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Documentation, Inspection, Workload Problems Cited In Incorrect Installation of Aileron-trim Cables

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Robert A. Feeler, editorial coordinator

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Documentation, Inspection, Workload Problems Cited in Incorrect Installation of Aileron-trim Cables

The pilot of a Jetstream 41 realized when he applied aileron trim shortly after takeoff on a maintenance test flight that the trim system was operating in reverse.

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FSF Editorial Staff

On March 29, 2000, the pilot of a Jetstream 41 applied aileron trim in an attempt to eliminate a roll tendency shortly after takeoff from Manchester (England) Aerodrome for a post-maintenance test flight. The application of trim increased the roll tendency. The pilot realized, during further application of the trim, that the trim was operating in reverse. He then applied trim in the opposite direction until the airplane was in balanced flight and returned to the airport for an uneventful landing. None of the three crewmembers — the only people aboard the airplane — was injured, and the airplane was not damaged.

Before the flight, the airplane had undergone a wing-splice replacement. The airplane was the second of several aircraft to undergo the replacement, which was performed by a subsidiary of the airplane manufacturer.

The U.K. Air Accidents Investigation Branch (AAIB) said, in its report on the incident, "Inspection showed that the aileron-trim cables had been wrongly routed around a pair of coaxial pulleys at the wing root and that their connections to the chain, which operates the trim-screw jack at the aileron, had been reversed."

The Jetstream 41 has a trim tab on the left aileron, and the aileron-trim system is a manual, cable-operated system. The two cables terminate in couplings that have different shank lengths and chain-end blocks of different sizes so that the coupling with the longer shank should not be able to fit into the shorter end block.

The wing-splice replacement was managed by a project leader. He was an aircraft maintenance engineer who was licensed by the U.K. Civil Aviation Authority and who had company sign-off authority. He supervised maintenance personnel who were working in three groups.

"Two of the groups worked three consecutive 13 1/2-hour day shifts (including Sunday …) and the third group worked on permanent night shift," the report said.

The project leader was present for most of the work performed during the day shifts and was available any time by telephone. In addition to managing the project, the project leader performed some tasks himself and also inspected and signed off much of the work.

The project leader had requested the full-time assistance of a second licensed maintenance engineer, who worked under contract to the company and who also had company sign-off authority. Despite the project leader's request, the contract maintenance engineer worked primarily on another aircraft and only occasionally on the Jetstream. (After the wing-splice replacement was completed, however, he worked more frequently on the Jetstream.) During the two weeks before the incident, the contract maintenance engineer worked about 60 hours a week.

Before the wing was removed from the Jetstream's fuselage, an experienced aircraft fitter working under subcontract with the maintenance company removed the aileron-trim cables from the trim-actuator chain, withdrew them from the wing-root pulleys, coiled them and tied them at the point of their exit from the pressure vessel.

"When the wing flying control cables had been de-tensioned, the fitter had blocked them at places within the fuselage to prevent them [from] becoming dislocated, had color-coded them and had labeled their coiled ends," the report said. "After the reattachment of the wing, when he returned to reinstall the trim cables, probably on [March 23], he did not find the labels. He then installed the cables in what he thought was their 'natural' routing from their exit from the pressure hull downwards to the pulleys at the wing root and then outboard along the wing's rear spar to the chain at the trim screw jack.

The trim cables emerge from the side of the fuselage one above the other and engage the coaxial pulleys one behind the other. He made the wrong selection in routing the cables around the pulleys. (He routed the upper cable around the forward pulley and vice versa.) He then routed the cables to the chain attachments so that they did not appear to cross in their passage along the wing rear spar. (Lower cable off the pulley to lower chain fitting; as the pulleys were angled to keep the cable entry and exit in place, the forward pulley appeared to be lower than the aft.) He was unaware that the cable [couplings] and chain-end fittings were sized to prevent mis-assembly and recalled having no difficulty in connecting the cables to the incorrect chain-end [blocks].”

After the aircraft fitter completed the cable installation, he tensioned the system. He inspected the tension again a day later, then fitted its securing devices.

An inspection after the incident revealed that the chain-end blocks conformed to the manufacturer’s drawings and that the longer cable-end coupling should not have fit into the shorter block. An inspection could not determine “whether there had been any non-conformity in the original dimensions of the longer [coupling], the swaging process or the design tolerances.”

After the incident, the aircraft manufacturer reviewed the design and manufacturing of the cable-end coupling and issued service bulletin (SB) J41-27-060 to address the problem.

The initial inspection and duplicate inspection of the aileron cables, aileron-trim cables and engine-control cables were conducted March 24, 2000, the same day that the aircraft fitter completed his work. That also was the day that the contract maintenance engineer was “occupied with the release to service of the [other aircraft he had been working on], for which the operator’s air crew had arrived and were waiting,” the report said.

