National Transportation Safety Board
Aviation Accident Final Report

Location:	GOULDSBORO, PA	**Accident Number:**	NYC00MA048
Date & Time:	12/12/1999, 1635 EST	**Registration:**	N50PL
Aircraft:	Israel Aircraft Industries 1124A	**Aircraft Damage:**	Destroyed
Defining Event:		**Injuries:**	3 Fatal
Flight Conducted Under:	Part 91: General Aviation - Personal		

Analysis

After a 5-hour flight, the Westwind jet began its descent to the airport. Air traffic control instructed the flight crew to cross a VOR at 18,000 feet. The flight crew was then instructed to cross an intersection at 6,000 feet. The flight crew needed to descend the airplane 12,000 feet, in 36 nautical miles, to make the crossing restriction. The flight crew acknowledged the clearance, and no further transmissions were received from the airplane. The airplane struck treetops and impacted the ground in a wooded area. The accident flight was the airplane's first flight after maintenance. Work that was accomplished during the maintenance included disassembly and reassembly of the horizontal stabilizer trim actuator. Examination of the actuator at the accident site revealed that components of the actuator were separated and that they displayed no damage where they would have been attached. Examination of the actuator by the Safety Board revealed that the actuator had not been properly assembled in the airplane. A similar actuator was improperly assembled and installed in a static airplane for a ground test. When the actuator was run, the jackscrews of the actuator were observed backing out of the rod end caps within the first few actuations of the pitch trim toward the nose-down position. As the pitch trim continued to be actuated toward the nose-down position, the jackscrews became disconnected from the rod end caps, and the horizontal stabilizer became disconnected from the actuator.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The improper assembly of the horizontal stabilizer trim actuator unit by maintenance personnel.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation: DESCENT

Findings
1. FLT CONTROL SYST,STABILATOR TRIM - DISCONNECTED
2. MAINTENANCE,INSPECTION - IMPROPER - OTHER MAINTENANCE PERSONNEL

Occurrence #2: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: DESCENT

Findings
3. AIRCRAFT CONTROL - NOT POSSIBLE

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Findings
4. TERRAIN CONDITION - GROUND

Factual Information

HISTORY OF FLIGHT

On December 12, 1999, about 1635 eastern standard time, an Israel Aircraft Industries (IAI) 1124A, N50PL, was destroyed after impacting terrain near Gouldsboro, Pennsylvania. The two certificated airline transport pilots and a passenger were fatally injured. Visual meteorological conditions prevailed, and an instrument flight rules flight plan was filed for the personal flight conducted under 14 Code of Federal Regulations (CFR) Part 91.

The flight departed from the Boeing Field/King County International Airport (BFI), Seattle, Washington, and proceeded eastbound, destined for the Teterboro Airport (TEB), Teterboro, New Jersey. After a 5-hour flight, the airplane began its descent to TEB. Air traffic control (ATC) instructed the flight crew to cross the Wilkes-Barre (LVZ) VOR at 18,000 feet, which the flight crew acknowledged. The flight was then instructed to cross the MUGZY intersection at 6,000 feet. The flight crew acknowledged the clearance, and no further transmissions were received from the airplane.

Several witnesses stated that they observed the airplane before its impact. One witness, who was riding in the front passenger seat of her car heading southeast on Interstate 380 in Pennsylvania, stated that she saw an airplane in a near vertical climb level off, then begin a pattern of "twists, swoops, and turns." The witness also observed a fairly dark smoke trail but stated that it was "not a thick trail of smoke." Several other people in the same car thought that the airplane was performing acrobatic maneuvers. The witness added that the airplane's movements became more erratic as it made more "flips and turns" and that it went straight down "nose first, no spinning, twisting, or corkscrewing."

Another witness, who was standing in his yard at a mobile home complex, observed an airplane flying close to the treetops. The witness stated that he heard the sound of the engines being "fired up" and that the airplane went into a vertical climb. He added that the airplane completed one spiral, then "the nose came down" into the ground.

A third witness, who was also traveling southeast on Interstate 380, stated that she observed the airplane "dipping" toward the highway. She stated that it then ascended steeply, completed several spins, and made a final descent. The witness added that, at the time, she thought it was a model airplane performing acrobatic maneuvers.

A fourth witness, who was getting out of his car at a nearby rifle range, stated that the airplane came at him from the trees. He added that it then went straight up into the air, and "nose dived" to the ground. He then heard an explosion about 10 seconds later, and observed smoke rising from the trees.

A fifth witness, who was sitting on his porch, stated that he observed an airplane and heard a "pop" noise, like the engine had quit. According to the witness, the airplane then flew "tipsy" like it was in turbulence and then the engine sounded like it had started up again. The witness added that as the airplane passed low overhead, it sounded like something out of "Top Gun." He further added that the airplane was intact and that the engines were red. The witness stated that there was no fire or smoke emanating from the airplane prior to impact.

The airplane struck treetops and impacted the ground in a wooded area, which surrounded a mobile home complex.

The accident occurred during the hours of daylight approximately 42 degrees, 28 minutes north latitude, and 76 degrees, 8 minutes west longitude.

