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Aviation Mechanics Bulletin

MARCH–APRIL 2005

Overheated Heater Ribbon, Contaminated Insulation Cited in B-767 Cargo Fire

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Aviation Mechanics Bulletin

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Robert A. Feeler, editorial coordinator

March–April 2005 **Vol. 53 No. 2**

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Overheated Heater Ribbon, Contaminated Insulation Cited in B-767 Cargo Fire

A report by the Transportation Safety Board of Canada said that water-line repairs during the two months before the fire probably were 'the catalyst that initiated the … heater-ribbon failure.'

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FSF Editorial Staff

At 1732 local time May 13, 2002, while on final approach to Lester B. Pearson International Airport in Toronto, Ontario, Canada, the crew of an Air Canada Boeing 767-300 received an aft-cargo-bay fire warning. They complied with emergency checklist procedures, activated the cargo-bay fire extinguishers and declared an emergency.

About 50 seconds after activation of the fire extinguishers, the fire-warning light extinguished. The airplane was landed normally and, after being stopped on the runway for an examination by airport firefighters, was taxied to the gate, where passengers deplaned normally. The airplane received minor damage, and none of the 185 people in the airplane was injured.

The Transportation Safety Board (TSB) of Canada said, in its final report, that causes and contributing factors were the following:

- "The B110 heater ribbon attached to the water-supply line failed at the site of a recent water-line repair, which allowed the elements of the heater ribbon to electrically arc, providing a source of ignition to surrounding materials. [A heater ribbon is a heating element enclosed within a covering of rubber, vinyl or silicone rubber that insulates the heating element, prevents arcing and prevents damage caused by abrasion. Heater ribbons are positioned outside water lines to prevent the water inside the lines from freezing.];

- "The polyethylene terephthalate (PET) covering material of the thermal acoustic insulation was contaminated. [The contaminated material included "soiled insulation blankets and … flammable debris in the form of paper, candy wrappers, Styrofoam packing peanuts, small polyethylene beads and rubber powder from a PDU (power drive unit)," the report said.] The contaminated material provided an ignitable source of fuel for a self-sustaining fire;

- "The open cargo floor provided a trap that collected contaminants and debris in the bilge area of the cargo compartment; the debris and contaminants were an ignitable source of fuel to sustain a fire; [and,]

- "Circuit-protection devices are designed to protect aircraft wiring and not aircraft components. The lack of circuit protection of the heater-ribbon system permitted the heater-ribbon failure to result in an arcing event."

Warning Occurred Near Destination

The occurrence flight, which began at Vancouver (British Columbia, Canada) International Airport, was uneventful until the airplane was about 10 nautical miles (19 kilometers) from the airport in Toronto and the "MASTER WARNING FIRE/OVERHEAT" light illuminated, the fire warning bell sounded and the "AFT CARGO FIRE" light illuminated.

Firefighters' initial post-landing inspection of the cargo bay — conducted after their external examination of the aircraft on the runway and after the crew had taxied the airplane to a position about 40 feet (12 meters) from the gate — revealed smoke and fumes, but no flames, in the aft cargo compartment.

"The firefighters entered the compartment with a hand-held FLIR [forward-looking infrared] camera and located a single heat source behind the aft wall of the cargo compartment," the report said. "Maintenance personnel removed the aft wall, and the heat source was identified as a recirculating fan. … Several hours later, after the aircraft had been towed to a hangar, the maintenance crew discovered that there had been a fire in the bilge area of the cargo compartment under the last two baggage containers. They also determined that the recirculating fan had been operating and was serviceable.

"The following morning … a preliminary examination showed that the B110 heater ribbon, made by Electrofilm Manufacturing Co., on the aft water supply/drain line had failed and [had] ignited the fire."

The fire occurred beneath the floor of the aft cargo compartment and burned a structural floor-beam web, thermal acoustic insulation on both sides of the floor beam, the underside of the floorboard, potable water lines, heater ribbons and electrical wires.

Airplane Imported Into Canada

The airplane was manufactured in 1991 and was operated for eight years by Trans Brazil Airways. In 2000, Air Canada leased the airplane and imported it, through the United States with a U.S. export certificate of airworthiness, into Canada.

The importation process included an inspection of the aircraft in the United States and an examination of maintenance records. The inspection resulted in a list of 1,959 deficiencies and required maintenance tasks.

"Hundreds of discrepancies were noted within the forward and aft cargo compartments, including items such as missing light covers, the wrong type of lamp in a light fixture and inoperable PDUs," the report said.

There were "very few" references to contaminated insulation blankets, the report said.

The aft cargo compartment of the passenger version of the B-767 is behind the wings and is divided into a main cargo section and a bulk cargo section, located at the aft end of the aft compartment. The bulk cargo section, which is separated by a cargo-restraining net from the main section, has a sloping aluminum floor; the bulk cargo section can be accessed through a door on the left side of the airplane. Beneath the floor are six power-driven roller tracks that are used to move cargo containers through the cargo compartments. The PDUs are operated by controls located behind a panel next to the cargo-compartment door on the right side of the airplane.