The inspections of the aileron work on the Jetstream “comprised a visual examination of the system’s general condition, correct assembly, security and locking, plus a re-check of cable tension,” the report said. “Neither of the engineers saw anything anomalous in the trim-cable routing, and it did not occur to the project leader that the trim cables could be incorrectly connected. In examining the cable [coupling] engagement in the chain fittings, he merely checked that the roll pins, which lock the [couplings] in place, were installed.”

Three days later, the contract maintenance engineer “functionally tested and adjusted the engine controls, and this occupied him for most of the morning," the report said. "The project [leader] had been working during the weekend and, in the mid-afternoon of Monday [March 27], learned that his wife had been involved in a car accident. As she had only been slightly injured, he elected to complete the tasks that he had outstanding before going home. He carried out the functional checks on the aileron, aileron trim and engine controls on his own, using a clinometer to check for flying surface range of movement."

To accomplish this, he set the control position in the cockpit, then walked around the airplane to the appropriate position to observe the control surfaces.

"In performing the check on the aileron-trim-tab range of movement, he did not recognize that its direction of movement was incorrect," the report said.

Both men then completed paperwork to certify that some of the tasks, including reconnection of the aileron trim, had been performed.

"The contract [maintenance] engineer learned from the project leader that he had carried out functional checks on the aileron and aileron-trim systems," the report said. "The contract [maintenance] engineer accepted that without further inspection at the time, signing for the duplicate inspection … and intending to carry out duplicate functional checks later, but, in progressing the aircraft's certification and preparation for flight, he overlooked the requirement."

The work was performed in accordance with SB J41-57-021, an 88-page document that the company's maintenance planning department had transcribed onto 16 work cards that outlined the wing-splice replacement as a series of separate tasks. The maintenance personnel also had an electronically transmitted copy of the service bulletin. Both the service bulletin and the work cards referred to the aircraft maintenance manual (AMM) and referred to section 27-15-00 of the AMM as the relevant section of the AMM for aileron trim.

"It was found, during the post-incident investigation, that this section did not contain instructions for the installation of the aileron trim cables," the report said. "It did contain a diagram, labeled 'schematic,' which showed the cable routings, which were not to scale but were referenced to station numbers. … The diagram had not been included in the service bulletin."

After the incident, the "shortcomings" in the AMM were addressed, the report said, and a revision was issued.

When the aircraft manufacturer's flight safety department examined the service bulletin and the work cards that the maintenance personnel had been given to implement the wing splice replacement, the report said, "a number of discrepancies in relation to the company's published procedures [were found], in … both the service bulletin and the pack of work cards and other documentation that had been raised to support this work."

When the wing-splice replacement was performed on the first airplane, the tasks to be performed were outlined on 50 work cards; after that procedure, the cards were modified and their number was reduced to 16.

"More work was covered by each card, and separate work items often contained multiple tasks … with provision for only one signature for operative or duplicate/functional checking," the report said. "This was contrary to the relevant company procedure."

The contract maintenance engineer used a nonroutine work card to list an additional duplicate functional inspection before the post-maintenance test flight that was not specified in the service bulletin but was required by U.K. Civil Aviation Regulations. The method of inspection — in accordance with the airplane operator's daily inspection to check flight controls for full, free and correct movement — was not approved by the maintenance company's maintenance planning department, as was required.

After the incident, the aircraft operator examined the first airplane to undergo the wing-splice replacement. The examination revealed that the aileron-trim cables had been routed incorrectly around the wing-root pulleys; nevertheless, because the cables had been attached correctly to the actuator chain, the aileron trim system functioned properly.

The report said that the aircraft operator identified three additional assembly defects in the wing-splice replacement on the first airplane:

- "An electrical harness was incorrectly routed (there being no reference in the AMM);
- "An aileron-trim-pulley guard had a mismatched nut and bolt, which were noted to be 'finger tight' [rather than tightened to the proper torque value]; [and,]
- "A fire-extinguisher pipe, which would have been disconnected during [the work] was found to be only loosely reconnected."

The report said that the documentation regulating the work on the Jetstream included "a number of discrepancies related to the disconnection and reconnection of the aileron-trim cables.

"This material was at times incomplete, illogically presented and deficient in supporting information," the report said. "The engineers and fitters appear, however, to have used their own knowledge of what was needed, using the work cards as a guide, and do not appear to have sought out any supporting information in the references. Some of the discrepancies, therefore, became irrelevant to the outcome. However, the system available to them for certifying their work, though it could have been interpreted in a way which would have met the requirements for certification, proved to generate some confusion and did not impose on them the discipline of accounting for and certifying the individual and distinct tasks."