FLIGHT CREW INFORMATION

Captain

The captain held an airline transport pilot certificate with a rating for airplane multi-engine land and commercial privileges for airplane single-engine land and sea. In addition, the captain was type rated in the Gulfstream G-1159, Israel Aircraft Industries IAI-Jet, and Lear Jet. The captain also held a flight instructor certificate for airplane single land.

The captain reported 9,700 hours of total flight experience on his last application for a medical certificate. The captain's pilot logbook was not recovered.

According to company records, the captain last attended recurrent training in the IAI-1124, on February 15, 1999.

The captain's most recent Federal Aviation Administration (FAA) first class medical certificate was issued on February 1, 1999.

First Officer

The first officer held an airline transport pilot certificate with a rating for airplane multi-engine land and commercial privileges for airplane single-engine land and sea. In addition, the first officer was type rated in the Israel Aircraft Industries IAI-Jet. He also held a flight instructor certificate for airplane single and multi-engine land.

According to the first officer's most recent pilot logbook entries, he recorded 4,413 hours of total flight experience.

According to company records, the first officer last attended recurrent training in the IAI-1124, on January 5, 1999.

The first officer's most recent FAA first class medical certificate was issued on January 29, 1999.

AIRCRAFT INFORMATION

Examination of the airplane maintenance records revealed that on February 20, 1998, the airplane's horizontal jackscrew actuator was overhauled and returned to service by Lucas Aerospace Power Equipment Corporation, Aurora, Ohio. The actuator was then installed in the airplane on February 26, 1998, and an entry was made in the airplane flight log describing the installation. The airplane flight log entry did not mention, however, that the installation of the new actuator would have terminated the repetitive inspections required by Airworthiness Directive (AD) 98-20-35, Amendment 39-10802.

On October 9, 1998, an "A" check was accomplished in accordance with the IAI inspection guide. The entries made in the airplane flight log did not mention compliance with AD 98-20-35 Amendment 39-10802, nor was it required.

The airplane maintenance records also revealed that on December 10, 1999, an "A" check was accomplished in accordance with the IAI inspection guide. Among the activities completed during the inspection, the left-hand elevator was removed from the airplane, painted, balanced per the maintenance manual, and reinstalled.

Examination of the airplane's flight log revealed stickers that were added to two pages of the log. The stickers were dated December 10, 1999, and described work that was accomplished during the "A" check. One of the stickers stated, "Complied with an "A" check in accordance with I.A.I. inspection guide. Complied with A.D. 98-20-35 Amendment 39-10802 on inspection of trim actuator. Actuator was replaced 3/98. This terminates the repetitive inspections I.A.W. Para. (2) (a) of this AD."

Review of the airplane's flight log revealed that the airplane had accumulated about 170 hours of total flight time in the previous year. The airplane's last flight prior to maintenance was on December 1, 1999. The airplane accumulated 3.6 hours of flight time and 3 cycles that day.

According to line service personnel at BFI, the airplane was last fueled on December 11, 1999, with about 958 gallons of Jet A fuel. A fuel additive was mixed with the fuel, as requested by the pilot.

METEOROLOGICAL INFORMATION

The weather reported at 1645, by the Wilkes-Barre Wyoming Valley Airport, Avoca, Pennsylvania, was calm winds, 10 statute miles of visibility, and clear skies.

FLIGHT RECORDERS

Cockpit Voice Recorder

The airplane was equipped with a B&D cockpit voice recorder (CVR). The CVR was transported to the Safety Board on December 13, 1999. The CVR group convened on December 20, 1999. A transcript was prepared for the entire 32 minute 50 second recording.

The following are excerpts of the CVR transcript:

1621:16, the first officer stated, "elevator up... my light just flashed on."

1621:22, the captain stated, "oh, your trim did?"

1621:22, the first officer stated, "yeah... there it goes again."

1621:25, the cockpit area microphone (CAM) recorded [sound of beep]

1621:48, the CAM recorded [six beeps similar to altitude alert signal]

1622:21, the captain stated, "your trim didn't work in the up position either, did it?"

1623:00, the captain stated, "let me know if you see that light again."

1623:03, the first officer stated, "I will, I will."

1623:20, the first officer stated, "where's it gonna go?"

1624:07, the captain stated, "they probably won't be able to do anything about the mic thing."

1627:12, the captain stated, "** box grounds in turbulence." [* denotes unintelligible word(s)]

1628:34, the first officer stated, "afraid to touch anything in here."

1629:25, the captain stated, "we got a problem here **** schedule anyway."

1630:04, the CAM recorded [six beeps similar to altitude alert signal]

1635:01, the first officer stated, "oooh, lights. oohoo."

1635:04, the captain stated, "amazing."

1635:07, the first officer stated, "what is *?"

1635:09, the first officer stated, "a series of lines with contacts with for these lights through there."

1635:13, the captain stated, "yeah."

1635:14, the first officer stated, "one of these lights, all the contacts around it were broken off. so they had to put a new one on there and weld them all together... complete the circuit."

1637:45, the first officer stated, "it's trimmin'."

1637:47, the captain stated, "yeah I left the autopilot on intentionally."

