



National Transportation Safety Board Aviation Accident Final Report

Location:	JAMAICA, NY	Accident Number:	NYC96FA174
Date & Time:	08/25/1996, 0710 EDT	Registration:	N31031
Aircraft:	Lockheed L-1011-100	Aircraft Damage:	Substantial
Defining Event:		Injuries:	262 None
Flight Conducted Under:	Part 121: Air Carrier - Scheduled		

Analysis

During arrival, the flight (flt) received vectors for ILS runway (rwy) 4R approach (apch). Before reaching final apch fix, visibility went below minimums for rwy 4R, & flt was offered ILS rwy 4L apch, which was still above minimums. Captain accepted, & 1st officer (F/O), who was flying the aircraft (acft), transitioned to 4L. On final apch, acft passed thru 500' AGL at 151 KCAS with throttles near idle. It continued decelerating to reference landing speed. During computer-driven, auto-land flare, acft nose rotated up, & acft's tail struck rwy. The operator's (oper's) procedures required mandatory go-around unless apch was stabilized at 500'. The crew reported all checklists had been completed; however, apch charts for rwy 4L were not reviewed, required call outs were not remembered as given by all crewmembers, & altimeter bugs remained set for runway 4R. DFDR data revealed the wing leading edge slats had not extended with the flaps. A green light on the pilot's instrument panel & 14 green lights & a gauge on the flt engineer's (F/E's) panel were not used to verify slat extension. Oper's expanded landing checklist did not require F/E to use gauge to verify slat extension. Oper's manuals did not list possibility of a "slat lock," which would not activate any warning lights or aural warnings. Maintenance records revealed slats had locked 12 times in preceding 2 yrs. Inspection methods provided by Lockheed & adopted by the oper, did not adequately specify how to check slat drive system for slack.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: failure of the flight crew to complete the published checklist and to adequately cross-check the actions of each other, which resulted in their failure to detect that the leading edge slats had not extended and led to the aircraft's tail contacting the runway during the computer-driven, auto-land flare for landing. Factors related to the accident were: the manufacturer's inadequate inspection procedures for the slat drive system; and the operator's inadequate checklist, which did not include having the flight engineer monitor the double needle slat gauge.

Findings

Occurrence #1: DRAGGED WING, ROTOR, POD, FLOAT OR TAIL/SKID
Phase of Operation: LANDING - FLARE/TOUCHDOWN

Findings

1. (F) FLIGHT CONTROL, SLAT - LOCKED
2. (F) MAINTENANCE, INSPECTION - INADEQUATE
3. (F) PROCEDURE INADEQUATE - MANUFACTURER
4. (F) CHECKLIST - INADEQUATE - COMPANY/OPERATOR MANAGEMENT
5. (C) CHECKLIST - NOT FOLLOWED - FLIGHTCREW
6. (C) MONITORING - INADEQUATE - FLIGHTCREW

Factual Information

HISTORY OF FLIGHT

On August 25, 1996, at 0710 eastern daylight time, a Lockheed L-1011-100, N31031, operated by Trans World Airlines (TWA), as flight 778 (TWA778), was substantially damaged when the tail struck the runway, while landing at John F. Kennedy International Airport, Jamaica, New York (JFK). The 3 flight crewmembers, 9 flight attendants, and 250 passengers were not injured. Instrument meteorological conditions prevailed at the time of the accident. The flight departed Las Vegas, Nevada (LAS), at 0310, and was operated on an Instrument Flight Rules (IFR) flight plan under 14 CFR Part 121.

The flight crew was on the last flight of a 3 day trip. The trip sequence originated on the evening of August 23, 1996, where the crew flew the accident airplane from JFK to LAS, as TWA flight 777 (TWA777). According to interviews, the flight crew then went into a 24 hour crew rest period, during which the crewmembers had no contact with each other.

While the crew was in rest, N31031 was flown to JFK, and returned to LAS by other flight crews.

The accident flight, TWA778, started with the crew pickup at the hotel, at 0030, on August 25. They meet the inbound flight crew of N31031, as they passed through the terminal, and were informed that the airplane was "OK."

TWA778, which was scheduled to depart the gate, at 0200, departed, at 0254. The first officer was the flying pilot and performed the takeoff. The airplane became airborne, at 0310, and was hand flown to altitude. The flight crew described the departure and en route phases of the flight as being routine and uneventful until they began their descent. Entering the New York area, flight 778 was cleared to descend to FL 190.