The cargo compartments in the occurrence airplane were class C compartments, defined by Canadian Aviation Regulations (CARs) 525.857(c) as compartments in which:

- "There is a separate approved smoke detector or fire detector system to give warning at the pilot [station] or flight engineer station;

- "There is an approved built-in fire-extinguishing [system] or [fire-]suppression system controllable from the cockpit;
- "There are means to exclude hazardous quantities of smoke, flames or extinguishing agent from any compartment occupied by the crew or passengers; and,
- "There are means to control ventilation and drafts within the compartment so that the extinguishing agent used can control any fire that may start within the compartment."

Smoke sensors are installed in the ceilings of the cargo compartments of the occurrence airplane to provide fire warnings to the flight crew; a Halon fire-extinguishing system also is installed and is activated remotely by the flight crew.

The report said, "When the aft-cargo extinguishing system is armed, the fire warning bell is silenced, the aft squib test function is disabled, and the aft and bulk cargo compartment heat valves close. [A squib is a small pyrotechnic device used to activate the fire-extinguishing system when selected by the crew.] As well, electrical power is removed from the galleys, the left and right recirculation fans and the aft lavatory … galley vent fan, but not from the waterline heating system. The system is designed such that, after activation, one extinguishing bottle is discharged immediately into the affected cargo area to provide a dousing shot of Halon to the fire. After a 30-minute delay, the remaining extinguishing agent is metered out to provide 195 minutes of continuous fire suppression. In the event the aircraft lands before the system has been depleted, all remaining Halon is discharged on touchdown."

Fireproof Panels Cover Walls, Ceiling

In compliance with CARs 525.855(b) and (c) and appendix F, which discuss fire-protection requirements for cargo compartments and baggage compartments, the walls and ceiling of the cargo compartment are lined with fireproof fiberglass panels sealed with fireproof tape, and the belly (bilge) is lined with thermal acoustic insulation to prevent a fire in the compartment from spreading outside the compartment. In addition, maintenance records indicated that in June 1993, Trans Brazil completed airworthiness directive (AD) 90-NM-1077-AD, which called for installation of a fire stop near the bottom of the sloping sidewall cargo compartment liner to prevent fire from spreading behind the cargo liner.

Hot air is directed into the cargo compartments through a two-inch-wide (five-centimeter-wide) tube. Heat loss is limited by thermal acoustic insulation in the compartment.

Many Heater Ribbons Used

Most transport category aircraft are equipped with heater ribbons to prevent water lines from freezing and rupturing. Twenty-six heating ribbons are used in a standard B-767, and the occurrence airplane was manufactured with that number. After Air Canada took delivery, the airplane was modified for extra freeze protection; after the modification, the airplane had a total of 51 heating ribbons, manufactured by Cox and Co. and Electrofilm.

The heater ribbons are held in place by flame-resistant vinyl tape (3M 474), and, in some instances, depending on the specific installation, the water line may be wrapped with an insulation blanket or with Rubatex, a closed-cell foam insulation tape.

In the occurrence airplane, the temperature of the B110 heater ribbon and a number of other heater ribbons was controlled by a remotely mounted external thermostat below the floor of the bulk cargo compartment. The thermostat activated the heater ribbons when the ambient air temperature decreased to 50 degrees Fahrenheit (F; 10 degrees Celsius [C]) and deactivated the heater ribbons when the ambient air temperature increased to 60 degrees F (16 degrees C). Rubatex was wrapped around portions of the water lines, and the report said that when a water line and its heater ribbons are wrapped with vinyl tape and Rubatex or other additional insulation, "the temperature of the heater ribbon can be significantly higher than the [temperature of the] water line and ambient air temperature."

In the occurrence airplane, the B110 heater ribbon was grouped with six other heater ribbons on the same circuit breaker. The circuit breaker did not open (trip) during the occurrence, but the report said that "not all fault situations will cause a [circuit breaker] to open"; instead, the circuit breaker is designed to open "when the temperature and time duration characteristics of the over-current condition exceed the design limits of the [circuit breaker]."

Water-line Leak Repaired

The water line — a Teflon tube with nylon outer braid — was repaired March 7, 2002, after a leak was found in the bilge area of the aft cargo compartment. The repair involved removing the damaged section of the water line, replacing it with a stainless steel tube and securing the tube with two hose clamps at each end. The B110 heater ribbon was unserviceable and was replaced.

Another leak, from the same section of the water line that had been repaired, was found April 18, 2002. The water line again was repaired. Maintenance records did not mention the B110 heater ribbon.