1638:05, the captain stated, "yeah, I think this autopilot bus looks * mine."

1638:55, the CAM recorded [sound of three beeps]

1638:56, the first officer stated, "elevator out of trim."

1638:57, the captain stated, "which way?"

1638:58, the CAM recorded, "up."

1639:00, the CAM recorded [increase in general cockpit noise similar to aircraft increasing in speed]

1639:23, the captain stated, "keep pushin'."

No further conversations or noises were recorded on the CVR.

Sound Spectrum Study

A sound spectrum study was performed to analyze a sound that was heard in the last 27 seconds of the accident recording. According to the Safety Board specialist's report, the CVR recording consisted of four channels of fair quality audio information. All four channels were examined for the noise in question. The noise was not contained on any of the three channels designated for the captain, first officer and CAM. The noise appeared to be contained on the fourth channel only. The fourth channel did not contain any vocal or acoustic audio information.

The noise on the fourth channel consisted of signals that decreased and increased in frequency until the end of the recording. Specifically, two signals appeared to increase in frequency at about the 27-second mark, and one signal of about 750 Hz at 20 seconds decreased to about 300 Hz at the end of the recording. The sound spectrum also revealed a decreasing frequency signal at about 24 seconds emerging from the background noise that decreased in frequency from approximately 7,500 Hz to 3,000 Hz when the recording ended. The last 10 seconds of the recording contained the sound of an electrical buzz, which decreased in frequency until the end of the recording. Notably, a 60-Hz signal and corresponding harmonics were present in the spectrum, that was not attributed to the CVR or the aircraft because the signal continued through the end of the recording. Although the exact cause for the electrical noise was not ascertained, it did not appear to be the result of a malfunction or anomaly of the CVR. Moreover, the noise was generated by the aircraft but was not acoustically recorded through the microphone. It was determined to most likely be a by-product of the electrical system that had been introduced into the fourth channel wiring and recorded by the CVR.

Flight Data Recorder

There was no flight data recorder installed in the airplane, nor was it required.

WRECKAGE INFORMATION

The airplane wreckage was examined at the accident site on December 13, 1999. Inspection of surrounding trees, the impact crater, and wreckage revealed that the airplane struck the ground about 80-degrees nose-down, wings level, with the nose of the airplane facing about 235 degrees. Debris from the wreckage was scattered from the main impact crater outward, about 337 feet, in a 180-degree arc about the centerline of the airplane.

All of the airplane's major components and flight control surfaces were located at the accident site; however, the cabin and fuselage were fragmented into numerous pieces by the impact.

Both wings were separated from their respective wing-to-fuselage attach fittings and remained at the impact crater. Both the left and right flaps were damaged; however, they remained partially connected at their wing flap track assemblies and were found in the full-retracted position. Sections of the outboard wings were located with the ailerons attached. Portions of the left and right wings and fuel tip tanks were located near the impact crater.

The vertical stabilizer was found about 200 degrees and 57 feet forward of the impact crater. The rudder was about 250 degrees and 91 feet forward of the impact crater.

The engines and sections of the aft portion of the airplane were located about 5 feet forward of the main impact crater. The horizontal stabilizer trim actuator was attached to its support structure on the aft main fuselage. The actuator was missing one of its electric motors, and did not have a dust shield surrounding the jackscrew torque tubes. Closer examination of the actuator revealed that the jackscrews inside the torque tubes were sheared. Attached to the horizontal stabilizer front spar attach point were two rod ends. Attached to one of the rod ends was an adapter with a tie rod installed through it. The other adapter remained attached to the tie rod. Examination of the rod end adapters did not reveal any jackscrews threaded into them, and the threads were clean and displayed no visible damage. When the aft portions of the airplane were removed from the crater, the horizontal stabilizer trim actuator dust shield and separated pieces of jackscrews were found underneath. The top of the dust shield was crushed. Holes, which were machined at the top of the dust shield to accept a tie rod, did not display any visible damage and the tie rod was not installed. The separated pieces of the jackscrews, which were found inside the dust shield, contained two different thread types. A fine thread was at the machined end, and a coarser thread was at the fractured end. The finer thread section of the jackscrews also had machined holes through them to accept a tie rod. The holes and threads were not damaged and the tie rod was not installed. One of the electric motors for the horizontal stabilizer trim actuator was also located inside the crater.

The rudder and elevator control stops were examined and revealed normal wear.

Continuity of the engine and flight control surfaces could not be determined due to impact damage.

Both main landing gear assemblies were found inside the impact crater. The nose gear was found about 152 feet forward of the impact crater. The main and nose gear actuators were not found during the on-scene examination.

Pieces of circuit breaker panels from the cockpit area were located in numerous areas of the

accident site. When the panels were examined, no visual signs of arcing or soot were observed.

MEDICAL AND PATHOLOGICAL INFORMATION

Neither an autopsy nor toxicological testing was performed on the two pilots.

TEST AND RESEARCH

Engine Teardown

The airplane's engines were examined at the Honeywell Aerospace Investigation Laboratory, Phoenix, Arizona, on February 16, 17, and 18, 2000, under the supervision of an FAA inspector. The examinations revealed that the engines sustained impact and fire damage. Both engines exhibited indications of rotation at impact. No pre-impact conditions were found that would have interfered with normal operation of either engine.