The report also said, "The project leader was working long hours; [had] combined management, operative and inspection duties; and had been continuously on call. His supporting contract [maintenance] engineer, although working normal, non-shift hours, was regularly working overtime hours beyond his shift and on Saturdays. His duties were also split between projects with responsibility for release-to-service on [another] aircraft."

The report identified a series of events that led to the cross-connection of the aileron-trim controls and to the release of the airplane for flight:

- "The fitter who installed the aileron-trim cables did not refer to instructions. (No written instructions existed, but a schematic drawing was available in the referenced AMM);
- "The fitter assessed cable routing, wrongly, by appearance;
- "The built-in mechanical protection against mis-assembly was ineffective;
- "In carrying out their duplicate inspections of this work, the project leader and contract [maintenance] engineer did not consider the possibility that the cables could be misconnected;
- "The project leader decided to finish tasks in hand, including the functional check of the aileron trim, after he had heard that his wife had been slightly injured in a car accident;
- "The project leader carried out the controls functional check alone;
- "The project leader did not identify that the aileron trim moved in the wrong direction;
- "The contract [maintenance] engineer did not carry out a duplicate functional inspection of the aileron controls;
- "Contrary to company procedures, the worksheets included multiple tasks under one set of signatures, which obscured

accountability and made certification less specific;

- "The project leader misinterpreted the requirements for inspection and functional checking of the flying controls as presented on the work cards and misunderstood the certification entry made by the contract [maintenance] engineer for inspection of the system;
- "The nonroutine work card calling for a daily inspection … to be carried out before the post-maintenance test flight had not been approved by maintenance planning; [and,]
- "The [post-maintenance] daily inspection, which required a check of all flying controls for correct … [movement], was carried out by the same personnel who had already inspected the flying controls and who did not, again, detect the mis-rigging of the aileron trim control."

After the aircraft manufacturer's flight safety department investigated the incident, the design and manufacture of the aileron-trim chain-end blocks and the coupling attachments were reviewed, and "shortcomings of the maintenance documentation" were addressed, the report said. Therefore, AAIB issued no safety recommendations.♦

[Editorial note: This article, except where specifically noted, is based on U.K. Air Accidents Investigation Branch report EW/C2000/03/08.]

Further Reading From FSF Publications

Crotty, Bart J. "Improperly Installed Trim Actuators Blamed for Takeoff Accident." *Aviation Mechanics Bulletin* Volume 48 (September–October 2000).

Crotty, Bart J. "Fatal Accident Shows Risk of Using Blind Rivets." *Aviation Mechanics Bulletin* Volume 48 (July–August 2000).

Crotty, Bart J. "Omission of Oil-plug Seals Leads to In-flight Engine Shutdowns." *Aviation Mechanics Bulletin* Volume 47 (July–August 1999).

FSF Editorial Staff. "Loose Connection on Battery Shunt Involved in Boeing 767 Emergency-landing Incident." *Aviation Mechanics Bulletin* Volume 47 (January–February 1999).

Crotty, Bart J. "F-117A Accident during Air Show Flyover Caused by Omission of Fasteners in Wing-support Structure." *Aviation Mechanics Bulletin* Volume 46 (September–October 1998).

FSF Editorial Staff "Fractured Fuse Pin in Engine Pylon Results in Dragged Engine During B-747's Landing Roll-out." *Accident Prevention* Volume 52 (March 1995).

Inspections Recommended for Turbine Disks in GE CF6-80C2 Engines

The U.S. National Transportation Safety Board (NTSB) has recommended inspections of specific General Electric (GE) CF6-80C2 engines, citing the uncontained failure of a high-pressure turbine (HPT) stage 1 disk in a Boeing 767 engine during a high-power maintenance ground run on Sept. 22, 2000.

NTSB recommended that the U.S. Federal Aviation Administration (FAA) require operators of the engines to review maintenance records for any HPT stage 1 disks with blade-slot bottoms that have been blend-repaired. Those engines should be removed from service for inspection within 1,675 cycles of the repair and at subsequent "appropriate" intervals, NTSB said.

NTSB also recommended that FAA:

- Issue a flight standards information bulletin to inform principal maintenance inspectors and engine overhaul facilities of the circumstances involved in the cracking that was detected in the HPT stage 1 disks of CF6-80C2 engines on the incident airplane and on two other aircraft. NTSB said that the bulletin should emphasize "the potentially catastrophic consequences of damage caused by not adhering to prescribed maintenance procedures when removing the thermal shield, or any other components, from GE CF6-80C2 HPT stage 1 disks";
- Require implementation of the eddy-current inspection procedure being developed by GE for HPT stage 1 disk blade-slot bottoms; and,
- Review the design of the CF6-80C2 HPT stage 1 disk. NTSB said that FAA should consider the results of the review and the results of the operators' inspections of blend-repaired disks in requiring "appropriate changes" in the design of the disk and/or in the continuing airworthiness program. FAA also should consider establishing hard-time inspection intervals for the disks or modifying either the blend-repair procedures and/or the circumstances under which the repairs are allowed.

