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Improper Assembly Of Trim Actuator Causes In-flight Separation of Stabilizer

All three people on board were killed when the Westwind struck the ground out of control. The U.S. National Transportation Safety Board said that the flight was the first after maintenance that included disassembly and reassembly of the trim-actuator unit.

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FSF Editorial Staff

About 1635 local time, Dec. 12, 1999, an Israel Aircraft Industries (IAI) Westwind struck terrain near Gouldsboro, Pennsylvania, U.S. The airplane was destroyed, and the two pilots and their passenger were killed.

The U.S. National Transportation Safety Board (NTSB) said, in its final report, that the probable cause of the accident was the "improper assembly of the horizontal stabilizer trim-actuator unit by maintenance personnel."

Day visual meteorological conditions had prevailed for the five-hour personal flight from Boeing Field/King County International Airport, Seattle, Washington, to Teterboro (New Jersey) Airport. The last recorded communication was the crew's acknowledgment of an air traffic control (ATC) clearance to descend the airplane from 18,000 feet to 6,000 feet.

Witnesses said that the airplane was in a near-vertical climb before leveling off and beginning a series of "twists, swoops and turns." Several witnesses at first believed that they were observing aerobatic maneuvers. The airplane's movements became more erratic, and then the airplane descended "nose first, no spinning, twisting or corkscrewing," one witness said.

The airplane first struck treetops, then the ground.

The report said, "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 [NTSB] revealed that the actuator had not been properly assembled in the airplane."

During the accident investigation, a similar actuator was assembled improperly and was installed in an airplane for a static 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," the report said. "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."

Airplane maintenance records showed that the horizontal-jackscrew actuator was overhauled and returned to service Feb. 20, 1998, and was installed in the accident airplane Feb. 26, 1998. An entry in the airplane flight log described the installation but did not mention that the new actuator eliminated the requirement for repetitive inspections in accordance with Airworthiness Directive (AD) 98-20-35, amendment 39-10802.

Subsequent entries in the flight log and in the maintenance records said that "A" checks were conducted Oct. 9, 1998, and Dec. 10, 1999, in accordance with the IAI inspection guide. The flight-log entry for the Oct. 9, 1998, "A" check did not mention compliance with the AD; no mention was required in the flight log.

The maintenance records said that the Dec. 10, 1999, "A" check included removal of the left elevator, which was painted, balanced according to the maintenance manual and reinstalled.

"Examination of the airplane's flight log revealed stickers that were added to two pages of the log," the report said. "The stickers were dated Dec. 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 IAI inspection guide. Complied with AD 98-20-35 Amendment 39-10802 on inspection of trim actuator. Actuator was replaced 3/98. This terminates the repetitive inspections … of this AD.'"

A flight data recorder was not installed, and was not required to be installed, in the airplane.

The cockpit voice recorder (CVR) transcript showed that the flight crew observed indications of a problem with the horizontal-stabilizer trim 18 minutes before the accident, when the first officer said, "Elevator up … my light just flashed on. … There it goes again."

Sixteen minutes later, the first officer said, "It's trimming."

The captain said, "Yeah, I left the autopilot on intentionally."

One minute later, the first officer said, "Elevator out of trim."

The captain asked, "Which way?"

The CVR recorded an unidentified voice saying "up" and an increase in general cockpit noise that resembled the sound of an increase in aircraft speed. Twenty-three seconds later, the captain said, "Keep pushing.'"

No further sounds were recorded on the CVR.

Examination of the wreckage showed that the airplane had struck the ground about 80-degrees nose-down with wings level. The major components and flight-control surfaces were found at the accident site. The horizontal-stabilizer trim actuator was found 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," the report said. "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."

The horizontal-stabilizer trim-actuator dust shield, separated pieces of jackscrews and an electric motor for the horizontal-stabilizer trim actuator were found in the impact crater. The dust shield and the pieces of the jackscrews were beneath aft portions of the airplane.