Airplane Pitch Control

The airplane's pitch was controlled by two methods, the horizontal stabilizer and two elevators. The horizontal stabilizer had a NACA 64.A010 airfoil and was swept back at an angle of 28 degrees at the quarter-chord line. It had a taper ratio of 0.457:1, with no dihedral. The rear spar of the horizontal stabilizer was hinged to the fuselage structure at station 521.750, which allowed an electrically powered actuator, installed at station 492.750, to raise and lower the stabilizer leading edge. The stabilizer travel was as follows: up 0 degrees 30 minutes and down 4 degrees 42 minutes. The elevators were attached to the aft section of the horizontal stabilizer by three sealed bearing hinged brackets. Torque tubes moved the elevators a maximum of up 22 degrees 30 minutes and down 12 degrees.

Horizontal Stabilizer Jackscrew Actuator

The airplane was equipped with a dual-jackscrew actuator, powered by either of two reversible motors, to drive the horizontal stabilizer leading edge up or down for trim changes.

The base of the jackscrew actuator was fixed to the airplane's aft fuselage by two rod end fittings. Two torque tubes, which housed threaded jackscrews, extended vertically from the actuator housing. When commanded, a gearbox inside the actuator housing would then rotate the torque tubes, which, in turn, would drive the threaded jackscrews in a forward or reverse direction. Threaded onto the top of the jackscrews, were rod end adapter fittings, which also had rod ends threaded on top of them. The rod ends were attached to the front spar of the horizontal stabilizer. The jackscrews were covered by a one-piece dust shield, which moved with them as they were extended. The dust shield was installed around the torque tubes to protect the threaded jackscrews from contamination. Holes were machined through the rod end adapter fittings, jackscrews, and the dust shield to allow the passage of a tie rod. The tie rod's purpose was to not only secure the components together, but also to prevent the jackscrews from turning and unscrewing from the rod end adapter fittings when the actuator was powered.

During installation or inspection of the actuator, the dust shield would be fitted over the upper ends of the jackscrews and allowed to temporarily rest on the top of the actuator housing. The upper ends of the jackscrews would then be threaded into the lower ends of the rod end adapter fittings until the tie rod holes of the jackscrews and rod end adapter fittings aligned. The dust shield would then be raised over the jackscrews until it's tie rod holes aligned with the tie rod holes of the jackscrews and rod end adapter fittings. A tie rod would then be inserted

through each end of the dust shield, the lower ends of the rod end adapter fittings, and the upper ends of the jackscrews. Threaded nuts on each end of the tie rod would then secure it. Sealant would then be applied around the holes of the dust shield, the tie rod, and at the top openings where the rod end adapter fittings extend from the top of the shield to protect the jackscrews from contamination.

Horizontal Stabilizer Jackscrew Actuator Manufacturer Examination

Two FAA inspectors hand carried the horizontal stabilizer jackscrew actuator to its manufacturer, TRW/Lucas Aerospace, Aurora, Ohio, on Jan. 18, 2000.

Upon receipt, the actuator was unpacked and photographed to document its condition. The actuator was in multiple pieces, one main housing with the torque tubes, two rod end fitting adapters with tie rod attached, a dust shield, a separated electric motor from the main housing, and two broken sections of the jackscrews.

The actuator main housing was cracked, one torque tube was bent, and the extend limit switch cover was missing.

The rod end adapter fittings and tie-rod were loose from the actuator and the jackscrew ends. One end fitting was missing. The jackscrew ends displayed no damage to the holes, which the tie rod would extend through.

The motor that was separated from the actuator housing was damaged beyond testing. The motor remaining on the housing was also damaged beyond testing.

The broken ends of the jackscrews were two different lengths and did not appear to match the position of the remains of the jackscrews in the torque tubes. It was determined that the remaining ends of the jackscrews inside the torque tube were loose and that they had migrated back into the end of the torque tube causing the apparent mismatch.

The exposed extend limit switch cam was at the actuation point of the micro switch, revealing that the actuator was in the full extend position.

The damaged remains of the position sensor were removed from the actuator, and the retract limit switch cover was removed to expose the cam position of the retract limit switch cam. The retract limit switch cam was at the full extend position.

The rod end fittings remaining on the actuator were removed to expose the gearing on the inside the actuator. No damage or wear were exhibited on any of the gearing.

The examination determined that the actuator was in the full extend position at the time of the crash.

According to one of the FAA inspector's who observed the examination, all pieces of the actuator that were delivered to the manufacturer were packed for shipment to the Safety Board Materials Laboratory.