The NTSB action was prompted by the Sept. 22, 2000, incident in which a US Airways B-767-2B(ER) experienced an uncontained failure of the HPT stage 1 disk in the no. 1 engine during a high-power maintenance ground run at Philadelphia International Airport in Philadelphia, Pennsylvania, U.S. Maintenance personnel had replaced a seal on the no. 1 engine's integral drive generator and were conducting high-power ground runs to check for oil leakage.

The maintenance technicians performed three run-ups and noted no anomalies.

"During the fourth excursion to high power, at around 93 percent N1 rpm (low pressure rotor speed), there was a loud explosion, followed by a fire under the left wing of the airplane," NTSB said. "The mechanics shut down the engines, discharged both fire bottles into the no. 1 engine nacelle and evacuated the airplane. Although both fire bottles were discharged, the fire continued until it was extinguished by airport fire department personnel. The no. 1 engine and the airplane sustained substantial damage. The three mechanics were not injured.

"This incident raises serious safety concerns because, if it had occurred during flight rather than on the ground during maintenance, the airplane might not have been able to maintain safe flight," NTSB said.

The ruptured HPT stage 1 disk was machined from an Inconel 718 nickel-alloy forging and had accumulated 7,547 cycles since new (CSN). Maintenance records said that, in December 1989, at 2,439 CSN, some of the disk's blade-slot-bottom aft corners were blend-repaired and that other blend repairs were performed in April 1994, at 5,873 CSN (1,675 cycles before the disk ruptured). In April 1994, a fluorescent penetrant inspection (FPI) revealed no defects. The disk was installed in the incident engine at 6,942 CSN.

"Examination of the recovered pieces of the disk … revealed that it had separated from a rim-to-bore radial fracture that intersected a blade-slot bottom," NTSB said. "[M]ost of the fracture was overstress stemming from a pre-existing intergranular fatigue region adjacent to the blade-slot bottom. Although the periphery of the fatigue region contained secondary damage, the presence of the randomly located areas of fatigue striations indicated that fatigue initiation was from the corner between the blade-slot bottom and the aft face of the disk. Metallurgical examination also showed that the material composition, grain size, microstructure and hardness conformed to material specifications. The examination did not reveal any evidence of melt-related inclusions or disk overheating at the fracture location. The aft face of the disk and the blade-slot-bottom surface contained dimpled features indicative of shot-peening."

GE had inspected two other CF6-80C2 HPT stage 1 disks with cracks emanating from blade-slot bottoms — from airplanes operated by Thai Airways International and Gulf Air. The cracks in the Thai Airways disk originated from areas of blending marks between the blade-slot bottom and the aft face of the disk. The crack in the Gulf Air disk originated from an area of surface damage in the same area; there was no evidence of a blend repair, but NTSB said that the damage "was significant enough to warrant a blend repair."

HPT stage 1 disks are inspected "on condition," not at regular intervals.

"Consequently, … there may be other CF6-80C2 engines with HPT stage 1 disks in which damage to blade-slot bottoms could exist, which, even if blend-repaired, could allow cracking to initiate and propagate to failure," NTSB said. "Although there is no clear method for identifying all disks that have sustained surface damage that might lead to cracking, the accomplishment of a blend repair would likely identify many, if not most, disks that have sustained such damage."

NTSB said that, although FPI detected the cracks in the HPT stage 1 disks in the Thai Airways airplane and the Gulf Air airplane, the process might not always detect such cracks. GE is developing an eddy-current inspection procedure, which NTSB said should be more effective than FPI in detecting damage on blade-slot bottoms.

Sealant Blamed for Flap Failure on BAE 146

A British Aerospace (now BAE SYSTEMS) 146 was on final approach to Brisbane, Australia, when the flight crew applied full flap, then observed "an aerodynamic vibration through the airframe which was associated with a tendency for the aircraft to roll to the right," said an incident report by the Australian Transport Safety Board (ATSB).

The crew controlled the roll, and the landing was uneventful. An examination of the airplane after the Dec. 30, 1998, incident revealed that "about 600 millimeters [23.4 inches] of the forward edge of the bonded and riveted upper-surface panel for the right wing flap had partially separated," the report said.