The report described their condition as follows:

> 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.

Examinations of the rudder stops and elevator-control stops showed normal wear. Impact damage prevented a determination of the continuity of the engine controls and flight controls, but a laboratory analysis revealed that both engines showed indications of rotation when the accident occurred and that there were no pre-impact conditions that would have interfered with normal engine operation.

The pitch of the airplane was controlled by the horizontal stabilizer and two elevators. A dual-jackscrew actuator, powered by one of two reversible motors, drove the horizontal-stabilizer leading edge up or down to make trim changes. The base of the jackscrew actuator was attached by two rod-end fittings to the aft fuselage. Two torque tubes housed the threaded jackscrews and extended vertically from the jackscrew-actuator housing.

The report described the operation of the unit as follows:

> When commanded, a gearbox inside the actuator housing would … rotate the torque tubes, which, in turn, would drive the threaded jackscrews in a forward [direction] 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.

When the actuator was being inspected or installed, the dust shield was designed to be fitted over the upper ends of the jackscrews so that it could rest atop the actuator housing. After the inspection or installation was completed, the upper ends of the jackscrews were threaded into the lower ends of the rod-end adapter fittings, and the dust shield was raised above the jackscrews. Tie rods were inserted through each end of the dust shield, the lower ends of the rod-end adapter fittings and the upper ends of the jackscrews, and threaded nuts were installed at each end of the tie rod. Sealant was applied around the holes of the dust shield, the tie rod and the openings where the rod-end adapter fittings extended from the top of the dust shield.

After the accident, the horizontal-stabilizer jackscrew actuator was taken to the manufacturer, TRW Aeronautical Systems/Lucas Aerospace. The actuator was in several pieces, and the jackscrews were broken.

The report said that the exposed extend-limit switch cam was at the actuation point of the microswitch and that the actuator was in the full-extend position. The retract-limit switch cam also was in the full-extend position. Inspection revealed no damage or wear on the gearing inside the trim actuator.

The metallurgical report from the NTSB Materials Laboratory said that, although the extend-limit switch cam was at the approximate full-extend-limit actuation point, the extend-limit microswitch was not activated.

"Additional rotation of the cam did not activate the microswitch," the report said. "[T]he extend-limit switch cam did not cause sufficient motion of the arm of the microswitch to sufficiently contact the switch button."

The metallurgical inspection also found a crack in the housing body left of the microswitch.

The report said that the inspection found a "slight, simultaneous rotation of both torque tubes." Both torque tubes were bent forward about six degrees, and damage was found on the aft side of the tubes that was "consistent with longitudinal sliding contact with other components," the report said.

"The lower pieces of the [fractured] 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."

The metallurgical inspection also found that:

- The length of the centerline holes in the jackscrews was 3.38 inches (8.59 centimeters) for the left jackscrew and 3.81 inches (9.68 centimeters) for the right jackscrew. Photographs from TRW/Lucas Aerospace showed that the upper piece of the left jackscrew measured about 2.72 inches (6.91 centimeters) and the upper piece of the right jackscrew measured about 2.25 inches (5.72 centimeters). The IAI maintenance manual said that the jackscrews should have had a stroke of 2.32 inches (5.89 centimeters) limited electrically and 2.55 inches (6.48 centimeters) limited mechanically.

  "At the mechanical retract limit, the length of jackscrew extending beyond the upper surface of the torque tubes was approximately one inch [2.54 centimeters] in a correctly assembled actuator assembly," the report said. (At the electrical retract limit, it was expected that slightly more than one inch would extend beyond the upper surface of the torque tubes.) Adding 2.32

inches (the electrically limited stroke) to the one-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";

- The right rod-end bearing was bent aft about 17 degrees relative to the rod-end adapter fitting. The left rod-end bearing had a similar deformity next to the fracture, and the fracture surface features "were typical of overstress separation." The mechanical stop was present on the lower end of the left rod-end adapter fitting but not on the right fitting.