According to TRW/Lucas Aerospace, as part of an overhaul of a horizontal jackscrew actuator, an acceptance test of the unit would have been performed to assure proper assembly. The inspection included assurance that the tie rod was installed through the dust shield. The unit was then run to the "retract electrical limit." A distance was then measured from the bottom of the dust shield to the actuator housing. The maximum distance should have been 2.25 inches. If the dust shield was not in its proper position or if the measurement was greater than 2.25

inches, the unit would have failed the test and have been returned for repair. Also, as part of the acceptance test, the jackscrew "end play" is checked. This was performed by extending the actuator to the full extend position. The tie rod would then be removed, the dust shield lowered away from the end fittings, and the tie rod re-inserted. A reversing load of 100 pounds is applied, and the "end play" is measured on each jackscrew. After the measurement, the load is removed from the actuator. The tie rod is again removed, the dust shield replaced over the jackscrews end fittings, and the tie rod re-inserted. The actuator is operated several times to the extend and retract stops to verify performance and ultimate load.

Review of the airplane maintenance records revealed that TRW/Lucas Aerospace completed an acceptance test of the accident actuator on January 22, 1998.

Safety Board Metallurgical Lab Report

The horizontal stabilizer trim actuator assembly, including the actuator housing with two torque tubes, two rod end adapter fittings with the attached tie rod, one separated end bearing, one separated actuator motor, and one separated dust shield, was received in the Safety Board Materials Laboratory for examination. The Materials Laboratory had no record that the fractured jackscrew pieces were received.

Actuator Housing and Torque Tubes

According to the Metallurgical Factual report, the actuator main housing was cracked in several locations. The extend electrical limit microswitch cover was missing, exposing the extend limit microswitch. The lower left side of the area where the extend limit microswitch cover was attached contained deformation consistent with compressive loading. The extend limit switch cam was at the approximate full extend limit actuation point, but the extend limit microswitch was not activated. Additional rotation of the cam did not activate the microswitch. It was noted that the extend limit switch cam did not cause sufficient motion of the arm of the microswitch to sufficiently contact the switch button. A crack was observed in the housing body to the left of the microswitch.

The forward motor was separated from the housing body. The aft motor remained attached, but the motor housing was dented and loose. On the housing body, the exposed gear shaft for the forward motor was rotated back and forth until resistance was felt. A slight, simultaneous rotation of both torque tubes was observed. Of the two lower attachment bearings on the lower surface of the actuator housing, only the left one could be moved by hand.

Both torque tubes were bent forward approximately 6 degrees. The aft side of the torque tubes exhibited damage, consistent with longitudinal sliding contact with other components. The lower pieces of the jackscrews remained in each torque tube, with the fracture surfaces near the top surfaces of the torque tubes. The jackscrew fracture surfaces were rough in texture and did not contain crack arrest positions, which is consistent with overstress separations. The left jackscrew could not be rotated within the torque tube by hand, but the right jackscrew was free to rotate approximately 180 degrees counterclockwise. The fracture surface of the right jackscrew contained a small lip along the edge of the fracture at a position corresponding to the thread start location in the torque tube. "River patterns" on the jackscrew fracture surfaces indicated that the fracture initiated at the aft side of each jackscrew. The top of the left torque tube contained sliding deformation adjacent to the forward side of the fracture, which is consistent with contact with the jackscrew threads.

The right torque tube was cut from the remainder of the actuator. The torque tube and

retained piece of the jackscrew were then sectioned longitudinally. Rotation of the torque tube also turned the jackscrew nut, which was located at the upper end of the tube. Rotation of this nut over the threads of the jackscrew caused the jackscrew to translate into and out of the torque tube. After sectioning, the nut for the right jackscrew was located in its proper position inside the upper end of the right torque tube. The threads of the nut generally appeared undamaged with little wear. However, the thread roots in the upper threaded portion of the nut appeared shiny with rotational scoring. Some shiny areas and rotational scoring were observed in the lower threaded portion also but to a lesser extent.

Jackscrews

The length of the centerline holes (which is directly related to the length of the jackscrew piece retained in the actuator) in the jackcrews was measured from the top surface of the torque tubes. The hole lengths measured approximately 3.38 inches and 3.81 inches for the left and right jackscrews, respectively.

Using photographic documentation provided by TRW/Lucas Aerospace, the upper pieces of the jackscrews measured approximately 2.72 inches and 2.25 inches, respectively. According to the Israel Aircraft Industries maintenance manual for model 1124A aircraft, a properly adjusted jackscrew should have had a stroke of 2.32 inches limited electrically and 2.55 inches limited mechanically. At the mechanical retract limit, the length of jackscrew extending beyond the upper surface of the torque tubes was approximately 1 inch in a correctly assembled actuator assembly. (At the electrical retract limit, it was expected that slightly more than 1 inch would extend beyond the upper surface of the torque tubes). Adding 2.32 inches (the electrically limited stroke) to the 1 inch length of jackscrew at the mechanical retract limit, the minimum length of jackscrew extending from the top surface of the torque tubes at the electrically limited full extension was approximately 3.32 inches in the correctly assembled actuator assembly.

Rod Ends

The rod end adapter fittings, the attached tie rod, right rod end bearing, and separated left rod end bearing, were examined. The right rod end bearing was bent aft approximately 17 degrees relative to the rod end adapter fitting. The left rod end bearing was deformed similarly adjacent to the fracture, and the fracture surface features were typical of overstress separation. Neither bearing could be moved by hand. The mechanical stop was present on the lower end of the left rod end adapter fitting, but was missing from the right fitting.