Both repairs were performed in accordance with Air Canada Production Permit (ACPP) 6-38-10/351-38-093. (Ten days before the second repair, the ACPP had been superseded by ACPP 6-38-10/351-38-0095; the difference between the two ACPPs was that the second required that the repaired water line be replaced with a new water line "no later than the next A07 check," the report said. "At the time of the occurrence, the A07 check was due in 243 flight hours.")

"When examined after the fire, the repaired water line was still in place," the report said. "There were three clamps securing each end of the hose to the stainless steel tube. The hose and the repair, including the six hose clamps, were covered with the 3M 474 tape. The failed B110 Electrofilm heater ribbon was installed longitudinally over the area of the repair, with 3M 474 tape securing the heater ribbon to the hose assembly. The entire assembly was then wrapped with Rubatex."

Investigation of the fire revealed that the heater ribbon, which had been installed longitudinally along the water line, over the repair, failed and arced at the forward edge of the repair at the point where the stainless steel tube began.

"This resulted in the heater ribbon burning through the protective tape and the Rubatex foam insulation," the report said. "Because electrical power was still being provided to the heater ribbon, the failure continued to move forward along the water line toward the source of the electrical power. Approximately eight inches [20 centimeters] forward of the failure, where the water line passes through the … floor beam web, the thermal acoustic insulation blanket mounted on the forward [face] and aft face of the vertical web of the floor beam ignited. At this point, the fire became self-propagating."

Among the contaminants on the insulation blanket was an isoparaffin solvent. These solvents are present in cleaning and degreasing substances, inks, paints and pesticides and may have originated in aircraft cargo, luggage, recent maintenance activity or pesticides such as those that might have been used in the tropical environment of South America.

"The isoparaffin contaminant would, if retained, create a significant heat release once ignited," the report said. "The relatively high-temperature, localized fire damage observed on the floor beam web of the occurrence aircraft is consistent with a post-fire effect from the isoparaffin solvent alone or in combination with combustible debris."

In addition to the fire on the occurrence flight, the investigation found that a similar, less serious, event had occurred previously on the same airplane. During the investigation, a burned Cox and Co. heater ribbon, protective tape and Rubatex foam insulation were found behind the aft wall of the aft cargo area. "Although a self-propagating fire had not occurred, the area had become hot enough to burn through the Rubatex foam insulation and a nearby plastic clamp," the report said.

About five months after the occurrence, on Oct. 20, 2002, during a seasonal check of the airplane's heater ribbons, maintenance personnel found that the B241 heater ribbon had overheated and its insulating jacket had been burned. That discovery came 10 years after The Boeing Co. issued service bulletin (SB) 767-30-0024, which called for replacement of the B241 heater ribbon on some B-767s, including the occurrence airplane.

The report said, "The existing spiral-wrapped heater ribbon rated at 24 watts per foot [per 0.3 meter] was continuously activated. Boeing recognized that if the heater ribbon was powered while no water was in the water fill line, overheating of the heater ribbon could occur, resulting in the heater ribbon, adjacent insulation blankets and any debris being scorched. The SB called for the replacement of the existing heater ribbon with a thermostatically controlled seven-watt per foot longitudinally installed heater ribbon."

Compliance with the SB was not mandatory.

During the investigation, another Air Canada B-767-300 was found to have a burned heater ribbon near the same location as the burned heater ribbon in the occurrence airplane and a second overheated heater ribbon behind a sidewall panel in the aft cargo compartment.

Air Canada's inspection of its fleet of 55 B-767-200 and B-767-300 airplanes revealed "numerous occurrences of overheated and/or burned heater ribbons … in both visually accessible areas and hidden areas, such as behind wall [panels] and floor panels," the report said. "Thirty of the aircraft were found to have defective heater ribbons (including both Cox and Co. and Electrofilm brands), resulting in 66 ribbons being either removed or deactivated."

On Dec. 20, 2002, a heater ribbon was destroyed by overheating on another Air Canada B-767 while the airplane was being prepared for departure.

The investigation revealed that between June 1985 and June 2002, operators filed 67 reports of heater-ribbon failures involving thermal degradation, including charred insulation material. In two incidents, the fires resulted in structural damage.

Authorities Have Warned Against Insulation-blanket Contamination

The report said that the aviation industry has not quantified the effects of contamination on the continuing airworthiness of insulation blankets. Nevertheless, the anti-flammability characteristics of various materials used in insulation blankets can deteriorate through exposure to dust, lint, adhesives, grease, oil, corrosion inhibitors and other contaminants; and several aircraft fires have been fueled by contaminated insulation blankets.

Several times since the early 1990s, aviation authorities have issued advisories and safety recommendations to address the problem. In 1992, after a fire the previous year in a Lockheed L-1011 and after a TSB safety advisory, Transport Canada issued service difficulty advisory AV-92-04, which recommended that "whenever planned inspections allow, an inspection [should] be carried out for accumulation of lint, dust and cabin debris, and … visible accumulations [should] be cleaned out to remove the fire hazards."