The failure occurred at midspan, and 38 rivets were damaged or missing. The outboard end of the separated section had a chordwise crack about 25 millimeters (0.96 inch) long. The report said that the rivets "had failed progressively over an extended period."

Maintenance documents showed that the flap had accumulated 25,642 cycles and 25,203 hours in service.

During a maintenance "C" check 11 days before the incident (at which time the manufacturer's maintenance system called for an external visual inspection), maintenance personnel had replaced 35 loose or cracked rivets on the outboard section of the flap.

A metallurgical examination after the incident revealed that the crack consisted of fatigue fractures emanating from opposite sides of a rivet hole.

"The crack grew under spanwise tension loads," the report said. "These loads developed progressively after a number of rivets had separated, allowing a part of the panel to lift when subjected to aerodynamic loads. The upward movement of the panel then translated into spanwise tension at the crack location."

The metallurgical examination also revealed that a sealant used on mating surfaces of the flap structure and an aluminum sheet panel had penetrated into some rivet holes and countersinks, and that the presence of the sealant between the joint mating faces had led to the failure of the riveted joint. The examination did not determine whether the sealant was introduced during manufacture or during a subsequent repair.

The Australian Civil Aviation Safety Authority (CASA), which investigated the flap failure in response to concerns raised by ATSB, said, "There were no special circumstances that led to the flap failure so soon after repair work in the area. The BAE Structural Task Group for Aging Aircraft [has] indicated that the flap is a weak area, with corrosion and exfoliation a problem."

The CASA report also said that the manufacturer's corrosion-prevention program would address the question of deficiencies in the maintenance system.

Ice-protection Shields Required for Some Bombardier Aircraft

Transport Canada has issued an airworthiness directive (AD) to require the operators of specific Bombardier aircraft to install protection shields in the wheel bay of the main landing gear to prevent water, ice or slush from accumulating during ground rolls.

The AD, CF-2000-30, which took effect Oct. 25, 2000, said that liquid that accumulates on the aileron quadrants or the control-cable pulleys in the wheel bay of the main landing gear can freeze during the climb to cruise altitude, causing stiffness in the aileron controls. In one reported incident, normal aileron control was restored after the pilots flew the airplane to a lower altitude, where the ice melted.

CF-2000-30 applies to aircraft models CL-600-1A11 (CL-600), CL-600-2A12 (CL-601) and CL-600-2B16

(CL-601-3A, CL-601-3R and CL-604) and says that operators should, within 120 days of the effective date, install the shields in accordance with Bombardier Service Bulletins 600-0684, 601-0507 or 604-32-007, issued in June 1998 and July 1998.

The U.S. Federal Aviation Administration (FAA) issued a similar AD, effective Dec. 19, 2000, for the same aircraft models registered in the United States. The AD says that operators should install the protective shields within 45 days of the AD's effective date.

Changes Recommended In Oxygen Bottle Regulator/Shutoff Valves

The U.S. National Transportation Safety Board (NTSB), citing an Oct. 25, 1999, accident involving a Learjet 35, has recommended modifications of the oxygen bottle regulator/shutoff valve assembly on Learjet 35/36 aircraft and similar models.

NTSB, in a letter to the U.S. Federal Aviation Administration (FAA), also recommended that FAA evaluate the feasibility of requiring automation of emergency pressurization systems in the airplanes.

The recommendations followed an accident in which a Learjet 35 lost cabin pressurization and flew for nearly five hours before fuel was exhausted and the aircraft descended to the ground, striking terrain. All six people in the airplane, including professional golfer Payne Stewart, were killed.

Air traffic control lost radio contact with the pilots shortly after the flight was cleared to Flight Level 390 (39,000 feet). U.S. military aircraft intercepted the accident airplane as it flew northwest, and the military pilots said that the forward windshields appeared to be covered with frost or condensation. The military pilots also said that they could not see inside the cabin but that they observed no other unusual condition. Information obtained from the cockpit voice recorder (CVR) indicated that the airplane had lost cabin pressurization. NTSB said that the CVR, which recorded the last 30 minutes of the flight, contained the sound of the cabin altitude aural warning, which is activated when the cabin altitude exceeds 10,000 feet, and no conversation between the flight crew.

"In addition, the flight crew's failure to respond to numerous radio calls from controllers and military airplanes and to control the airplane indicated that the cabin altitude climbed to levels at which consciousness could be maintained only with supplemental oxygen and that the flight crew failed to receive supplemental oxygen; the reason for this failure could not be determined," NTSB said.

NTSB said that there was insufficient evidence to determine the cause of the depressurization.

NTSB said that the probable cause of the accident was "incapacitation of the flight crewmembers as a result of their failure to receive supplemental oxygen following a loss of cabin pressurization for undetermined reasons."