When the Materials Lab received the tie rod, it was installed through the rod end adapter fittings but was not inserted through either the dust sleeve or the upper ends of the jackscrews. The tie rod was bent where it entered each of the rod end adapters. The exposed threads on the tie rod were damaged.

The threaded portions of the rod end adapter fittings were examined where the upper portion of the jackscrew attaches to the rod end adapter fittings. Some damage to the lowermost one or two threads was observed, but the remaining threads appeared intact with little wear.

Remnants of a dark brown and a yellow sealant were observed on the assembly. The dark brown sealant was observed around the end bearing lock nut and circumferentially around the rod end adapter fittings at the approximate location where the dust shield opening should be located (slightly above the holes for the tie rod). The dark brown sealant was also observed on both tie rod nuts and on the threaded portion of the tie rod on the right side. The yellow

sealant was located on the rod end adapter fittings around the holes for the tie rod, and the sealant appeared to be molded around the tie rod and the tie rod nuts. In areas that yellow and brown sealant were observed together, the brown sealant was under the yellow.

Dust Shield

When examined, the upper end of the dust shield was crushed. The diameter of the rod end adapter fitting was 1 1/2 inches at the location where the tie rod was inserted. The top openings of the dust shield were crushed to an inch or less in the area where the tie rod hole was located, indicating that the crushing damage occurred when the dust shield was not assembled around the lower ends of the rod end adapter fittings. Also, the holes in the dust shield for the tie rod were not ovalized or fractured. Brown sealant was observed on the exterior of the dust shield around the upper openings and the tie rod holes, but no yellow sealant was observed.

The Materials Lab split the tubes for the dust shield longitudinally for closer examination. Thread impressions, consistent with contact with the jackscrews, were present. The thread impressions were aligned with the dust shield tube axis and were consistent with contact with threads having 18 threads per inch and 10 threads per inch, respectively. The upper threaded portions of the jackscrews had 18 threads per inch, where the jackscrews were threaded into the lower end of the rod end adapter fittings. The remainder of the jackscrew (the lower end, which threads through the nut in the actuators) had 10 threads per inch. Impressions and sliding marks, consistent with a sliding contact with the top aft edges of the torque tubes, were observed. The distance from the top of the torque tube mark to the top of the threaded impressions measured 2.84 inches and 2.35 inches for the left and right sides, respectively; these lengths were consistent with the separated sections of the jackscrew within 0.12 inches. Additional thread impressions that were not aligned with the dust shield axis were observed on the inner surfaces. These impressions were consistent with contact with the upper sections of the jackscrews after separation from the torque tubes.

Horizontal Stabilizer Trim Actuator Inspection/Check

The IAI-1124A maintenance manual provides guidance on the procedures needed to complete an inspection of the horizontal stabilizer trim actuator. Included in the procedures are:

Remove access panels on both sides of the vertical stabilizer to allow access to the trim actuator.

Remove cotter pins, nuts, washers and bolts securing actuator to stabilizer front spar.

Remove nut from one end of tie bar and remove tie bar from actuator. Inspect tie rod for wear, thread damage and straightness.

Slide dust shield down to gain access to jackscrews.

Inspect jackscrew, one at a time, by applying slight push pull pressure on rod ends to ensure jackscrew is not sheared.

Repeat inspection procedure on opposite jackscrew.

Slide dust shield up until tie rod holes align with holes in jackscrew. Install tie rod through dust shield and both jackscrews.

Install nut on tie rod. Tighten nut so that tie rod will have a slight axial movement.

Apply sealant P/N 3M (or P/N PR-1422 or PR-1750) around top of dust shield at each jackscrew and on inner and outer side of dust shield at tie rod holes.

Install bolts, washers and nuts securing actuator rod ends to stabilizer front spar.

Safety Board Interviews

On April 11, 2000, a Safety Board investigator interviewed four mechanics that were employed by the maintenance facility where the airplane was maintained.

The first mechanic interviewed stated that he was tasked with the removal of the access panels on the tail section of the airplane.

The second mechanic stated that he had never "touched a wrench to the jackscrew actuator." The only work that he had accomplished on the airplane in relation to the actuator was research to check the compliance of the actuator AD. The mechanic added that he accomplished the research in about 1 hour.

The third mechanic recalled that he had installed an actuator in the airplane in the past. The mechanic stated that the actuator was received at the maintenance facility as a complete unit. The actuator was then installed in the airplane as a complete unit, per the maintenance manual. The mechanic did not recall observing any irregularities with the actuator during the installation. The mechanic did not recall any further maintenance being conducted on the actuator after the installation.

The fourth mechanic, who inspected the work performed by the first mechanic, was questioned about his familiarity of the installation and general assembly of the horizontal stabilizer jackscrew actuator and if he had observed the jackscrew threads when he inspected the first mechanics work. The mechanic stated that he was familiar with the installation and assembly of the actuator. When asked if he observed the jackscrews on the actuator, the mechanic replied "yes." The mechanic was then asked again if he had observed the threaded jackscrews on the actuator, the mechanic again replied "yes." In a follow-up letter dated April 18, 2000, from the maintenance facility, the mechanic stated that he might have spoken in haste when he responded that he had seen the jackscrews on the actuator. He stated that, in fact he may not have actually seen them because the shield covered both.