  The tie rod was installed through the rod-end adapter fittings but was not inserted through the dust sleeve or the upper ends of the jackscrews. The tie rod was bent where the tie rod entered the rod-end adapters, and the exposed threads on the tie rod were damaged. The inspection also found remnants of a brown sealant and a yellow sealant on the assembly; in areas in which both sealants were observed, the brown sealant was beneath the yellow sealant; and,

- The upper end of the dust shield was crushed. Because the diameter of the rod-end adapter fitting was 1.5 inches (3.8 centimeters) where the tie rod was inserted and the top openings of the dust shield were crushed to one inch or less around the tie-rod hole, this indicated that "the crushing damage occurred when the dust shield was not assembled around the lower ends of the rod-end adapter fittings," the report said. "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."

When the torque tubes for the dust shield were split for further inspection, thread impressions were found that were consistent with contact with the jackscrews. Impressions and sliding marks were found that were consistent with a sliding contact with the top aft edges of the torque tubes.

Investigators from NTSB and the U.S. Federal Aviation Administration (FAA) conducted separate interviews with maintenance technicians employed by the facility that maintained the airplane.

During the NTSB interviews, conducted April 11, 2000, the first mechanic interviewed said that he removed the access panels on the tail section of the accident airplane.

The second mechanic interviewed said that he had never "touched a wrench to the jackscrew actuator" but that he had conducted one hour of research to check the compliance of the actuator AD. The third mechanic said that he previously had installed an actuator in the airplane and that the actuator had been received at the maintenance facility as a complete unit and was installed in the airplane as a complete unit; he said that he did not recall observing any irregularities with the actuator during the installation and did not recall further maintenance on the actuator after the installation. The fourth mechanic, who inspected the first mechanic's work, said that he had observed the jackscrews on the actuator.

Nevertheless, the report said, "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 maintenance facility's follow-up letter said that the director of maintenance (DOM) had interviewed each employee who had worked on the accident airplane and that each person interviewed said 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."

During the FAA interviews on May 5, 2000, the first mechanic said that his task was to determine whether AD 98-20-35 applied to the horizontal-stabilizer-jackscrew actuator on the accident airplane.

"The mechanic then stated that a determination was made that the AD did not apply to the installed actuator," the report said. "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 interviewed by FAA said that he was the "acting lead" on the airplane during maintenance and that he did not recall inspecting the actuator, did not recall whether the actuator jackscrews were visible and did not recall anyone else disconnecting the actuator or performing maintenance on the actuator.

The third mechanic said that he closed inspection panels that covered the area in which the actuator was installed and that he did not recall observing anyone working in the area where the actuator was installed. He said that he did not inspect the actuator.

The fourth mechanic told FAA that he had removed inspection panels to allow access to the area where the actuator was installed and that he did not recall observing anyone working in the area. He said that he had not inspected the actuator. He did, however, recall that another mechanic had applied paint to the airplane's tail section.

The fifth mechanic said that he could not recall anyone who might have performed maintenance on the airplane.

The sixth mechanic said that he had worked on the airplane and that he could not recall removing the horizontal-stabilizer access panels. He said that he had worked on a lighting AD and had performed final engine runs and operational checks before returning the airplane to the hangar.

The report said, "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."

An examination of maintenance records showed that an "A" check work order listed discrepancies with the airplane and numbered them 1.1 through 1.18. "Discrepancy 1.2" said, "Comply with AD 98-20-35 inspection of trim actuator of the [horizontal stabilizer] per [service bulletin] 1124-37-133." The corrective action said, "C/W March 1998. This terminates the repetitive inspection … of AD 98-20-35." The report said that a mechanic and an inspector "signed off on the corrective action on Dec. 7, 1999."

Billing records sent to the airplane owner included $300.51 for labor involved in work on "Discrepancy 1.2."

"On April 18, 2000, [NTSB] asked the maintenance facility to convert the billed amount of $300.51 into total labor time," the report said. "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."