NTSB said that the oxygen bottle regulator/shutoff valve, which controls the availability of oxygen to the crew, is in the nose section of the airplane and is inaccessible during flight.

A gauge in the cockpit indicates oxygen bottle supply pressure but does not provide information about the position of the oxygen bottle regulator/shutoff valve.

"Therefore, the flight crew's only indication in the cockpit that the oxygen bottle regulator/shutoff valve is in the OFF position is the failure of the oxygen mask to deliver oxygen," NTSB said. "[I]t is critical that the valve position indicators are clearly visible and easily understandable during preflight inspections."

An examination of the accident airplane's oxygen bottle regulator/shutoff valve showed that it was in the "on" position and that the position of the valve, therefore, was not a factor in the accident. Nevertheless, the accident investigation revealed that flight crews "may have difficulty visually verifying the position of this valve during a preflight inspection" because of the manner in which the valve is installed in the airplane.

"The ON/OFF markings on the regulator cap indicate the position of the valve when aligned with a fixed index mark at the base of the valve," NTSB said. "The cap is also marked with arrows (next to the ON/OFF markings) that indicate the direction of rotation required to operate the valve. However, because of the installation of the valve in the airplane, the fixed index marks at the base of the valve are not visible from a normal viewing position; a pilot visually checking the valve status would see an [OFF marking with an arrow pointing to the left] on the regulator cap when the valve is in or near the on position."

NTSB said that the location of the oxygen bottle regulator/shutoff valve and the orientation of its markings create a "potential for misinterpretation" that could result in the oxygen supply being unavailable during flight.

"Because some [Learjet 35/36] pilots are accustomed to associating an OFF indication with an ON position, simply relabeling the valve assembly may create further confusion," NTSB said. "Therefore, … FAA should issue an AD [airworthiness directive] requiring [the manufacturer] to instruct operators of the Learjet Model 35/36 (and other affected models) to modify the oxygen bottle regulator/shutoff valve assembly so that flight crews can clearly and accurately verify the position of the valve during preflight visual inspections."

The investigation revealed that the accident airplane's flow-control valve was closed, preventing normal pressurization of the cabin. The airplane was equipped with an emergency pressurization system, but the system was not automatic, and the pilot was required to activate it.

Later models of the Learjet 35/36 are equipped with automatic emergency pressurization systems, which operate with aneroid (pressure) switches that activate the system when they sense increasing cabin altitudes.

NTSB said that retrofitting earlier-model Learjets with similar automatic emergency pressurization systems might be "economically impractical because of the extensive changes that would be necessary." Nevertheless, NTSB said that requiring automation of the existing emergency pressurization systems on the aircraft "would not likely be economically prohibitive."

"Therefore, … FAA should evaluate the feasibility of requiring design changes to automate the existing emergency pressurization systems on Learjet Model 35/36 airplanes (and other affected models) that do not have an automatic emergency pressurization system," NTSB said. "If the automation of their existing systems is determined to be feasible, the FAA should require such design changes. … [Furthermore,] FAA should evaluate all transport category aircraft that do not have automatic emergency pressurization systems to determine if automation of their existing systems is feasible and, if warranted, require changes to affected models as soon as possible."

NTSB also recommended that:

- FAA increase the frequency of unannounced inspection of commuter operators and on-demand charter operators (those operating under U.S. Federal Aviation Regulations Part 135) "to verify the accuracy and adequacy of pilot discrepancy and maintenance logbook record-keeping procedures and entries." (NTSB said that the operator of the accident airplane had not maintained records of pilot discrepancy reports and had operated the accident airplane on revenue flights with deferred maintenance on the pressurization system, although that item had not been authorized under an approved minimum equipment list.); and,

- FAA ensure that its review of aging transport aircraft systems and structures will include all transport category airplanes, regardless of their type of operation. (NTSB said that there was no evidence that aging aircraft systems or structures contributed to the depressurization that led to the accident. Nevertheless, NTSB said, the accident airplane was 23 years old, "and it is possible that its aging structure and/or systems could have been a factor.")

Misunderstanding Cited In Installation of Exhaust Valve Rocker Arm

The pilot of a Pezetel M-18 Dromader, a single-engine airplane used primarily in agricultural operations and fire fighting, conducted an emergency landing after the airplane lost power.

A report filed with Transport Canada said that a subsequent maintenance examination of the airplane showed that the exhaust valve pushrod for the no. 9 cylinder was in two pieces.

The engine had undergone a top overhaul 20 flight hours before the incident, and during the overhaul, the rocker arm on the no. 9 cylinder exhaust valve was replaced with another rocker arm that had been used previously on an intake valve. The maintenance technician who performed the work said that he had misinterpreted a section of the maintenance manual and had believed that exhaust valve rocker arms and intake valve rocker arms were interchangeable. In fact, the valve rocker arms were similar in appearance but had angular differences; they could not be interchanged.