About the same time, the U.S. Federal Aviation Administration (FAA), in response to a recommendation by the U.S. National Transportation Safety Board, issued an airworthiness inspector's handbook bulletin, *Origin and Propagation of Inaccessible Aircraft Fire Under In-flight Airflow Conditions*, which discusses safety hazards presented to transport category aircraft by lint and other debris that accumulates on wiring.

In March 1998, after a fire in a cargo compartment of a B-747-200, Boeing issued service letters 767-SL-25-084 and 747-SL-25-170, advising operators to "remove foreign materials and to increase attention to periodic inspections and cleaning of the aircraft during maintenance to avoid [insulation] blanket contamination."

FAA issued material in 2000 and 2001 discussing requirements for principal maintenance inspectors (PMIs) to "ensure that the operator has established procedures in their approved maintenance program for the inspection of contamination on thermal/acoustic insulation during heavy maintenance checks. If the operator discovers contamination of the insulation, the operator should take corrective action, cleaning or replacing the insulation as appropriate."

In addition, the FAA International Aircraft Materials Fire Test Working Group has formed a task force to review the contamination issue.

The report said that during the investigation, TSB found "significant contamination of the insulation blankets throughout the cargo compartments [of the occurrence airplane], including the areas behind the sidewalls and in the belly of the aircraft. This contamination consisted of soiled insulation blankets and large accumulations of lint, dust and other flammable debris. In the forward cargo compartment, numerous insulation blankets were incorrectly installed, were ripped and torn, or [were] not installed at all. Furthermore, there were unapproved blanket assemblies in the forward cargo compartment."

The inspection of the occurrence airplane and other B-767s revealed contaminated insulation blankets and debris in many cargo compartments with open floors. After the occurrence, Air Canada examined open-floor cargo compartments in all of the airline's B-767 airplanes and removed all debris. Nevertheless, the report said that the cleanup "did not fully address contaminated blankets."

Multiple Factors Contributed to Overheating

The report said that the flight ended safely because the problem occurred about six minutes before the end of the five-hour-and-21-minute flight and the fire-detection and fire-extinguishing system functioned properly to extinguish the fire, which had begun to spread outside the cargo compartment.

"Had the fire-extinguishing system not extinguished the fire quickly, the results could have been catastrophic," the report said.

The report said that the repairs to the water line were "most likely the catalyst that initiated the B110 heater ribbon failure." The repairs were conducted according to a plan approved by Air Canada's engineering department; the plan was not authorized by Boeing, and Boeing's authorization was not required.

The report said that the overheating of the heater ribbon likely resulted from the dissimilar "heat sinks" created by the temporary repair of the water line and was exacerbated by multiple layers of tape and foam insulation.

"The repair to the water line resulted in an uneven heat distribution and localized heating," the report said. "The localized heating, compounded by the layers of 3M 474 tape and Rubatex foam insulation, raised the temperature above the design specifications of the heater ribbon, thereby allowing thermal degradation of the heater ribbon's insulating matrix and surrounding material. Degradation of the insulating matrix allowed the heating elements to migrate towards each other and eventually arc."

Because the failure of the heater ribbon did not result in an over-current condition, the circuit breaker did not trip; there was no method of deactivating the heater ribbons from the flight deck.

"As long as power is available to the heater ribbon, the potential for the heater ribbon to arc exists and presents an ongoing risk," the report said.

Heater ribbons "have a propensity to fail," and the failures often are undetected for long periods of time, the report said. Overheating is the most common type of failure and often leads to destruction of the heater ribbon and localized damage.

The report called heater-ribbon-installation procedures published in maintenance manuals "generic and often ambiguous" and said that they resulted in confusion and difficulty in properly accomplishing an installation.

"The exact installation of each and every heater ribbon is critical, as an improper installation can result in an overheat condition that can lead to a fire," the report said. "There should be no ambiguity in the installation instructions.

"There also appears to be a general sense of complacency in the aviation industry with regard to heater-ribbon failures. Personnel working in the industry have known for years that heater ribbons fail regularly. They are considered by most to be non-critical systems, the failure of which usually results in very little damage. It is not until a serious occurrence that the potential danger posed by a faulty heater ribbon is fully realized."

The report said that the "most significant deficiency" in the series of events leading to the fire was the presence of flammable material on the insulation blankets.

"Research clearly indicates that contamination in aircraft is an ongoing problem," the report said. "Open cargo floors in aircraft provide a gathering area for flammable debris to collect, but they also permit easy access for the cleanup of debris. Even though the debris can be easily cleaned, fluids of unknown flammability can leak from baggage and cargo and go undetected. Additionally, fluids used for cleaning and lubricating cargo compartment components during routine maintenance can also spill and go undetected. Of more concern are the areas that are not readily accessible. It is in these areas that heavy accumulations of dust, lint and small flammable materials such as paper collect on insulation blankets, aircraft wiring and electrical components. As well, fluids spilled from the passenger cabin, lavatories and galleys can leak into these areas, [which] are not easily accessible, have no protection from fire and are usually only accessed every few years during heavy maintenance."