At 0658:09, the captain made initial contact with the New York TRACON, ROBER position, and reported that they were descending to FL190. They also reported they had Airport Terminal Information Service (ATIS) VICTOR [visibility 1/4 mile fog, 200 scattered, wind calm, temperature 19, dew point 19, landing ILS 4R]. The controller replied, "...Fly heading one three zero vectors to i l s four right be advised tower visibility now reported to be zero." This was acknowledged by the captain who inquired about the Runway Visual Range (RVR). The ROBER controller replied, "...runway four right r v r is three thousand five hundred the mid point is one thousand six hundred roll out one thousand four hundred."

At 0659:28, the ROBER controller transmitted to TWA778, and a preceding flight, "...kennedy special weather at one zero five eight zulu [0658 local] wind three six zero at six visibility less than one quarter mile with fog there is a broken layer at two hundred and altimeter three zero zero nine for uh be advised the remarks are surface visibility is one quarter and surface visibility south is one and one half." The transmission was acknowledged by the captain.

At 0706:39, the ROBER controller transmitted, "t w a seven seventy eight heavy the r v r is rapidly going down on four right what is your minimum for four right" The pilot replied, "...twelve hundred r v r," and the ROBER controller then transmitted, "that's exactly what it's indicating now t w a seven seventy eight heavy turn right heading zero two zero your eight miles from ebbe maintain one thousand five hundred till established on localizer cleared I l s

four right approach." This was acknowledged by the captain.

At 0707:34, the ROBER controller asked, "t w a seven seventy eight heavy the four right r v r is down to a thousand would you like to try slipping over to the left." With no reply, the controller then asked, "t w a seven seventy eight heavy would you like to try slipping over to four left its uh r v r for the right is down to thousand uh for the left is more than six." At this time the captain replied, "o k we'll take four left."

At 0707:52, the ROBER controller directed TWA778, "o k the left side I l s frequency is one one zero niner and zero two zero t w a seven seventy eight."

At 0708:17, the ROBER controller asked, "t w a seven seventy eight heavy are you able to pick up the left side all right," at which point the captain replied, "yeah we're coming left now."

At 0708:26, the ROBER controller transmitted, "t w a seven seventy eight heavy your at two and a half from tildi your cleared I l s four left approach contact kennedy tower one one niner point one." The flight engineer reported that she computed the Vref speed to be 131 knots and verified the setting on the captain's and first officer's air speed indicators. They had initially briefed for a category I approach to runway 4R. When the weather deteriorated, they then briefed for a category II approach to runway 4R. When approach control offered them runway 4L, it was accepted by the captain. While on the approach to runway 4L, attempts to engage the auto-throttles were unsuccessful, and the captain told the first officer to fly the approach using manual throttles. The captain reported that when the first officer requested the ILS 4L approach plate, he replied, "just fly the approach it is near VFR." The first officer also stated that the ILS 4L approach plate was never taken out for the approach and the altimeter bugs remained set for runway 4R.

According to TWA manuals, the correct altimeter bug setting for a Category II approach to runway 4R would be 112 feet, and for a Category I approach to 4L would be 212 feet.

At 0708:53, the captain contacted the JFK control tower and stated that they were on the localizer for runway 4 left.

At 0708:59, the JFK local controller replied, "t w a seven seventy eight kennedy number one wind calm runway four left cleared to land r v r more than six thousand rollout one thousand six hundred."

The first officer stated that at 50 feet above the ground (AGL), the autopilot began to flare the airplane, and he retarded the throttles. He said that it, "looked a little high." About that time, the stick shaker activated, followed by the airplane touching down firmly.

The flight engineer reported that while monitoring the annunciator lights, she heard the stick shaker activate. She observed the speed to be Vref minus 10 knots.

The captain stated that at 50 feet AGL, the first officer called "FLARE." At that point the nose was pitching up, and the first officer retarded the throttles. About 1second later the stick shaker sounded and the captain recalled checking the airspeed at 120 knots, and that the altitude was about 30 feet AGL. The captain pushed the throttles forward and the airplane touched down hard. The captain then took control of the airplane, closed the throttles, initiated reverse thrust, and made a normal rollout.

A witness reported that he was at the approach end of runway 4L at the time of

occurrence, at taxiway KILO, about 100 yards from the touchdown point. He stated that the airplane hit on the tail first and then the tires. The touchdown point was shorter than normal, and he heard a bang at touchdown. He said the visibility was about 1/4 mile with a light wind from the north at less than 5 knots.