Broken Nut Blamed For Landing-gear Actuator Failure

Several minutes after he retracted the landing gear, the pilot of a Beech King Air 200 heard a bang and observed that the green and red indicator lights for the left-main landing gear were illuminated. The pilot extended the landing gear and landed the airplane safely.

A report filed with the U.S. Federal Aviation Administration (FAA) said that a maintenance technician inspected the landing gear system and discovered that a nut (part no. 115-810029-1) that was used on the left-main landing-gear actuator (part no. 99-810057-152) had failed, rendering the landing-gear actuator inoperative.

The report filed with FAA recommended that the assembly be inspected frequently in accordance with the manufacturer's inspection criteria.

Main-rotor Blade Defect Found on Bell 222U

The pilot of a Bell 222U felt an in-flight vibration that appeared to come from the main-rotor system. When the vibration became more severe, the pilot conducted a precautionary landing.

A report filed with the U.S. Federal Aviation Administration said that a subsequent maintenance inspection showed that the lower pendulum support (part no. 222-011-114-103) was broken and that the pendulum was missing from one of the main-rotor blades. The report said that the maintenance technician also observed a nick in the trailing edge of the rotor blade. The maintenance technician then removed the rest of the pendulum assembly and observed evidence of a previous crack. He asked the manufacturer for an engineering evaluation.

The manufacturer said that further examination of the pendulum support showed that improper surface finish and excessive machining marks had led to the failure of the support.

The manufacturer's engineering report said, "Investigation also revealed that one other new part in stock exhibited the same discrepancies as the failed part. The surface finish on the edge break did not meet the engineering drawing requirements. Consequently, Bell Helicopters is proceeding with an action plan to remove from service all the supports manufactured by that specific vendor."

Gulfstream II Wing Flap Defect Found

A maintenance technician installing a right-outboard wing-flap actuator (part no. 1159SCC212-8) on a Gulfstream G-II found that the stop on the end of the jackscrew was loose. He also found that the pin was broken that holds the "extend" stop on the end of the jackscrew.

A report filed with the U.S. Federal Aviation Administration (FAA) said, "Approximately 0.1875 inch [4.8 millimeters] of the pin remained on one side of the stop attaching it to the jackscrew. It appeared the pin suffered from the effects of corrosion, which may have contributed to its failure."

The report suggested that maintenance personnel inspect the assembly on similar aircraft as soon as possible.

Cracks Found During Overhaul of Skycrane Main-rotor Gearbox

A maintenance technician observed five cracks in the main-rotor gearbox (part no. 6435-20400-063) of a Sikorsky S-64E Skycrane helicopter as he disassembled the gearbox for overhaul.

A report filed with the U.S. Federal Aviation Administration (FAA) said that the cracks "radiated from five of the nine lightening holes in the lower plate of the second-stage planetary plate assembly (part no. 6435-20231-014)."

The maintenance technician then conducted a magnetic-particle inspection and found three additional cracks. The longest crack, which extended into the center hub, was about 3.5 inches (8.9 centimeters) long. The report filed with FAA said that seven of the cracks originated on the inboard side of the lightening holes and extended toward the center hub radius at an angle of 45 degrees.♦

NEWS & TIPS

U.S. Agencies Announce Joint Conference on Aging Aircraft

The fifth Conference on Aging Aircraft, sponsored by the U.S. National Aeronautics and Space Administration, the U.S. Federal Aviation Administration and the U.S. Department of Defense, will be held Sept. 10–13, 2001, in Kissimmee, Florida, U.S.

The conference will disseminate information about maintaining the integrity of aerospace systems to individuals involved with aircraft design and manufacturing, fleet operation, aircraft research and development and aircraft maintenance. Presentations will address industry practices, operator practices, the status of ongoing research and emerging technologies.

For more information: Elaine Odell, Planners Collaborative, 9 Blueberry Court, Rockland, MA 02370 U.S. Telephone: +1 (781) 982-2819.

Inverter Accepts Any Type of Electric Current

The Maxstar 200, a direct current, tungsten inert gas (TIG)/stick inverter-based welding power supply designed for aerospace applications, can be powered by any type of primary electric alternating current, said the manufacturer, Miller Electric Manufacturing Co.

The 37-pound (16.8-kilogram) Maxstar 200 is portable, has an output of 200 amps; produces code-quality TIG and stick arcs; and accepts input power from 115 volts to 460 volts, single-phase or three-phase, and 50 hertz or 60 hertz without manual relinking. The device is available in three versions with a variety of options.