The report's findings as to risk were the following:

- "Unlike the cargo compartments, there are many areas that are solely dependent on human intervention for fire detection and [fire] suppression. However, there is no requirement that the design of the aircraft provide for ready access to these areas. The lack of such access could delay the detection of a fire and significantly inhibit fire fighting;
- "The consequence of contamination of an aircraft on its continuing airworthiness is not fully understood by the aviation industry. Various types of contamination may damage wire insulation, alter the flammability properties of materials or provide fuel to spread a fire. The aviation industry has yet to quantify the [influence] of contamination on the continuing airworthiness and safe operation of an aircraft;
- "There are no industry standards for detecting, accessing or cleaning contamination from thermal acoustic insulation;
- "The [influence] of age on thermal acoustic insulation is not fully understood by the aviation industry. Age may alter the flammability properties of the materials, providing fuel for a fire. The aviation industry has yet to quantify the [influence] of age on thermal acoustic insulation and the continuing airworthiness and safe operation of an aircraft;
- "Regulations do not require that aircraft be designed to allow for the immediate de-powering of all but the essential systems as part of an isolation process for the purpose of eliminating potential ignition sources;
- "Heat damage was found on other in-service heater ribbons. Although self-propagating fires did not occur in these instances, their design and installation near combustible materials constituted a fire risk;
- "There is no fire suppression beyond the cargo compartment, in the sidewall area of the aircraft, nor is [the sidewall area] accessible in flight. A sustained fire in this area could burn out of control, with catastrophic results; [and,]
- "Maintenance manual procedures for the installation of heater ribbons are generalized and ambiguous. The ambiguity in the installation procedures could lead to an improperly installed heater ribbon and possible component failure."

After the fire, Air Canada inspected specified areas of its B-767 airplanes to locate and remove (or deactivate) defective heater ribbons and to remove debris from the areas. Air Canada also amended its Boeing 767 service check (96-hour) maximum interval to require removal of debris found below floor level in the forward cargo compartment and the aft cargo compartment and included in the zonal general visual inspection a requirement that heater ribbons be inspected during scheduled 24-month "M" checks.

Boeing, on May 28, 2002, issued alert service bulletin (ASB) 767-30A0037 (applicable to B-767-200, B-767-300 and B-767-300F airplanes without fully enclosed cargo floors in the lower cargo areas), calling on operators to take several actions to avoid fires in the forward cargo area and aft cargo area: Remove debris on or near the potable water line and drain line, inspect heater ribbons on the potable water line and drain line for damage caused by excessive heat, inspect heater ribbons on the potable water line and drain line for damaged or missing protective tape and, if necessary, replace heater ribbons and add protective tape. On June 2, 2002, FAA issued AD 2002-11-11, to require compliance with ASB 767-30A0037. (On Feb. 6, 2003, FAA said that a notice of proposed rule making was being prepared to require similar inspections on B-747 airplanes and that Boeing had been asked to issue SBs to address long-term risks to B-747 and B-767 airplanes without fully enclosed cargo floors.)

The report said that TSB was "concerned that the FAA action is limited to Boeing 747 and 767 aircraft because only these aircraft have open cargo floor areas. The FAA believes that heater ribbons do not need to be removed or replaced in closed-in areas, because such areas do not accumulate sufficient debris and contamination to pose a risk of a self-sustaining fire. The [TSB] does not share this view. … Despite all of the action taken to date by the various agencies, the problem of contamination in closed-in areas still exists. … Dust and lint accumulation on wires has led to self-sustaining fires in closed-in areas, and the potential for such fires still exists."

On Oct. 31, 2003, Boeing said that it had selected Adel Wiggins replacement heater ribbon designs "for improved durability and reliability for water supply, fill lines and, where needed, drain lines" on B-767-200, B-767-300 and B-767-300F airplanes without fully enclosed cargo floors. Boeing also said that heater ribbons could be eliminated from "gray water-drain lines" in pressurized fuselage sections in forward and aft cargo compartments.

On Nov. 14, 2002, TSB issued the following recommendations:

- That "the Department of Transport take action to reduce the short-term risk and eliminate the long-term risk of heater ribbon installation failures starting fires, and coordinate and encourage a similar response from other appropriate regulatory authorities."

In response, Transport Canada said that it was working with other civil aviation authorities — in particular, with FAA — and with Boeing to determine whether AD 2002-11-11 should be applied to other aircraft with similar heater ribbons and to determine long-term corrective actions; [and,]

- That "the Department of Transport take action to reduce the short-term risk and eliminate the long-term risk of contaminated insulation materials and debris propagating fires, and coordinate and encourage a similar response from other appropriate regulatory authorities."

