform the quick reference handbook Gear Disagree checklist procedure. The checklist directed the crew to lower the landing gear using the alternate gear extension system, but the left MLG still did not extend. The next step in the checklist instructed the crew to land the airplane with all available landing gear.

The captain requested and obtained permission to fly a low approach to runway 24L so that the tower controller could try to see if the left MLG was extended. The airplane descended to an altitude of about 500 ft above ground level, but the tower controller could not tell whether the left MLG was extended. The crew then declared an emergency, the captain became the pilot flying, and he flew another low approach—this time at an altitude of about 200 to 300 ft above ground level and with airport operations personnel positioned along the runway to get a better view of the airplane. The second low approach determined that the left MLG was retracted.

Los Angeles approach control then directed the crew to climb the airplane to 5,000 ft and vectored the airplane away from the airport and over the water while the crew consulted with FedEx maintenance about the left MLG. FedEx maintenance suggested that the flight crew attempt to maneuver the airplane "in such a way as to possibly release the unsafe gear," which the crew did without success. The flight crewmembers then discussed the remaining items on the Gear Disagree checklist and the techniques that would best accomplish the gear-up landing.

The captain stated that, once the fuel "was down to the point where it was time to execute the gear up approach/landing," Los Angeles approach control vectored the airplane for an ILS approach to runway 25R, which was the longest runway at LAX. The captain also stated that he flew the coupled approach to about 200 ft, disconnected the autopilot, and made a "normal landing touchdown" while trying to keep the left engine nacelle from contacting the runway as the airplane decelerated. The captain further stated that, after the left engine contacted the runway, he maintained directional control "with ailerons, rudder and finally right wheel braking." After the captain manually deployed the speedbrakes, the airplane came to a stop on the runway centerline about 2,000 to 3,000 ft from the end of the runway.

The crew executed the Evacuation checklist, and the captain reported that the left engine fire lights and bell activated. The crew began evacuating through the first officer's (right-side) window (due to concerns about a possible fire on the left side of the airplane) using the escape rope. The first officer, who reported that he was wearing "safety gloves" at the time, lost his grip on the escape rope, fell to the runway, and fractured his left heel. As the captain was preparing to evacuate from the first officer's window, airport rescue and firefighting personnel informed him that no fire was present and that they would provide a vehicle with a platform and stairs so that he would not have to use the escape rope. The captain evacuated the airplane uneventfully.

Pilot Information

Certificate:	Airline transport	**Age:**	60,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	August 13, 2020
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	March 29, 2020
Flight Time:	11658 hours (Total, all aircraft), 2138 hours (Total, this make and model)		

Co-pilot Information

Certificate:	Airline transport	**Age:**	45,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	June 24, 2020
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	March 20, 2020
Flight Time:	8201 hours (Total, all aircraft), 2723 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Boeing	**Registration:**	N146FE
Model/Series:	767 300F	**Aircraft Category:**	Airplane
Year of Manufacture:	2017	**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	43551
Landing Gear Type:	Retractable - Tricycle	**Seats:**	
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	2 Turbo fan
Airframe Total Time:		**Engine Manufacturer:**	General Electric
ELT:		**Engine Model/Series:**	CF6-80C2B6F
Registered Owner:	Federal Express Corp	**Rated Power:**	24995 Horsepower
Operator:	Federal Express	**Operating Certificate(s) Held:**	Flag carrier (121)

The accident airplane was manufactured in 2017 and had accumulated 5,958 hours and 2,608 flight cycles. FedEx reported no deferred items per the minimum equipment list during the accident flight.

The Boeing 767 is equipped with left and right MLG assemblies and a nose landing gear assembly. Each MLG assembly consists of four wheels (two forward and two aft); each wheel has an independent brake. The MLG extension and retraction system includes door- and gear-operated sequence valves, door and latch actuators, transfer cylinders, truck positioners, and drag and side brace lock actuators. The landing gear control lever in the cockpit is moved to

the down or up position to extend or retract the gear, respectively, using center hydraulic system pressure.

An alternate extension system is available to unlock the landing gear and doors if the MLG extension system is unable to do so. The MLG was designed to rest on the closed MLG doors when the gear is up. The alternate extension system simultaneously releases the left and right MLG doors and the nose gear, which causes all three gears to drop into the down-and-locked position. If a gear is jammed in the retracted position, the alternate extension system would still extend the other gear.

A brake rod, which is installed between each brake assembly housing and the shock strut, transfers the torque generated by the brake to the MLG. The brake rod is connected to the torque arm on the brake assembly housing using a pin, a tang washer, a retaining bolt, and two lock screws secured by safety wire, as shown in figure 1.