After the landing roll, the airplane was taxied to the TWA gate complex, where the engines were shut down, and the flight was towed to the gate, which was a normal procedure. After the passengers deplaned through the jetway, maintenance personnel informed the captain that there was damage to the tail of the airplane. The captain performed an external examination of the airplane, returned to the cockpit, and after a short discussion, the flight crew departed the airplane.

The JFK weather observation, at 0658, recorded the visibility as less than 1/4 mile, a 200 foot broken ceiling, and the touchdown RVR greater than 6,000 feet.

The accident occurred during the hours of daylight at 40 degrees, 37 minutes, 19 seconds North Latitude, and 73 degrees, 47 minutes, 8 seconds West Longitude.

PERSONNEL INFORMATION

Captain

The Captain, age 58, was hired by TWA on August 19, 1966. He held an airline transport pilot (ATP) certificate with a rating for airplane multi-engine land and instrument airplane. He was type rated in the Boeing 727 and Lockheed L-1011. He also held a commercial pilot certificate for airplane single engine land, and a turbo-jet flight engineer's rating. The captain's most recent first-class medical certificate was issued on July 8, 1996, and contained the limitation, "Holder shall possess corrective glasses for near vision."

The captain was on reserve status and volunteered for the trip sequence. According to interviews, he had a total time of 18,643 hours, of which 4,855 hours were as Pilot-In-Command (PIC). He had accumulated 351 hours as PIC, and 917 hours as Second-In-Command (SIC), in the L-1011, and had no L-1011 flight engineer experience.

His initial captain line checkout in the L-1011 was completed on June 21, 1994. He was displaced by seniority and requalified as captain in the Boeing 727 on February 2, 1995. He requalified as captain in the L-1011 on June 27, 1996, and had flown the L-1011 for 105 hours during the preceding 90 days.

The captain's last checks in the L-1011 were a proficiency check on June 30, 1996, and a line check on July 14, 1996.

First Officer

The first officer, age 54, was hired by TWA on January 9, 1970. He held an ATP certificate with a rating for airplane multi-engine land and instrument airplane. He was type rated in the Falcon 20, and Lear Jet Model 23/24/25. He also held a commercial pilot certificate for airplane single engine land, and a turbo-jet flight engineer's rating. The first officer's most recent first class medical certificate was issued on July 8, 1996, and contained the limitation, "Shall carry corrective lenses when operating airplane." The first officer was furloughed twice by TWA, the first time April 3, 1970, to April 26, 1977, and the second time from January 5, 1980, to March 7, 1985.

He was initially qualified as a first officer with TWA on May 30, 1996, in the L-1011. He

had accumulated 210 hours as first officer, and 3,155 hours as flight engineer in the L-1011. He completed his line operating experience on the L-1011 on June 6, 1996.

The first officer's last checks in the L-1011 were a proficiency check on May 30, 1996, and a line check on June 14, 1996.

Flight Engineer

The flight engineer, age 28, was hired by TWA on March 4, 1994. She held an ATP certificate with ratings for airplane multi-engine land, and instrument airplane, and was type rated in the Beech 1900. She also held a turbo-jet flight engineer rating. She reported a total time of 3,900 hours, with 516 hours as flight engineer, including 379 hours as a L-1011 flight engineer.

The flight engineer's initial qualification was in the L-1011. She was displaced to the Boeing 727 as a flight engineer, in March of 1995. She then became a simulator instructor in the L-1011, while holding a bid status as a Boeing 727 flight engineer. She returned to line operations in the L-1011 as a flight engineer during June/July 1996.

The flight engineer's last checks in the L-1011 were a proficiency check on February 12, 1996, and a line check on August 7, 1996.

AIRCRAFT INFORMATION

The airplane, N31031, was a 1975 Lockheed L-1011-385-1-15 (L-1011-100), and was operated by Trans World Airlines Inc. It was powered by three Rolls-Royce RB-211-22 engines, and maintained under TWA's maintenance procedures.

At the time of the accident, the airplane's estimated landing weight was 313,900 pounds. The Center of Gravity (CG) was estimated to be about 25.5 % Mean Aerodynamic Chord (MAC). The forward and aft CG limits at the estimated landing weight were, 12.8 % and 34.0 % MAC.

According to the Lockheed Aircraft Company, the computed stall speed at the estimated landing weight, with the leading edge slats retracted and the trailing edge flaps set at 33 degrees, was 120 KIAS.

AERODROME INFORMATION

Runway 4L and 4R each had complete and separate ILS approaches. The two runways were separated by about 3,000 feet. Both approaches had glide slope intercept altitudes of 1,500 feet. The following decision heights and minimum visibility's were published for each approach.