Mandatory Service Bulletin 1124-24-133, issued Aug. 14, 1996, discussed inspections of the horizontal-stabilizer trim actuator and estimated that, "for planning purposes only," completion of the inspection would take four hours.

Static tests were conducted May 4, 2000, using an IAI Westwind equipped with a test actuator that had been installed in the same manner as that found in the wreckage of the accident airplane: The tie rod was removed, the dust shield was slid down to allow access to the jackscrews, and the rod-end caps were rotated out "to the point where the tie rod could be reinserted through both rod-end caps," the report said. "In this condition, the tie rod did not pass through the drilled holes of either jackscrew or dust shield. … [A]pproximately three threads of the jackscrew were engaged in the rod-end caps."

The aircraft pitch trim was placed in a position approximating the takeoff position, and a wooden block was installed to prevent excessive upward movement of the stabilizer in the event that the stabilizer became disengaged from the actuator.

The simulated flight was conducted by a pilot familiar with the route flown by the crew of the accident airplane. The pilot initially used the horizontal-stabilizer trim switch on the control wheel and later used the horizontal-stabilizer-override control switch "due to the control wheel horizontal stabilizer trim switch being trimmed beyond its limits," the report said.

The simulated flight began with the standard instrument departure and a climb to 37,000 feet. When the pilot was told to descend, the CVR transcript and partial ATC transcripts were used to help in assigning altitudes and ATC clearances to the pilot.

The report said, "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.”♦

[FSF editorial note: This article, except where specifically noted, is based on U.S. National Transportation Safety Board *Aircraft Accident Brief,* accident no. NYC00MA048. The 274-page report contains diagrams and photographs.]

MAINTENANCE ALERTS

NTSB Recommends Action to Secure Evacuation Slides/Rafts

The U.S. National Transportation Safety Board (NTSB), citing a March 17, 2001, accident involving an Airbus Industrie A320-200, has recommended that the U.S. Federal Aviation Administration issue airworthiness directives (ADs) to require operators to ensure that the dimensions of specific parts of girt bars on overwater-equipped A319, A320 and A321 airplanes conform to design specifications.

(A girt, the device typically used to attach an emergency-evacuation slide/raft to an airplane, consists of strong fabric wrapped around a girt bar, which is installed at the doorsill of an exit.)

The NTSB recommendations resulted from an accident in which a Northwest Airlines A320-200 overran the runway during a rejected takeoff from Detroit (Michigan, U.S.) Metropolitan Wayne County Airport. The airplane was damaged substantially. Three of the 151 people in the airplane received minor injuries.

After the airplane was stopped in mud beyond the departure end of the runway, an emergency evacuation was performed. During the evacuation, the emergency evacuation slide/raft at door 2L separated from the airplane and fell to the ground when the door was opened.

The accident airplane, like other overwater-equipped A319, A320 and A321 airplanes, had a slide/raft at each floor-level emergency exit. The slide/raft is attached to the door by a packboard. The slide/raft includes a fabric girt and a telescopic girt bar, which enables the slide/raft pack to be removed from one exit’s floor fittings for deployment outside another door, if necessary.

"When the door is 'armed,' the girt bar is attached to the floor fittings on the doorsill so that when the door is opened, the girt bar will pull on the slide/raft and initiate its deployment," NTSB said. "When a door is 'disarmed' and opened, the girt bar remains attached to and moves with the door, thereby preventing the slide/raft from deploying.

"The telescopic end of the girt bar is locked in the extended position by a spring-loaded trigger. … Squeezing the trigger causes the trigger-locking mechanism to retract within the telescopic end of the girt bar, allowing it to slide into the stationary portion of the girt bar and shorten the overall length of the girt bar so that the slide-raft can be removed from the floor fittings."

The exposed end of the trigger-locking mechanism overlaps and contacts the stationary portion of the girt bar to prevent the girt bar from retracting. During the accident investigation, NTSB determined that the likelihood of a secure engagement between the stationary portion of the girt bar and the trigger-locking mechanism is reduced if the amount of chamfer (bevel) on the stationary portion of the girt bar is increased.