The follow-up letter provided by the maintenance facility also stated that the Director of Maintenance (DOM) had personally interviewed each employee that had worked on the airplane. Each person interviewed stated that at no time did they see weights (shot bags) on the horizontal stabilizer leading edge, nor were blocks installed. With that information, the DOM stated that to the best of his personal knowledge, the maintenance facility did not perform any maintenance to the stabilizer actuator during the inspection performed in December of 1999.

FAA Interviews

On May 5, 2000, an FAA inspector interviewed six mechanics that were employed or had been employed by the maintenance facility where the airplane was maintained.

The first mechanic stated that he was tasked with determining if AD 98-20-35 was applicable to the horizontal stabilizer jackscrew actuator installed on the airplane. When the mechanic examined the actuator, he was unable to find part numbers on it and requested the maintenance facility's parts department to check on availability. The mechanic then stated that

a determination was made that the AD did not apply to the installed actuator. The mechanic performed a complete visual and operational inspection of the actuator. When the FAA inspector asked the mechanic if he had seen the threads of the actuator's jackscrews, he replied "yes." The FAA inspector then discussed more thoroughly what the mechanic had seen, and the mechanic was certain that he had seen the "coarse threads" of the actuator. The mechanic added that he had run the trim to the full up (nose down) position and inspected the actuator assembly and jackscrews. The mechanic stated that he did not "touch a wrench to the actuator," and that he did not observe anyone else performing maintenance on the actuator, or disconnecting the actuator from the horizontal stabilizer.

The second mechanic stated that he was the "acting lead" on the airplane during its maintenance and that he did not recall personally inspecting the actuator, nor did he recall whether the actuator jackscrews were visible. The mechanic also did not recall anyone disconnecting the actuator or performing any maintenance to the actuator.

The third mechanic stated that his only involvement with the actuator during the maintenance was to "close up" inspection panels that covered the area in which the actuator was installed. The mechanic did not recall observing anyone working in the area in which the actuator was installed and did not personally inspect the actuator.

The fourth mechanic stated that his only involvement with the actuator was to remove inspection panels on the right side of the airplane to allow access to the area in which the actuator was installed. The mechanic recalled having to drill and extract several screws on the inspection panels to remove them. The mechanic did not recall observing anyone working in the area in which the actuator was installed and did not personally inspect the actuator. However, the mechanic did recall another mechanic applying paint to the tail section of the airplane.

The fifth mechanic could not recall any individuals who may have performed maintenance on the airplane.

The sixth mechanic stated that he had worked on the airplane but could not recall working on the removal of the horizontal stabilizer access panels. The mechanic also stated that he had worked on a lighting AD and that he had performed the final engine runs and operational checks before returning the airplane to the hangar. He stated that he performed functional checks on "all systems" and ran each of the trims "stop to stop." Regarding the horizontal stabilizer trim, he believes that he used both the yoke switch and the secondary center pedestal switch to test the trim and that it functioned normally before he returned all trims to the "normal" positions.

Examination of records revealed that during the "A Check," a work order was generated to address discrepancies with the airplane. The discrepancies were numbered 1.1 through 1.18. One of the discrepancies, "Discrepancy 1.2," stated, "Comply with AD 98-20-35 inspection of trim actuator of the horiz. stab per S/B 1124-27-133." The corrective action was written as, "C/W March 1998. This terminates the repetitive inspection IAW Pars (2) (0) of AD 98-20-35." A mechanic and an inspector signed off on the corrective action on December 7, 1999.

On April 14, 2000, a Safety Board investigator examined billing records that were sent to the airplane owner by the maintenance facility. The records included a written explanation of the time allotted for the inspection performed by the maintenance facility in December 1999, of "Discrepancy 1.2," which was the AD compliance. The total labor cost billed to the owner was

$300.51.

On April 18, 2000, the Safety Board asked the maintenance facility to convert the billed amount of $300.51 into total labor time. The reply was that it required 7.62 hours of labor to complete discrepancy "1.2."

On April 20, 2000, an FAA inspector reviewed the amount of labor hours that were logged by the maintenance facility for the work order discrepancy "1.2." The total amount of labor was 7.22 hours. The FAA inspector also reviewed four other work orders related to the accident airplane that were issued during the previous year. None of the four work orders indicated any work that would have required access to the area of the horizontal stabilizer trim actuator.

Mandatory Service Bulletin No. 1124-24-133, which was issued on August 14, 1996, for the inspection of horizontal stabilizer trim actuator, stated that, "for planning purposes only," the estimated man-hours to complete the inspection totaled 4 hours.

Postaccident Horizontal Stabilizer Jackscrew Actuator Static Test

On May 4, 2000, in Seattle, Washington, a static IAI-1124A was used to test the results of an actuator that was installed in the same manner as that found in the wreckage of the accident airplane.

Before initiating the test, inspection panels were removed from the vertical stabilizer to gain access to the actuator. Using a mirror, a Safety Board investigator examined the data tag that was mounted to the actuator. The numbers, which appeared on the mirror inverted, were small and hard to read.