Approach	Decision Height	Minimum Visibility	ILS 4L
Category I	212 feet	RVR 4,000 or 3/4 mile	ILS 4R Category I
212 feet	RVR 1,800	ILS 4R Category II	112 feet
RVR 1,200			

FLIGHT RECORDERS

The airplane was equipped with a Sunstrand Data Control model 573A (S/N 3764) Digital Flight Data Recorder (DFDR). The unit was removed from the airplane and forwarded for readout at the National Transportation Safety Board's (NTSB) Vehicle Performance Division (RE-60), Washington, DC. According to the Vehicle Performance Division report of

the DFDR, the trailing edge flaps had extended; however, there was no indication that the leading edge slats extended. The DFDR data revealed a series of rolls occurred during the approach, with the auto-pilot engaged. The rolls had peak oscillations of 26 degrees left and right. When correlated with the radar data and ATC transcripts, the rolls began prior to the outer marker, and continued with lessening degrees until the altitude readout indicated below 500 feet. The rolls corresponded to flight control movements and magnetic heading changes.

Airplane touchdown was recorded at subframe reference number (SNR) 247 with a peak "G" of 2.11 Gs. At that time the airspeed was 117.5 knots CAS, and the left and right Angle of Attacks were recorded as 17.5 and 16.07 degrees respectively.

The DFDR data revealed that during the preceding flight, TWA777 to LAS, the slats had extended.

WRECKAGE AND IMPACT INFORMATION The Port Authority of New York and New Jersey reported that, at 0915, on August 25, 1996, they found a red and white paint transfer on runway 4L, about 1,000 feet from the approach end.

Following passenger embarkation, and baggage unloading, the airplane was towed from the gate to the maintenance hangar. The cockpit was not secured. The airplane was inspected in accordance with TWA's "Hard Landing or Off the Runway or Off the Taxi Strip Structural Check." This was conducted on August 25, 1996. The inspection included cycling the flaps. According to a written statement from the mechanic who cycled the flaps; "...the leading edge devices did not lower and no indication [on] the F.E. panel was noted." When it was determined there was substantial damage, the FAA and NTSB were notified.

According to the FAA and TWA, examination of the airplane revealed that the aft pressure bulkhead was cracked. Fuselage skin in the vicinity of the tail skid was scrapped. The number two engine thrust reverser shroud was scrapped. The right hand side APU mount was broken. In addition, several bulkheads in the immediate vicinity of the fuselage impact point were bent and/or cracked.

The FAA forwarded certified copies of the original hard landing inspection, and non-routine maintenance work records for N31031. A review of page 36, item 125, of the non-routine maintenance work records contained the following notation, "Prior to attempting to move flaps R/H leading edge brake was found tripped & was reset to facilitate flap movement." This was entered by a TWA mechanic with the identification LST28022. In a signed statement, LST28022 stated, "...was present during an NTSB and FAA investigation of said aircraft. On an attempt to perform an operation check of the flap system, the leading edge flaps failed to deploy. Upon investigation the leading edge brake assembly were found tripped. At this time I made non routine remarks on M139 sheets to this effect reference items # 125 and # 126 on page 36." Another mechanic who observed this also submitted a written statement.

MEDICAL AND PATHOLOGICAL INFORMATION

Toxicological testing of the flight crew was accomplished in accordance with the TWA procedures. Testing on the first officer and flight engineer was negative for alcohol or drugs. The captain provided a specimen for testing; however, due to an equipment failure, results were not obtained.

TESTS AND RESEARCH

Slat Operation

According to the TWA L-1011 Flight Handbook (FHB) 12.04.9:

SLATS

"There are seven leading edge slats on each wing. Each slat is operated by a jackscrew type actuator. The actuators are driven through a common torque tube by a power drive unit (PDU). The PDU uses two hydraulic motors pressurized by hydraulic systems A and C. The slats fully extend or fully retract.

Operation of the slats is controlled by the flap handle through a cable system. Movement of the flap handle from the zero position causes the slats to fully extend in approximately 10 seconds. Movement of the flap handle in the up direction past the four degree detent position causes the slats to fully retract. Flaps and slats operate together.

Slat position is indicated by amber and green lights on the flap position indicator [pilot's panel] and the engineer's slat monitor. On the flap position indicator, an amber LE TRANS intransit light appears if all the slats are not in the selected position. A green LE EXT light appears if all the slats are extended. The slat monitor on the engineer's panel has a slat position indicator that shows the position of the left and right slats. A number green light appears for each fully extended slat segment.