An inspection of the telescopic girt bar at exit door 2L of the accident airplane showed that its chamfer was 0.77 millimeter (0.03 inch) on the horizontal surface and 0.93 millimeter (0.04 inch) on the vertical surface, instead of 0.50 millimeter (0.02 inch), as required by the design.

"When the 2L door was opened in the 'armed' mode, the force of the door opening apparently allowed the telescopic end of the girt bar to retract within the stationary portion of the girt bar," NTSB said. "This retraction allowed the aft end of the girt bar to slip from its floor fitting and rotate forward. This movement and the weight of the slide/raft pulled the forward end of the girt bar from its floor fitting and caused the uninflated slide/raft pack to separate completely from the airplane and fall to the ground."

Although the other two slides/rafts on the airplane deployed normally, girt bars on those two doors also were chamfered improperly. NTSB said that meant there was potential for slide-raft separations at those doors and that, "if this had occurred, three of the four floor-level emergency exits on the accident airplane would have been unusable by passengers during the evacuation."

During the investigation, Airbus Industrie said that two other slide/raft separations — on an A321 and an A320 — had been attributed to improperly chamfered girt bars. Both separations — one on June 3, 1999, and the other on April 1, 2001 — involved airplanes operated by Air Macau, and both occurred during routine maintenance tests.

A March 1999 revision of the A319/A320 Airbus Maintenance Manual (AMM) included a new item, subtask 52-10-00-220-077, "Check of the Adjustment of the Girt Bar," to be conducted every 36 months to ensure that the length of the telescopic girt bar can be shortened only by depressing the trigger.

The check had not been conducted on the accident airplane. When accident investigators tried to retract the telescopic end of the 2L girt bar, they succeeded every time; when they tried to retract the telescopic ends of girt bars on the other two slides/rafts, some of their attempts were successful.

"This indicates that the results from conducting the test specified in the AMM are likely unreliable," NTSB said.

On April 11, 2001, Airbus Industrie issued All Operators Telex (AOT) A320-52A1110, which recommended that operators of all overwater-equipped A319, A320 and A321 airplanes conduct a "one-time test for the non-retraction of the telescopic girt bar without manually activating the trigger." The AOT said that the test should be conducted within 500 flight hours after operators received the AOT. The AOT also said that, if the girt bar retracts without manually activating the trigger, it must be replaced or modified before the next flight.

Eight days after the AOT was issued, the 2L slide/raft of an A320 operated by FTI, a German charter company, detached from its floor fittings during an operational test, fell to the ground and inflated. Airbus Industrie personnel said that the chamfer of the girt bar was slightly outside design requirements and that a required seven-degree cutback at the end of the trigger-locking mechanism was not present. The operator had conducted the AOT test the day before and had found no anomalies.

NTSB also said that the test outlined in the AOT may not detect improperly chamfered girt bars and trigger-locking mechanisms with improper cutbacks. The accident airplane, the Air Macau airplanes and the FTI airplane had manually chamfered girt bars; NTSB said that A319, A320 and A321 airplanes with machine-chamfered girt bars could experience similar problems.

Therefore, NTSB asked FAA to issue an emergency AD to require operators of overwater-equipped A319, A320 and A321 airplanes with manually chamfered girt bars to accomplish the following:

- “Ensure that the dimensions of the trigger-locking mechanism and the stationary portion of the girt bars conform to the design specifications;

- “Perform a reliable functional test to demonstrate the proper engagement of manually chamfered girt bars under realistic door-opening conditions; and,

- “Repair or replace any girt bars that do not meet the dimensional requirements or do not pass the functional test, before the airplanes are returned to service.”

NTSB said that FAA also should issue an AD to require operators of A319, A320 and A321 airplanes with machine-chamfered girt bars to implement the same actions “by the next scheduled maintenance activity.”