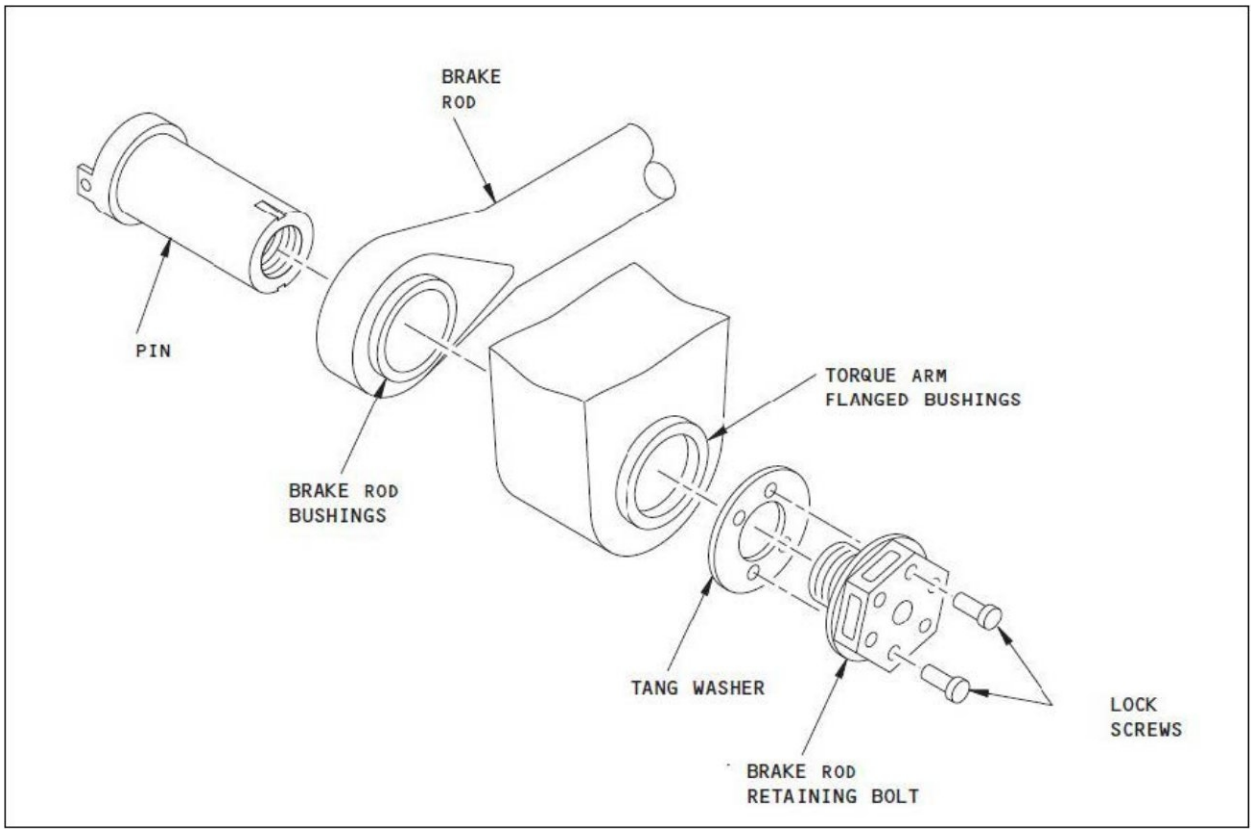

Figure 1. Brake rod attaching hardware. (Copyright © Boeing. Reproduced with permission.)

Postaccident examination of the left MLG assembly revealed that the No. 6 brake rod (corresponding to the aft inboard wheel) was not connected to the torque arm on the No. 6 brake assembly housing. Of note, the head of the pin would be in the down direction when the

gear was in the up (retracted) position. (Other findings from the postaccident examination are discussed later in this report.)

FedEx stated that the most recent removal and replacement of the No. 6 brake rod occurred during a No. 6 brake assembly change on July 18 and 19, 2020, and that the airplane had accumulated 73 flight cycles between this maintenance and the accident flight. The maintenance personnel who performed the No. 6 brake assembly change did not recall anything unusual or concerning about the installation of the No. 6 brake assembly or brake rod. A review of the airplane's maintenance history between June 18, 2020 (1 month before the No. 6 brake rod change), and August 19, 2020 (the accident date), revealed no other related maintenance activities.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night
Observation Facility, Elevation:		**Distance from Accident Site:**	
Observation Time:		**Direction from Accident Site:**	
Lowest Cloud Condition:	Few / 1200 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	4 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	110°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.85 inches Hg	**Temperature/Dew Point:**	23°C / 19°C
Precipitation and Obscuration:			
Departure Point:	Newark, NJ (KEWR)	**Type of Flight Plan Filed:**	IFR
Destination:	Los Angeles, CA	**Type of Clearance:**	IFR
Departure Time:	02:41 UTC	**Type of Airspace:**	