Slat asymmetry is sensed by position sensors at the outboard end of the torque tube. When an asymmetric position is detected, both system A and C pressures are shut off, a brake at the left and right outboard ends of the drive is set, and the FLAP/SLAT LOCK light appears at the engineer's annunciator panel. This asymmetric lock can only be reset on the ground. Any fault in the slat asymmetry detection system will cause the SLAT ASYM DET FAULT light to appear at the engineer's annunciator panel.

Any fault in the flap asymmetry detection system causes the SLAT ASYM DET FAULT light to come on. This indicates that the monitor has detected a fault in the slat detection system. Annunciation may not mean that asymmetry protection is lost. There are three logic channels in each comparator. Slat lock operates only when at least two channels agree, through a voter, that an asymmetric condition exists. Any one of several failures in a single channel will cause the SLAT ASYM DET FAULT light to come on. Under certain conditions, using Flight Handbook procedures, it is possible to correct the fault in flight.

Manual operation of the slat lock system is also provided on the slat monitor. Pressing the slat lock switch in locks all the slats in position. When the slats are manually locked in position, 1 LOCK and 2 LOCK lights appear. The slats may be unlocked by pressing the slat lock switch to the released or out position."

Slat Protection Features

The investigation revealed that the slat locks were located in the wing tips. During slat extension/retraction, speed sensors measure the speed of the drive system. If an overspeed was sensed in the drive motor, then a slat lock would engage. When initiated by overspeed protection, there were no cockpit indications. Once a slat lock was engaged by overspeed protection, no further action from the flight crew can reset it. It required a reset by maintenance personnel. The investigation found that slack in the drive system could allow the drive motor to overspeed, and initiate a slat lock.

No description of a slat lock due to drive motor overspeed was contained in TWA L-1011 FHB.

Autoland

According to the TWA L-1011 FHB, Section 7.04.04:

"...A flare signal is initiated at 50 feet AGL. The flare is completed at approximately 20 feet. The flare is programmed to achieve a rate of sink at touchdown of approximately 120 feet per minute...."

Testing at JFK The NTSB Systems Group convened at the TWA maintenance hangar at JFK, on September 5, 1996, and examined the airplane. All flight paper documents had been removed, and all settings and switch positions corresponded to a secured cockpit.

The flap handle was found in the retracted position. All pertinent circuit breakers were found in the "in" (electrical power on) position. The slats visually appeared to be retracted; however, when measured, they were found to be extended 0.3 inch. The right slat brake was found in the tripped (locked) position, and the left slat brake was found in the normal (unlocked) position.

When the cockpit was powered, the slat extension gauge on the flight engineer's panel displayed the left and right needles at the zero degree extension mark. None of the slat warning lights, advisory lights, or green indication lights illuminated.

Hydraulic power was applied to the airplane and the flap handle was moved to the first detent, which was the 4 degree position. The trailing edge flaps extended to 4 degrees. There was no movement of the leading edge slats, or associated lights. In addition, no aural warning sounded or warning lights were visible. The flap handle was then moved to the 10, 18, 22, and 33 degree positions. At each stop, the trailing edge flaps were properly positioned; however, there was no change in the status of the leading edge slats, and indications for them. No aural warning sounded and no warning lights were illuminated during the process of flap extension.

Electrical and hydraulic power was then removed from the airplane and maintenance personnel reset the right slat brake.

When hydraulic and electrical power was reapplied, the slats were observed to retract 0.3 inch, to the fully retracted position. All cockpit indications corresponded to retracted slats. When the flap handle was extended to the 4 degree position, the leading edge slats began to extend. While in transit, the amber LE TRANS light illuminated, and movement was noticed on the double needle gauge on the flight engineer's panel. When the slats were fully extended, the amber LE TRANS light extinguished and the green LE EXT light illuminated. In addition, the double needle gauge on the flight engineer's panel displayed both needles at 30 degrees, and the 14 green lights were illuminated. The flap handle lever was moved through its normal range of operation several times, and no abnormalities were observed. Neither slat lock engaged during the testing.

The slat drive mechanism was inspected for slack, with the slats in the retracted and extended positions, and found to be satisfactory. At the request of the System Group Chairman, the slats were then placed in mid-position and checked for slack. The couplings were found to be loose and considered by a representative from Lockheed to be out of tolerance.

A review of the slat inspection procedures used by Lockheed and TWA was performed. The examination revealed that the inspection procedures used for the slat drive system, did not specify a slat position to be used during the inspection.