Improper Maintenance Cited in Wheel Separations

The U.S. National Transportation Safety Board (NTSB) has cited improper action by maintenance personnel in two 1999 incidents in which wheel assemblies separated from airplanes during takeoff.

The first incident involved a McDonnell Douglas DC-9-51, from which a left-outboard main wheel and tire assembly separated during takeoff Oct. 14, 1999, from Chicago (Illinois, U.S.) Midway Airport. The assembly struck an airport perimeter wall, dislodging two panels from the wall. Two panels and the tire-and-wheel assembly then struck two vehicles on a nearby road.

The airplane received minor damage and was flown to the destination airport for a normal landing. None of the 109 people in the airplane was injured. The driver of one vehicle was taken to a hospital for observation; the other driver and two passengers were not injured.

NTSB said that the probable cause of the accident was “the landing gear’s wheel separation due to the improper installation of the wheel by company maintenance personnel using incomplete maintenance steps and the maintenance steps not listed in the manufacturer’s manual.”

The separated tire was found, still inflated and with the axle nut correctly in place. NTSB said that the anti-skid transducer adapter was “loosened and backed out 4 1/2 turns” and in contact with the back of the axle nut, although the design required space between the adapter and the axle nut.

The tire had been changed Oct. 1, 1999, in accordance with the manufacturer’s 32-40-01 maintenance manual.

"The manual was reviewed, and its steps did not caution mechanics to check for the proper depth of the adapter," NTSB said.

After the incident, the manufacturer issued temporary service bulletins that said that maintenance personnel should "check the depth [space] dimension of the transducer adapter with reference to the applicable technical data."

In the second incident, the right-main-landing-gear inboard wheel separated from a Boeing 737-347 during takeoff Dec. 24, 1999, from Salt Lake City (Utah, U.S.) International Airport. The flight crew continued the takeoff and returned for a normal landing. The airplane received minor damage; none of the 133 people in the airplane was injured.

The separated tire-and-wheel assembly struck and damaged runway lighting.

Investigation showed that a Boeing 757 main-wheel bearing had been installed on the incident airplane during build-up in the operator's maintenance facilities. The B-737 main-wheel inner bearing (part no. 596) has a diameter of 3.375 inches (8.573 centimeters); the B-757 main-wheel inner bearing (part no. 594) has a diameter of 3.750 inches (9.525 centimeters).

NTSB said that the probable cause of the incident was "improper assembly of the wheel."

NTSB said that five other incidents of incorrect bearing installation had been reported to The Boeing Co.

Chafing in Flexible Hose Blamed for Oil Leak

The pilot of a Piper PA-31 Navajo observed oil on the right-cockpit floor during a flight in Canada. The oil-pressure gauge for the no. 2 engine indicated that oil pressure was low and was continuing to decrease.

An inspection by maintenance personnel showed that the replacement flexible-hose assembly (part no. 23745-14) to the no. 2 engine oil-pressure gauge had been chafed through behind the instrument panel where the hose was bundled. The replacement hose was not bundled because technicians believed that, by supporting the hose outside a bundle, chafing would be less likely and inspection would be easier.

Loose Clip Cited in Failure of Hydraulic Pump

An Avions de Transport Regional (ATR) 72-202 was being taxied for takeoff from an airport in England when the flight crew experienced what they believed was an elevator-pitch disconnect, accompanied by the failure of the green-system hydraulic pump, which provides power for the landing gear and brakes. The airplane was taxied back to the gate.

Inspection of the green-system hydraulic pump showed that the electrical supply loom had chafed against the right-elevator control cable (part no. 13S27381310-000/A00) and had worn away the insulation on the hydraulic-pump power-supply cables. As a result, the conductors short-circuited and tripped the circuit breaker for the hydraulic-pump electrical supply.