In response, Transport Canada published Maintenance Staff Instruction 42, *Procedures for the Inspection of Thermal/Acoustic Insulation During Heavy Maintenance Checks for Contamination* to require primary maintenance inspectors to ensure that operators have established procedures for the inspection of thermal acoustic insulation during heavy maintenance. Transport Canada also said that it was working with other civil aviation authorities to develop harmonized standards on material flammability and contamination.♦

[FSF editorial note: This article, except where specifically noted, is based on Transportation Safety Board of Canada aviation investigation report no. A02O0123, *Cargo Bay Fire: Air Canada Boeing 767-300, C-GHML; Toronto/Lester B. Pearson International Airport, Ontario; 13 May 2002*. The 42-page report contains illustrations and appendixes.]

MAINTENANCE ALERTS

WOW-switch Anomaly Leads to Hard Landing

The landing gear of the Gulfstream V could not be retracted after takeoff from West Palm Beach (Florida, U.S.) International Airport. The flight crew performed the "Landing Gear Failure to Retract" checklist, with no resulting change in the gear-down indication. The crew decided to return to the departure airport.

While on final approach with the ground spoilers armed, the throttle levers were retarded to idle about 15 feet above ground level. The aircraft suddenly and abruptly descended onto the runway for a hard landing. "According to the FDR (flight data recorder), the ground spoilers deployed at 57.7 feet on the radar altimeter, with a vertical acceleration of 4.25 g [4.25 times standard gravitational acceleration] on impact," said the report by the U.S. National Transportation Safety Board. The aircraft's right main landing gear collapsed during landing. The two pilots, the airplane's only occupants in a positioning flight, were not injured in the Feb. 14, 2002, accident.

The accident aircraft had been serviced at a maintenance facility Feb. 11, 2002, to troubleshoot an apparently false overspeed warning from the crew-alerting system.

"The airplane was on jacks for a tire change when a [maintenance technician] needed access to the airplane's maintenance data acquisition unit (MDAU) to check out the problem that the airplane was having with the overspeed," said the report. "[Because] the airplane was on jacks, the [technician] had to disable the WOW [weight-on-wheels] switches in order to simulate that the WOW was in the ground mode, not the air mode, to gain access to the MDAU."

The technician used tongue depressors (flat wooden sticks) to disable the WOW switches, the report said.

"After the maintenance was completed, the sticks were not removed, and the inspector that returned the airplane to service was not aware that the WOW switches had been disabled for any reason … and no notation was mentioned in the work logs," said the report. A technician and an inspector signed off the work order on Feb. 13, 2002.

"According to Gulfstream, with the ground spoilers armed, the spoilers will come up automatically anytime the throttles are brought to idle and the airplane is on the ground," said the report. "When the airplane gets airborne, the WOW switches, located on each main [landing] gear, switch to the air mode and inhibit the spoilers from extending in the event the pilot retards the throttle [levers] to idle. If the WOW switches remain in the ground mode after takeoff, and the throttles are retarded to idle, the ground spoilers will deploy."

Melting Ice Causes In-flight Electrical Failure

The Airbus A300 was on a scheduled cargo flight inbound to Copenhagen (Denmark) Kastrup Airport when an uncontrollable, intermittent alternating-current electrical-power failure occurred. The flight crew requested radar guidance from air traffic control because of the loss of primary navigation instruments. The aircraft was landed without further occurrences. There were no injuries to the three crewmembers and no aircraft damage in the Jan. 7, 2002, incident.

The Danish Aircraft Accident Investigation Board (AAIB) investigation determined that the incident aircraft had arrived at Oslo (Norway) Gardamoen Airport the previous evening and had been parked on a remote cargo ramp overnight. "The flight crew left the aircraft just after parking," said the AAIB report. "The crew did not drain the potable [drinkable]-water tank. The aircraft was parked on the remote ramp for 20 hours with an average ground temperature between minus 9 degrees C [Celsius] to minus 12 degrees C [16 degrees Fahrenheit (F) to 10 degrees F]."

The electrical-system failure occurred when ice in a cracked tee tube melted and soaked into the electrical bay and equipment compartment, the report said.

"Water under pressure hit the generator-control system," said the report. "This system initiated an uncontrolled short circuit and power transfer, resulting in interruption of [the] autoflight [system], navigation [system] and cockpit-light [system]."

The report said that the A300 aircraft maintenance manual included, under the heading "Potable-water system draining procedures," the following item: "All water tanks and containers should be drained to protect them from freezing if the airplane is to be left unattended for an extended period of time."

Loose Wiring Fools Fuel Gauge

The pilot of the Hughes 369D helicopter had been engaged in logging operations for about an hour at Taholah, Washington, U.S., when the engine failed. He executed an autorotation to a road; in the hard landing, the left skid collapsed. The pilot was uninjured in the April 7, 2003, accident.

The post-accident investigation found that there was no fuel in the fuel tank, and that the fuel-quantity-sending float was entangled in the unsecured start-pump wiring. The float, therefore, was unable to register less than about 120 pounds (54 kilograms), or about 60 pounds (27 kilograms) more than the activation setting for the "LOW FUEL" warning light.