Component Testing

The slat system logic boxes were removed and examined at the TWA overhaul facility in Kansas City, Missouri. The boxes and individual cards were tested under changing conditions of heat, cold, moisture, and vibration. No abnormalities were detected.

Examination of the auto-throttle (A/T) system revealed that it was powered through the logic cards used by the slat system. If the slats were not extended to the point that the LE EXT light illuminated, then power for the A/T was not available. This information was not available in the TWA L-1011 FHB.

Maintenance Records

According to the Systems Group Chairman report:

"...A review was conducted of the airplane's historical records for a previous two year period. The records examination revealed that there had been 12 leading edge slat failures during approach or landing. The 12 malfunctions were the result of right hand brake trips. The corrective action was the resetting of the brake for the first four occurrences, followed by a removal and replacement of the brake assembly, then after the sixth, a complete inspection of the drive system including wear of the couplings. According to the records, the slat lock ups occurred with greater frequency in the past year. The last occurrence was on July 20, 1996. Some of the records indicated that the crews recognized the failure to extend situation and performed the appropriate actions.... "

A check of TWA records indicated the airplane was operated for 316 hours, and 106 cycles between the last occurrence, and the date of the accident.

TWA Engineering Watch

According to the TWA General Policies and Procedures Manual, Maintenance Program - General, (10) Engineering Watch Items:

"Under certain conditions and with the concurrence of Engineering, problems known to be of an 'Engineering Watch' nature that are within accepted limits, may be carried through Time Control Service or Check 'C' as a deferred log item or open AMPS item with the appropriate notation 'This item under MCI Engineering control.' Engineering will monitor this condition and direct appropriate action. Additionally, the front cover of the logbook should be placard with a brief description of the time and include the words, 'This item under MCI Engineering control.' However, any item deferred under MEL must be cleared within the required time limits."

According to TWA procedures, in addition to the current airplane log book, the previous log book is also carried in the airplane for flight crew reference.

TWA's Director of Maintenance reported that to the best of his knowledge, an engineering watch (also known as a maintenance watch) was not in effect in effect for N31031 on August 25, 1996. When queried as to how long an airplane would be on an engineering watch, he replied that it depended upon many variables, which included the type of event and previous history of the airplane. A fixed number of hours was not established for specific types of events.

ADDITIONAL DATA/INFORMATION

Cockpit Voice Recorder

The cockpit voice recorder was removed and reviewed by the NTSB; however, the unit had been left running after the flight crew departed the airplane and the approach and landing were erased and recorded over; therefore a transcript was not prepared.

Failure of Slats to Extend - Emergency Procedure

According to TWA, the FAA approved procedure for landing when the slats are not verified as fully extended, include an increase of the reference speed by 20 knots, and a landing flap limit of 22 degrees.

Previous Known Failures of Slats to Extend

The Operations Group Chairman Report contained summaries of two telephone interviews with pilots who reported cockpit indications of slat extension without actual slat extension. The Air Line Pilots Association (ALPA) submitted correspondence from two pilots with similar occurrence. A further check of Safety Board, TWA, and ALPA records failed to find any additional documentation of these events, or any other slat failures on L-1011s.

In addition, AIR CARRIER OPERATIONS BULLETIN NO. 8-76-35, issued by the FAA, discussed a failure of the leading edge slats to extend on an L-1011, and which resulted in a stalled condition in flight. The bulletin further stated, "...We understand that the flap position indicators functioned properly; however, the flightcrews apparently failed to note from these indications that the flap systems had not responded as selected."

Recorded Radar Study

Radar data was supplied by the New York TRACON, and examined by the Safety Board Vehicle Performance (RE-60) division in Washington, DC. The data revealed that, at 0707:52, the CAMRN controller gave TWA778 a heading of 020 degrees for the final approach course intercept. According to the data, the airplane maintained its present ground track and flew parallel to the final approach course. At 0708:17, approach control queried the pilot if they were receiving the localizer, at which point the captain replied, "yeah, we're coming left now." The radar data revealed that the airplane's ground track changed 35 seconds after the initial requested heading change.

Between 0708, and 0709, the ground speed averaged in excess of 210 knots. During a 35 second period, the airplane could travel about 2 nautical miles.

According to the Aeronautical Information Manual (AIM), Chapter 5 - Air Traffic Procedures, Section 5 - Pilot/Controller Roles and Responsibilities, 5-5-2, Item 4, states: "Promptly complies with an air traffic clearance upon receipt except as necessary to cope with an emergency."