Airport Information

Airport:	Los Angeles International KLAX	**Runway Surface Type:**	Concrete
Airport Elevation:	128 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	25R	**IFR Approach:**	Visual
Runway Length/Width:	12923 ft / 150 ft	**VFR Approach/Landing:**	Full stop

Wreckage and Impact Information

Crew Injuries:	1 Serious, 1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	1 Serious, 1 None	**Latitude, Longitude:**	33.969615,-118.24037(est)

The airplane was found resting on the left engine nacelle and the right MLG (see figure 2), and the nose gear and tail were found suspended in the air. The left MLG door was open, but the left gear had not deployed.

Figure 2. Airplane after accident landing. (Copyright © Boeing. Reproduced with permission.)

The left engine cowling and left MLG door were damaged from contact with the runway during the landing. Further examination revealed deformation of and cracking on the left engine pylon structure.

Examination of the left MLG assembly revealed that the No. 6 brake rod remained connected to the lugs on the shock strut but was not connected to the torque arm on the No. 6 brake assembly housing. All attaching hardware was missing. The brake rod was found “hung up” on the landing

gear upstop (see figure 3), which is inside the left landing gear bay. No damage was found on the brake assembly or the associated hydraulic line. EWR and LAX airport operations personnel performed a search of the departure and landing runways, respectively, and no brake rod attaching hardware components were found.

Figure 3. Location of brake rod during postaccident examination (Source: FedEx).

The damaged left MLG door was disabled, and the brake rod was secured to the brake assembly housing torque arm. Normal gear extensions and retractions and alternate gear extensions were then performed; no anomalies were identified.

The No. 6 brake rod was examined by Boeing's Equipment Quality Analysis Laboratory. Visual examination of the No. 6 brake rod revealed shallow gouges and chipped paint on the forked end, consistent with the brake rod contacting and becoming hung up on the landing gear upstop. No evidence (scrape marks or gouging) indicated that the brake rod had previously contacted a runway during a takeoff or landing. All measurements of the brake rod end bores were found to be within specification drawing limits.

The brake pin assemblies from the other seven brake rods were also examined by Boeing's Equipment Quality Analysis Laboratory using techniques such as fluorescent penetrant inspection and magnetic particle inspection. The examination of the seven brake rod pins and all attaching hardware (tang washer, bolt, and screws) found no defects that could indicate the existence of an airplane-specific problem or a hardware manufacturing lot problem that would have precluded normal extension of the left MLG.

Additional Information

The *Boeing 767 Aircraft Maintenance Manual*, dated April 22, 2020, described the removal and installation instructions for the MLG brake rods; these instructions were in effect at the time of the last No. 6 brake rod removal and replacement. FedEx used a customized version of this manual; the version that was current at the time of the No. 6 brake rod removal was dated August 21, 2019. Review of both sets of instructions revealed no major issues concerning the brake rod removal and installation procedures, but some minor areas for improvement were identified. On August 22, 2021, Boeing released a revision to its *Boeing 767 Aircraft Maintenance Manual* that, among other things, included information in figures and notes that clarified the brake rod installation steps.

On the basis of a 1995 exemption that the Federal Aviation Administration granted to FedEx, its fleet of 767-300 airplanes was not required to be equipped with evacuation slides or slide/rafts at the main boarding doors. Instead, the airplanes were equipped with inertial reel descent devices and harnesses for each airplane occupant. Each cockpit was also equipped with an escape rope. The FedEx *Flight Crew Operating Manual* and *Aircraft Systems Manual* both showed the step-by-step use of both the inertial reels and escape rope but did not provide specific information about which device should be used as the primary means for evacuating the airplane. Further, neither the *Aircraft Systems Manual* nor the FedEx Boeing 767 *Flight Training Manual* mentioned the use of heat-resistant gloves and chemical gloves during evacuations. After the accident, FedEx reviewed its internal safety processes and modified its pilot evacuation training program to (1) emphasize the flight crew evacuation decision-making process and (2) prioritize the use of an inertial reel rather than an escape rope during an evacuation.

Administrative Information

Investigator In Charge (IIC):	Lovell, John
Additional Participating Persons:	John Miller; Boeing Ian Carrero; FedeX ALPA David Keenan; FAA Stewart Harro; FedEx Scott Reeves, replaced Stewart Harro; FedEx
Original Publish Date:	July 12, 2023
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=101865