The helicopter had undergone a 100-hour inspection just before the accident flight, during which the fuel-quantity-sending unit had been replaced, the report by the U.S. National Transportation Safety Board (NTSB) said.

"The maintenance manual for the Hughes 369D helicopter contained procedures for securing the electrical-power-supply lines to the fuel line to prevent interference with the fuel-quantity-indicator sending unit," said the report. The procedure included the following caution, the report said:

"CAUTION. Ensure start-pump wire lead is wrapped around or tie-wrapped to fuel-supply hose so that there is no possibility of its interfering with fuel-quantity-transmitter float mechanism."

That cautionary note, however, was specifically related to the "Start Pump Installation" procedure found in the maintenance manual, the report said. There was no corresponding caution or reference in the section for "Fuel Quantity Transmitter Replacement."

The report said that the only reference in the maintenance manual to the start-pump electrical lines was contained in the section "Fuel System General Inspection," in item (5): "If start-pump wire is [tie-wrapped] to start-pump line, inspect security and condition of [tie wraps]." But no guidance was provided in the event that the start-pump wires were found unsecured, the report said.

NTSB determined that the probable cause of the accident was "the entanglement of the fuel-quantity-sender float in the start-pump wiring within the fuel tank as a result of the wiring not being properly secured. This rendered the fuel gauge inaccurate and the 'LOW FUEL' warning light inoperative, which led to fuel exhaustion. The improper securing of the wiring was a result of unspecified maintenance personnel not identifying the unsecured condition. Contributing factors were the lack of adequate guidance in the maintenance manuals on inspection of the wiring and the low rotor [revolutions per minute] during the autorotation, resulting in a hard landing."

Elevator-trim Failure Jeopardizes Flight Control

The Raytheon Beech King Air C90A was being flown on a training flight from Winnipeg, Manitoba, Canada, to Prince Albert, Saskatchewan, Canada. At Flight Level 220 (about 22,000 feet), the flight crew heard a loud noise that was accompanied by severe airframe vibration and a substantial pitch-up attitude. The captain (the pilot flying) disconnected the autopilot and hand-flew the airplane to regain stability. The copilot requested clearance from air traffic control for a diversion to Dauphin, Manitoba, the nearest suitable airport. Despite limited elevator control, the crew completed the landing without further incident. After leaving the aircraft, the flight crew observed that the left elevator trim-tab pushrod had failed. Neither crewmember was injured in the March 13, 2003, incident.

"The elevator-trim system incorporates a pushrod attached to the trim tab with a set of stainless-steel bushings, an inner bushing rotating inside an outer bushing, at the attachment point," said the report by the Transportation Safety Board of Canada.

The trim tab–clevis assembly was inspected and serviced about 150 flight hours before the failure and, at that time, the inner bushing was found seized in the outer bushing and corroded, the report said. The mating faces of the inner bushing and outer bushing were cleaned, lubricated and reinstalled with new attachment hardware.

"The seizing of the inner bushing … may have initiated the fatigue cracking of the pushrod end if the rotational resistance of the clevis at that time was sufficient," said the report.

The report listed the following causes and contributing factors:

- "The elevator-trim pushrod failed from fatigue cracking in the threaded section of the rod end. The fatigue crack was initiated by the increased bending load generated from a progressively stiffening pushrod-to-trim-tab adjustment, resulting in limited elevator control;
- "The original fit between the inner and outer bushings was less than ideal, with an interference fit occurring between these two parts at points around the interface;
- "Movement between the two ill-fitting inner and outer bushings, aided by the higher-than-prescribed installation torque on the through bolt, likely produced the galling [wearing by friction], which eventually resulted in seizure; [and,]
- "The elevator trim-tab pushrod-attachment bolt was found to be tightened to a value higher than that prescribed by the manufacturer. As a result, when the inner bushing became seized, the pushrod clevis was not free to rotate."

Several new bushings obtained from the manufacturer did not meet the specified dimensions, the report said.

"Distribution of such bushings could result in the machining or reaming of bushings to facilitate installation," said the report. "Reaming of the bushings without the associated drawings increases the risk of seizure if dimensional and out-of-round limits are not strictly observed."

On March 21, 2003, Transport Canada issued Service Difficulty Alert AL-2003-03, recommending that operators of Raytheon Beech 90 series aircraft disassemble and thoroughly inspect the elevator trim-tab fixtures and ensure that the inner bushing rotates freely.

In April 2004, Raytheon Aircraft Co. issued a Safety Communiqué to alert operators to inspect for seized elevator trim-tab bushings. In addition, the company inspected bushings in the spares inventory for correct dimensions and revised the installation procedures in the maintenance manual.♦

NEWS & TIPS

They've Got Your Part Number

SmartBench from Avexus automates the flow of electronic configuration-management data to aircraft inspection teams and maintenance teams. The software is designed to reduce turnaround times and reduce labor costs of repairing high-value assets such as gas-turbine engines.