According to the radar data, at 0707:52, the airplane was located about 3.8 NM from TILDI intersection, 10.41 NM from the localizer antenna, and 1.59 degrees from the localizer center line. At 0708:17, when questioned if they were receiving the localizer, the flight was located about 2.5 NM from TILDI intersection, 9.11 NM from the localizer antenna, and 1.21 degrees from the localizer centerline. The localizer width for runway 4L, centerline to full scale deflection, was 1.64 degrees.

TWA Flap Extension and Stabilized Approach Procedures

According to the L-1011 FHB, TWA allowed for pilot discretion, conditions permitting, as to the point of landing gear and flap extension. This allowed for a higher approach speed to the final approach fix. TWA defined a stabilized approach as follows:

1. During precision instrument approaches, the aircraft should be in the landing configuration, stabilized on final approach airspeed with normal sink rate, and the engines spooled up by 1,000 feet.
2. The aircraft must not continue descent below 500 feet on any approach unless it is in the landing configuration, stabilized on final approach airspeed and sink rate, with the engines spun up. Any time these conditions are not met when the aircraft is at or below 500 feet, a go-around is mandatory.

The following were the times of flap extension, with altitudes and airspeeds.

Flap Setting	Time Extended	Altitude	Airspeed	Maximum
4 degrees	0707:11	1,500 feet	202 KCAS	250 KIAS
1,500 feet	221 KCAS	230 KIAS	18 degrees	0709:07
210 KIAS	22 degrees	0709:17	1,100 feet	205 KCAS
degrees	0709:51	700 feet	162 KCAS	170 KIAS
				10 degrees 0708:53
				1,300 feet 214 KCAS
				205 KIAS 33

The flight recorder data was correlated with the radar data, and subframe 0 was matched to the time of 0706:38 seconds.

According to the flight data recorder, the engine EPRs were reduced to 1.01, at 0708:59, when the airplane was at 1,500 feet, past TILDI intersection. The EPRs were at 1.01 as the airplane passed through a radar altitude of 500 feet, with a calibrated airspeed (CAS) of 151 knots. The EPRs remained at 1.01, until 0710:09, when they started to increase as the airplane passed through 400 feet, at an airspeed of 144 CAS. An EPR of 1.1 was reached, at 0710:19, as the airplane passed through 300 feet, at an airspeed of 136 CAS.

According to a TWA L-1011 Management Pilot, an EPR of 1.01 would correspond to a closed or nearly closed throttle. An EPR of 1.1 would be a lower than normal power setting for a stabilized approach. Based upon the landing weight of 313,000 pounds, a final flap setting of 33 degrees, and with the leading edge slats extended, a pilot would expect to see an EPR of 1.18 to 1.20, when established on the approach.

TWA L-1011 Landing Checklist - Flaps

The checklist callout and checklist amplification of duties applicable to flaps and slats were as follows:

FLAPS & GREEN LIGHT

Call out indicated flap position [Pilots]

Check LE EXT slats green light on. [Pilots]

"Engineer confirms the flap and leading edge device positions by calling out the indicated flap position and the number of green leading edge lights on the engineer's panel...."

Flightcrew Post Accident Interviews

During crew interviews, the flight engineer reported that she was monitoring the

annunciator lights [autoland] and not the altitude or airspeed on the approach. The captain reported that he remembered making a 500 foot callout with airspeed at 140 knots, and sink of 700 FPM, but this was not remembered by the first officer. Additionally, the captain reported that he made a 100 foot callout. This also was not remembered by the first officer. All crewmembers reported that they felt rushed. No crewmember verbalized a go-around, although the first officer said that he was close to calling for one.

TWA Crew Coordination Procedures

Examination of the TWA L-1011 FHB, Section 2.40.2, revealed that all cockpit crewmembers were required to participate in crew coordination. Specific callouts for the pilot flying and the pilot not flying were required for localizer alive, glide slope alive, 500 feet above touchdown (including sink rate and airspeed), 100 feet above minimums, minimums, and pitch attitude, if in excess of 10 degrees. In addition, specific duties listed for the flight engineer, along with the statement, "Back up both pilots for all required callouts. If a callout is omitted, make the callout in a timely manner."

Sleep and Rest History

The operations group, with the assistance of a Safety Board human performance specialist, conducted interviews relative to the flight crews sleeping habits and rest.