The original actuator in the airplane was removed and a test actuator was installed. The test actuator was prepared by removing the tie rod from the actuator and sliding the dust shield down to allow access to the jackscrews. The rod end caps were then rotated out to the point where the tie rod could be reinserted through both rod end caps. In this condition, the tie rod did not pass through the drilled holes of either jackscrew or dust shield. In this condition there were approximately three threads of the jackscrew were engaged in the rod end caps. The test actuator was installed in the airplane. The aircraft pitch trim was placed in an approximate takeoff position and a wooden block was installed to prevent the stabilizer from moving up excessively if it disengaged from the actuator.

A pilot, who was familiar with the route that was flown by the accident airplane the day of the accident, was seated in the left seat of the airplane and requested to simulate the probable route flown by the accident flight crew. The pilot was asked to use the horizontal stabilizer trim switch on the control wheel to run the horizontal trim but was later requested to use the horizontal stabilizer override control switch due to the control wheel horizontal stabilizer trim switch being trimmed beyond its limits. The simulated flight included the standard instrument departure procedure for BFI, then a climb to 37,000 feet. The pilot used the trim inputs necessary to climb and level the airplane to altitude. The pilot was then instructed to descend the airplane to 35,000 feet. At this point, the Safety Board investigator referred to the CVR transcript and partial transcripts of the New York ATRCC communications between the accident pilots and controllers to provide assistance in commanding altitudes and ATC clearances to the pilot. The pilot was requested to descend the airplane to 35,000 feet, level off, and then descend again to 29,000, with a "good rate" through 31,000 feet. After the airplane was leveled off, the pilot was requested to descend to 24,000 feet. The airplane was leveled and the pilot was requested to cross the LVZ VOR and maintain 18,000 feet. About 3

minutes later, the pilot was requested to descend to 13,000 feet. About 4 minutes after the request to cross the LVZ VOR, the pilot was requested to cross MUGZY intersection at 6,000 feet. The pilot was advised of the distance from his present position to the crossing restriction and responded that he was familiar with the excessive descent rate that would be necessary to meet the crossing restriction on the arrival route to TEB.

An FAA inspector observed the testing from the rear of the airplane. He was positioned on a work stand on the right side of the vertical stabilizer where he could observe movement of the horizontal stabilizer actuator jackscrews with a mirror. When the pitch trim was actuated several times toward the nose-up position, the jackscrews did not rotate relative to the rod end caps. At that point the pitch trim began to actuate toward the nose-down position. The inspector observed the jackscrews backing out of the rod end caps within the first few actuations of the pitch trim toward the nose down position. Rotation of the two jackscrews was not even, and the amount of rotation varied with each actuation of the trim. As the pitch trim continued to be actuated toward the nose-down position, the jackscrews became disconnected from the rod end caps, and the horizontal stabilizer became disconnected from the actuator.

ADDITIONAL INFORMATION

The airplane wreckage was released on March 30, 2000, to a representative of the owner's insurance company.

Pilot Information

Certificate:	Airline Transport; Flight Instructor; Commercial	**Age:**	52, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land; Single-engine Sea	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane Single-engine	**Toxicology Performed:**	No
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim.	**Last FAA Medical Exam:**	02/01/1999
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:	10250 hours (Total, all aircraft), 1500 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Israel Aircraft Industries	**Registration:**	N50PL
Model/Series:	1124A 1124A	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	338
Landing Gear Type:	Retractable - Tricycle	**Seats:**	12
Date/Type of Last Inspection:	12/10/1999, AAIP	**Certified Max Gross Wt.:**	16000 lbs
Time Since Last Inspection:	0 Hours	**Engines:**	2 Turbo Fan
Airframe Total Time:	5035 Hours	**Engine Manufacturer:**	Airesearch
ELT:	Not installed	**Engine Model/Series:**	TFE 731SER
Registered Owner:	PANDA LEASING COMPANY	**Rated Power:**	3500 lbs
Operator:	PANDA LEASING COMPANY	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	AVP, 962 ft msl	**Distance from Accident Site:**	15 Nautical Miles
Observation Time:	1645 EST	**Direction from Accident Site:**	310°
Lowest Cloud Condition:	Clear / 0 ft agl	**Visibility**	10 Miles
Lowest Ceiling:	None / 0 ft agl	**Visibility (RVR):**	0 ft
Wind Speed/Gusts:	Calm /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30 inches Hg	**Temperature/Dew Point:**	36°C / 25°C
Precipitation and Obscuration:			
Departure Point:	SEATTLE, WA (BFI)	**Type of Flight Plan Filed:**	IFR
Destination:	TETERBORO, NJ (TEB)	**Type of Clearance:**	IFR
Departure Time:	0800 PST	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	1 Fatal	**Aircraft Fire:**	On-Ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 Fatal	**Latitude, Longitude:**	

Administrative Information

Investigator In Charge (IIC):	STEPHEN M DEMKO	**Report Date:**	04/20/2001
Additional Participating Persons:	DONALD BORDA; ALLENTOWN, PA ; HOUSTON, TX ; PHOENIX, AZ ; AURORA, OH		
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.ntsb.gov/pubdms/.		