The incident report by the U.K. Air Accidents Investigation Branch (AAIB) said, "The associated localized thermal damage to the elevator control cable had caused it to break. The heat generated by the shorting/arcing had also initiated a small fire in the adjacent insulation blanket, but this self-extinguished without damaging any other adjacent systems or components."

The electrical cable loom was retained by a number of cable clips; one clip was too large and could not retain the loom securely. As a result, the electrical supply cables contacted the right-elevator control cable. The illustrated parts catalog (IPC) showed that the size –16 clip (part no. NSA 935807-20) was correct to specification.

Maintenance personnel replaced the damaged section of the power-supply cable and both elevator control cables in the affected area. They also wrapped the loom with electrical tape. The electrical tape was intended to increase the diameter of the loom so that the loom could be held more securely by the clip.

After the incident, other ATR 72 airplanes in the United Kingdom were inspected to determine the size and orientation of the clip at the same position on the cable. Two other airplanes had clips at the same position, and both were a smaller size than specified in the IPC.

"It was believed that these had been installed at manufacture," the report said.

The manufacturer issued ATR all operators message (AOM) 72/01/001 and mandatory service bulletin (SB) ATR72-92-1004 (applicable to ATR 72-100, ATR 72-200 and ATR 72-210 airplanes) on Jan. 26, 2001, to require inspection, replacement of damaged looms or cables, installation of a size –16 clip and reorientation of the clip for increased clearance from elevator control cables.

Engine Cowling Separates During Takeoff

An Avions de Transport Regional ATR 42-300 was at 19,000 feet on a flight from England to France when a cabin crewmember told the flight crew that a passenger had observed a panel missing from the no. 1 engine. The flight crew then observed that part of the no. 1 engine outboard cowl door had broken off. They returned to the departure airport, where they observed the broken part of the cowl door and smaller pieces of debris near the runway threshold.

Investigation showed that a maintenance technician had conducted a routine weekly check of the airplane the day before the incident. The check had been conducted in darkness but in a lighted area on the apron in front of the terminal building. The maintenance technician said that he believed that, after the inspection, he had followed his customary practice of releasing the cowl-door stay, supporting the door while descending a stepladder until he could "allow the door to hinge closed past his head" and then fastening the latches.

The morning of the incident, the captain conducted a preflight, walk-around inspection in darkness, using artificial light.

The incident report by the U.K. Air Accidents Investigation Branch (AAIB) said, "He believed that all engine-bay doors had been flush with the surrounding panels although, because of their height above ground, he was not able to confirm that the latches were engaged."

Investigation showed that the left door of the no. 1 engine bay "had not been restrained by its latches and had hinged open under the influence of the propeller slipstream when engine power had been increased at the start of the takeoff run. … The mostly likely cause of the failure … appeared to be that the door had inadvertently not been latched following the weekly check and that this had not been noticed during the preflight [walk-around] inspection. … Both the check and the inspection were conducted in the hours of darkness, with the aircraft positioned such that the door would have been shadowed from the apron lights."

AAIB recommended that the operator review procedures to ensure that all airplane access doors are properly latched before flight and repeated an earlier recommendation that the European Joint Aviation Authorities and the U.S. Federal Aviation Administration consider — for future aircraft certification — a requirement for warning systems to alert flight crews to the presence of unlatched access panels or doors.♦

Cleaning Systems Remove Contaminants From Hydraulic Oils

Kleentek electrostatic oil-cleaning systems remove tars, varnishes and other insoluble contaminants from hydraulic oil systems, said the manufacturer, Kleentek, a division of United Air Specialists.

The systems use electrostatic principles to draw contaminants from oil in machines and trap the contaminants on the surface of the Kleentek collector. The systems help reduce the need for oil changes and system down time, said the manufacturer.

For more information: Kleentek, 4440 Creek Road, Cincinnati, OH 45242 U.S. Telephone: (888) 281-4888 (U.S.) or +1 (513) 891-0400.