Based on a similar application developed by Pratt & Whitney Canada, SmartBench matches the part number of the component being serviced to the most current original equipment manufacturer (OEM) technical specifications and regulatory documents. The documents — such as engineering orders, maintenance manuals, OEM service bulletins and airworthiness directives from the U.S. Federal Aviation Administration and the European Joint Aviation Authorities — are electronically presented on the user's monitor.

The application's capabilities include need forecasting, procurement management, inventory management and product life-cycle tracking.

For more information: Avexus, 10182 Telesis Court, Suite 600, San Diego, CA 92121 U.S. Telephone: +1 (858) 352-3300; 40 Occam Road, Surrey Research Park, Guildford, Surrey GU2 7YG U.K. Telephone: +(44) 1483 688 263.

System Provides Key to Aircraft-theft Deterrence

Ramplock, a lightweight, portable wheel-locking system, is an aircraft theft-deterrent device that is said to fit virtually all business aircraft and regional airliners. This device meets the requirement for a "secondary lock" currently required by the U.S. Transportation Security Administration (TSA) and the U.S. Federal Aviation Administration (FAA) at some airports, such as Teterboro (New Jersey, U.S) Airport. A key-operated, hardened-steel lock quickly and easily secures the aircraft on the ramp, the manufacturer says.

Weighing 12.0 pounds (5.4 kilograms), the unit is collapsible for flat storage in a baggage compartment, and is sold with a carrying bag.

For more information: Tronair, 1740 Eber Road, Holland, OH 43528 U.S. Telephone: 1 (800) 426-6301 (U.S.); +1 (419) 866-6301.

Laser Scanner Models Parts

The ModelMaker Z series portable laser scanner from NVision can be used to reverse-engineer aerospace components. The unit creates a solid model for quickly and economically producing replacement parts that are no longer in production by the original equipment manufacturer, the manufacturer says.

The ModelMaker system comprises a portable coordinate-measuring machine, to which a three-dimensional (3D) laser-stripe sensor is attached. A laser-stripe sensor performs significantly faster than a simple laser-point sensor, the manufacturer says. A personal computer and dedicated software extract, display, manipulate and export the data.

Portable Laser Scanner

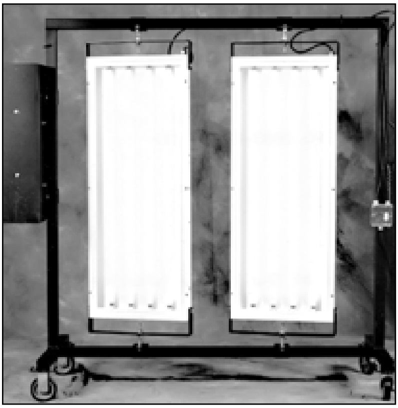
To record the shape of a component, a technician moves the sensor over the surface, and a dedicated interface card translates the video image of the line into 3D coordinates. The data can be exported to standard 3D computer-aided design (CAD) packages to fabricate the replacement object.

For more information: NVision, 112 Welford Lane, Suite 126, Southlake, TX 76092 U.S. Telephone: +1 (817) 749-0050.

Units Shed New Light on Subject

Portable light carts from LDPI Lighting offer a means for quickly brightening work areas. The LDPI line includes several versions, including explosion-proof models and hazardous-location models, as well as carts for general tasks and for detecting flaws in high-quality finishing applications.

Models are available with a single four-foot (1.2-meter) light fixture, as well as with two, three or four four-foot fixtures. All carts require either a 120-volt power supply or a 277-volt power supply.



Portable Light Cart

Single-fixture carts and two-fixture carts can be positioned in either a horizontal configuration or a vertical configuration. On the two-fixture cart, the fixtures are mounted on swiveling brackets for aiming the lights.

For more information: LDPI Lighting, 800 Wisconsin St., Eau Claire, WI 54703 U.S. Telephone: 1 (800) 854-0021 (U.S.); +1 (715) 839-9585.

Eyewear Grows Accustomed to Your Face

The cushioned, lightweight design of safety eyewear from Uvex FitLogic is said by the manufacturer to be capable of customized fitting to any face.

Wearers can adjust the eyewear at four different locations. The nosepiece design, for example, rotates, pivots and slants to provide a precise fit for the user's nose bridge. The temple arms ratchet up and down, then snap securely into place to accommodate cheekbone contours. Cushioning at all contact points and soft materials provide comfort for all-day wear, the manufacturer says.

Safety Eyewear

The extended wraparound lens of polycarbonate blocks 99.9 percent of ultraviolet (UV) rays, the manufacturer says, and is available with anti-fog coatings and a variety of tints.

For more information: Uvex, 910 Douglas Pike, Smithfield, RI 02917 U.S. Telephone: +1 (401) 757-2220.♦