Inverter-based Power Supply

For more information: Miller Electric Manufacturing Co., P.O. Box 100, Lithonia, GA 30058 U.S. Telephone: (800) 426-4553 (U.S.) or +1 (920) 735-4554.

Cable Reel Designed for Hazardous Areas

The Hannay HGR Series spring rewind cable reel is designed for hazardous applications, including aircraft refueling, in which static electricity could produce a spark and an explosion, said the manufacturer, Hannay Reels.

HGR Series reels are available with four cable lengths, ranging from 20 feet to 100 feet (six meters to 31 meters) of static-grounding cable and a spring rewind for smoother operation.

For more information: Hannay Reels, 553 State Route 143, Westerlo, NY

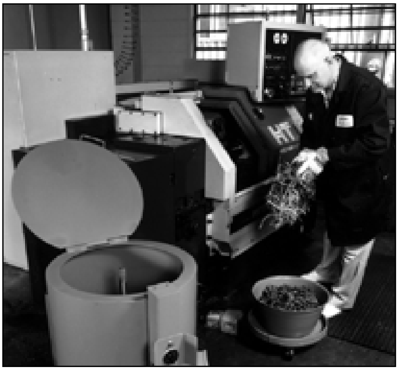
Spring Rewind Cable Reel

12193-0159 U.S. Telephone: (877) 467-3357 (U.S.) or +1 (518) 797-3791.

Compact Chip Wringer Designed for Easy Operation

The Bear 5-Gallon Chip Wringer has a capacity of five gallons (19 liters), recovers as much as 98 percent of cutting fluids and produces clean, dry scrap, said the manufacturer, Bear Equipment Co.

The chip wringer, useful in machine shops for recovering metal scraps, has a balanced chip pan that can be handled by one person and an electrical interlocking cover latch. The device has an average cycle of 10 minutes and operates at speeds up to 1,200 revolutions per minute to clean chips, turnings and small parts.



5-Gallon Chip Wringer

For more information: Vincent Gambardella, Bear Equipment Co., P.O. Box 272, Warwick, RI 02887 U.S. Telephone: +1 (401) 732-5832.

Electric Torque Wrench Pumps Designed for Higher Work Speed

A line of electric torque wrench pumps has been designed for higher working speeds, accurate bolting and precise repeatability, said the manufacturer, Enerpac.

Enerpac's PTE torque wrench pumps have a reservoir capacity of 3.8 liters (four quarts), and a 1.1-kilowatt (1.5-horsepower) motor. The torque wrench pumps also have two-stage pumps for faster torque cycles, a submerged motor for less noise and less heat build-up and a remote pendant with safety button for one-person operations.

For more information: Enerpac, 6100 N. Baker Road, Milwaukee, WI 53209 U.S. Telephone: (800) 433-2766 (U.S.) or +1 (262) 781-6600.

Electric Torque Wrench

Magnetic Retriever Extends Around Obstructions

The MAG-ATTACH is a flexible magnetic retriever that can be extended around obstructions to pick up metal objects that weigh as much as 10 ounces (283 grams), said the manufacturer, E.C. Mitchell Co.

The device is 17 inches (43 centimeters) long, made of heavy-gauge wire and coated with an elastomer (rubber-like substance). There is a magnet at one end and a handle at the other.

For more information: Michael D. Kelly, E.C. Mitchell Co., P.O. Box 607, Middleton, MA 01949-0907 U.S. Telephone: +1 (978) 774-1191.

Protective Eyewear Combines Function, Styling

Willson Millennia Crystals protective eyewear combines lightweight comfort and quality optics with fashionable styling for greater acceptance by the wearer, said the manufacturer, Dalloz Safety.

Protective Eyewear

The eyewear has a 180-degree clear field of vision and a nonslip design to eliminate the need for mechanical adjustments. The frames are available in five colors.

For more information: Elizabeth A. Antry, Dalloz Safety Director of Marketing Communications, P.O. Box 622, Reading, PA 19603-0622 U.S. Telephone: (800) 345-4112 (U.S.) or +1 (610) 376-6161.

Blast Nozzle Speeds Coating Removal

The FBN-6C wide-path cabinet-size blast nozzle provides a wide, uniform blast pattern to allow blast-cabinet operators to double their production rates, said the manufacturer, Pauli Systems.

The nozzle works on metals and composite materials to remove coatings such as epoxy primer and polyurethene top coats. The nozzle has a coating-removal path 1.3 inches (3.3 centimeters) wide, is six inches (15 centimeters) long and weighs 0.8 pound (0.36 kilogram).

For more information: Pauli Systems, 1820 Walters Court, Fairfield, CA 94533 U.S. Telephone: +1 (707) 429-2434.♦