Clamp-on Meters Measure Electrical Current

Three AEMC clamp-on meters measure alternating current (AC) amperage to 1,000 amperes, AC and direct current (DC) voltage to 600 volts, ohms, continuity and frequency, said the manufacturer. The clamp-on meters also have a diode-test function.

Clamp-on Electrical Meters

The Model 514 provides AC and DC current measurements to 1,000 amperes. The Model 511 provides average sensing; Model 512 and Model 514 provide true RMS (root mean square, which indicates the effective voltage of an AC signal) measurements.

For more information: AEMC Instruments, 200 Foxborough Blvd., Foxborough, MA 02035-2872 U.S. Telephone: (800) 343-1391 (U.S.) or +1 (508) 698-2115.

Software Provides Improved Servicing Of Emergency Battery Packs

New software for Christie's CASP/2500 battery-maintenance system has made servicing aircraft emergency battery packs more efficient, said the manufacturer, a division of Marathon Power Technologies.

The TD-750 software includes a data-logging system for instant data capture and documentation. The software maintains a record of service tasks performed, eliminating the need for manual documentation, and allows for easy calibration and testing of emergency battery packs, said the manufacturer.

Battery-maintenance System Software

For more information: Marathon Power Technologies Co., 8301 Imperial Drive, Waco, TX 76712 U.S. Telephone: +1 (254) 776-0650.

Flaw Detector Provides Detailed Information, Digital Signal Processing

Krautkramer's USN 60 Ultrasonic Flaw Detector combines digital signal processing with detailed dynamic echo information that previously was available only with analog cathode ray tube displays, said the manufacturer.

The USN 60 has a capability of 250 kilohertz to 25 megahertz, with eight selectable frequency ranges; a high-resolution (640 pixels by 480 pixels) color liquid-crystal display; a 60-hertz update rate; and a single-shot measurement technique for a fast response from immersion testing and from critical weld testing, said the manufacturer.

For more information: Krautkramer Branson, 50 Industrial Park Road, Lewistown, PA 17044 U.S. Telephone: +1 (717) 242-0327.

Cotton Mounted Points Retain Geometry of Machined Parts

Non-woven cotton-fiber mounted points can deburr and finish precision-machined parts without changing their geometry, said the manufacturer, Rex-Cut Products.

Rex-Cut Mounted Points are available in bullet shapes and cylindrical shapes. Their non-woven cotton fiber and abrasive grains of aluminum oxide or silicon carbide provide smooth, controlled grinding, and they reveal fresh abrasives as they grind. They are available in very-fine-grain sizes to coarse-grain sizes; in soft bonds, medium bonds or hard bonds; and with shanks of 0.25 inch (6.35 millimeters) and 0.13 inch (3.30 millimeters). They are suitable for titanium, stainless steel and highly alloyed parts, said the manufacturer.

Mounted Points

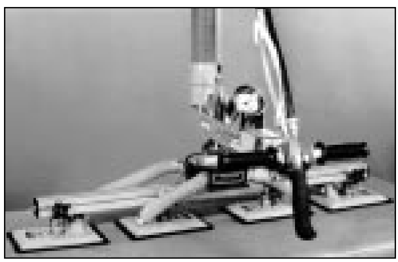
For more information: Rex-Cut Products, P.O. Box 2109, Fall River, MA 02722 U.S. Telephone: (800) 225-8182 (U.S.) or +1 (508) 678-1985.

Attachments Function As Part of Vacuum Lifting System

Custom vacuum attachments are available for use on systems with compressed-air balancers as part of a non-weight-sensitive vacuum lifting system, said the manufacturer, Anver Corp.

Anver Custom Vacuum Attachments for air balancers bolt on to compressed air balancers to create a non-weight-sensitive vacuum lifting system that will not float, the manufacturer said. The attachments are based upon standard components and are interchangeable.

For more information: Franck Vernooy, Anver Corp., 36 Parmenter Road, Hudson, MA 01749 U.S. Telephone: (800) 654-3500 (U.S.) or +1 (978) 568-0221.♦



Vacuum Attachment

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