The captain reported that he had difficulty adjusting to disruptions in his sleeping schedule, and for this reason did not bid to fly international routes. According to his sleep schedule, he had been awake about 24 hours at the time of the accident and reported that he that he felt, "awful, just tired and exhausted." The first officer said that the captain attempted to rest during the cruise portion of the flight to JFK, with his head back in the seat, but that there were visiting crewmembers in the cockpit and the captain might not have received good rest. In addition, the captain commented that he had not slept well in the hotel.

The first officer reported that he had flown the LAS layover trip several times during July, and had learned the importance of good sleep for flying it. He reported that he had in excess of 14 hours of rest in the scheduled 24 hours of off duty, which was split over two periods. At the time of the accident he had been awake for over 9 hours following a rest in excess of 5 1/2 hours.

The flight engineer reported that she had not slept well in the hotel on the layover. Additionally, she reported that she felt rested when the accident trip began; however, at the time of the landing she was getting tired.

Additional Persons

In addition to the persons listed on page 5 of the NTSB Report 6120.4, the following persons also participated:

John E. Schade	NTSB (RE-60)	Washington, DC	Steve	
Shataka	FAA	Garden City, New York	Jeb Blume	
	Lockheed-Martin Aero Sys	Marietta, Georgia	Capt. John A. Rholing	
	Air Line Pilots Association	Herndon, Virginia	Mr. Pierre Huggins	Air Line
Pilots Association	Herndon, Virginia			

The airplane was released to TWA on October 4, 1996.

Pilot Information

Certificate:	Airline Transport; Flight Engineer	Age:	58, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim.	Last Medical Exam:	07/08/1996
Occupational Pilot:		Last Flight Review or Equivalent:	
Flight Time:	18643 hours (Total, all aircraft), 1267 hours (Total, this make and model), 4855 hours (Pilot In Command, all aircraft), 105 hours (Last 90 days, all aircraft), 41 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	Lockheed	Registration:	N31031
Model/Series:	L-1011-100 L-1011-100	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Transport	Serial Number:	193B-1115
Landing Gear Type:	Retractable - Tricycle	Seats:	269
Date/Type of Last Inspection:	06/15/1996, Continuous Airworthiness	Certified Max Gross Wt.:	466000 lbs
Time Since Last Inspection:	559 Hours	Engines:	3 Turbo Fan
Airframe Total Time:	3425 Hours	Engine Manufacturer:	Rolls-Royce
ELT:	Not installed	Engine Model/Series:	RB211-22B
Registered Owner:	TRANS WORLD AIRLINES	Rated Power:	42000 lbs
Operator:	TRANS WORLD AIRLINES	Air Carrier Operating Certificate:	Flag carrier (121)
Operator Does Business As:	TWA	Operator Designator Code:	TWAA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument Conditions	Condition of Light:	Day
Observation Facility, Elevation:	JFK, 13 ft msl	Observation Time:	0658 EDT
Distance from Accident Site:	0 Nautical Miles	Direction from Accident Site:	0°
Lowest Cloud Condition:	Unknown / 0 ft agl	Temperature/Dew Point:	66 °C / 66 °C
Lowest Ceiling:	Broken / 200 ft agl	Visibility	0.25 Miles
Wind Speed/Gusts, Direction:	3 knots, 30°	Visibility (RVR):	0 ft
Altimeter Setting:		Visibility (RVV):	0 Miles
Precipitation and Obscuration:			
Departure Point:	LAS VEGAS, NV (LAS)	Type of Flight Plan Filed:	None
Destination:	(JFK)	Type of Clearance:	IFR
Departure Time:	0310 EDT	Type of Airspace:	Class B

Airport Information

Airport:	JOHN F KENNEDY (KJFK)	Runway Surface Type:	Asphalt
Airport Elevation:	13 ft	Runway Surface Condition:	Dry
Runway Used:	4L	IFR Approach:	ILS
Runway Length/Width:	11351 ft / 150 ft	VFR Approach/Landing:	None

Wreckage and Impact Information

Crew Injuries:	12 None	Aircraft Damage:	Substantial
Passenger Injuries:	250 None	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	262 None	Latitude, Longitude:	

Administrative Information

Investigator In Charge (IIC):	ROBERT L HANCOCK	Adopted Date:	03/31/1998
Additional Participating Persons:	EDWARD STROSCHEIN; GARDEN CITY, NY DAVID IVEY; WASHINGTON, DC RONALD PRICE; WASHINGTON, DC WENZEL WILLIAMS; ST. LOUIS, MO		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov , or at 800-877-6799. Dockets released after this date are available at http://dms.nts.gov/pubdms/ .		

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