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# MELs for Corporate and Business Aircraft Guide Deferred-maintenance Decisions

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Robert A. Feeler, editorial coordinator

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Cover: Darol V. Holsman, FSF manager of aviation safety audits, examines minimum equipment list documents for a Gulfstream IV. (FSF photo)



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# MELs for Corporate and Business Aircraft Guide Deferred-maintenance Decisions

***A minimum equipment list (MEL) provides a common basis for maintenance technicians and pilots to determine whether an aircraft can be operated safely — and legally — with inoperative instruments/equipment.***

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*Robert A. Feeler*

Minimum equipment lists (MELs) have been used for nearly 50 years by commercial aircraft operators throughout the world; but corporate/business aircraft operators, which are governed by "general aviation" regulations in many countries, are relative newcomers to the use and application of the MEL concept.[1]

The International Civil Aviation Organization (ICAO) defines an MEL as "a list which provides for the operation of aircraft, subject to specified conditions, with particular equipment inoperative, prepared by an operator in conformity with, or more restrictive than, the MMEL [master MEL] established for the aircraft type."[2]

The MEL concept is described by ICAO as follows:

> The [MEL] is not intended to provide for operation of the aircraft for an indefinite period with inoperative systems or equipment. The basic purpose of the [MEL] is to permit the

> safe operation of an aircraft with inoperative systems or equipment within the framework of a controlled and sound program of repairs and parts replacement.[3]

ICAO standards for commercial aircraft operators call for MELs to be included in the operations manual, so that the pilot-in-command (PIC) can "determine whether a flight may be commenced or continued from any intermediate stop should any instrument, equipment or systems become inoperative."[4]

ICAO has not established standards for the use of MELs by general aviation aircraft operators. Nevertheless, several ICAO member countries have developed such standards. For example, in North America, where nearly 80 percent of worldwide corporate/business aircraft operators are located,[5] regulations established by Transport Canada (TC) and the U.S. Federal Aviation Administration (FAA) include MEL provisions for general aviation aircraft operators.

The provisions differ, in that commercial/business aircraft PICs in Canada may use some discretion in determining whether a flight can be conducted safely with inoperative instruments/equipment.

Canadian Aviation Regulations (CARs) Part 605.08 says that "no person shall conduct a takeoff in an aircraft that has equipment that is not serviceable or from which equipment has been removed if, in the opinion of the [PIC], aviation safety is affected."

The CARs require that the PIC of an aircraft for which an MEL has not been approved base his/her determination of aircraft airworthiness on several factors, including:

- Equipment required by the CARs for the intended flight (e.g., day or night, visual flight rules or instrument flight rules);
- Equipment required by the aircraft manufacturer for the intended flight; and,
- Requirements of airworthiness directives.[6]

In addition, any unserviceable equipment must be "isolated or secured" and placarded, and the PIC must record the actions in the aircraft logbook.

The CARs require that, if an MEL has been approved for the aircraft, the PIC's determination of aircraft airworthiness must be based also on the conditions or limitations specified in the MEL.[7]

In the United States, Federal Aviation Regulations (FARs) Part 91 prohibits general aviation aircraft operators from conducting a takeoff in an aircraft that has *any* inoperative instruments or equipment unless the operation is conducted under the provisions of an MEL.[8] (The regulation includes exceptions for specific equipment aboard specific aircraft, such as rotorcraft and small, non-turbine-powered airplanes.)

For U.S. operators, proper use of an approved MEL enhances operational flexibility because an aircraft can continue to be flown, under specific conditions and for a limited time, with certain instruments/equipment inoperative.

Another benefit, especially for operators of complex multi-engine aircraft and/or turbine aircraft, is that an MEL ensures that those involved in the operation of the aircraft use the same information to evaluate a malfunction and its effect on continued operations. An MEL assists pilots, as well as maintenance technicians, in determining what is safe, logical and legal.

(An MEL also assists an operator in documenting aircraft airworthiness to ensure that insurance coverage remains valid. There have been instances in which an aircraft was damaged as a result of something that was not related to inoperative equipment, such as a landing light; nevertheless, because the operator failed to document approved continued operation under the provisions of an MEL, the insurance company ruled that the operator had failed to maintain the aircraft in airworthy condition and deemed the insurance invalid.)

The FAA, in Advisory Circular (AC) 91-67, defines MEL as follows:

> The MEL is the specific inoperative equipment document for a particular make and model aircraft by serial and registration numbers (e.g., BE-200 [Beech Super King Air 200], N12345). A [FARs] Part 91 MEL consists of the MMEL for a particular type aircraft, the preamble for Part 91 operations, the procedures document and a LOA [letter of authorization]. The FAA considers the MEL as an STC [supplemental type certificate]. As such, the MEL permits operation of the aircraft under specified conditions with certain equipment inoperative.[9]

MMEL is defined in AC 91-67 as follows:

> An MMEL contains a list of items of equipment and instruments that may be inoperative on a specific type of aircraft (e.g., BE-200 …). It is also the basis for the development of an individual operator's MEL.

An MMEL typically is developed as part of the aircraft-certification process:

An aircraft undergoes initial flight-testing before issuance of a type certificate and a production certificate under the auspices of an FAA Aircraft Evaluation Group (AEG). Although the manufacturer conducts the testing and provides most of the engineering talent, it does so under the direction of the AEG.

As the certification process nears completion, a group of FAA engineers, FAA pilots and FAA technicians is convened as the Flight Operations Evaluation Board (FOEB). The manufacturer, prospective customers/operators of the aircraft and others may assist the FOEB, but the FOEB has final authority over the certification-approval process and the issuance of the aircraft flight manual (AFM).

The FOEB also evaluates proposals submitted by the manufacturer and by prospective operators for items to be included on the MMEL. Although many people may be involved in data collection and evaluation, the FOEB has sole authority for deciding what goes into the MMEL.

Copies of approved MMELs are available from FAA flight standards district offices (FSDOs) or from the FAA Web site at <www.faa.gov/fsdo/abq/mmel.html>. MMELs are available from other sources, including aircraft manufacturers; nevertheless, the only authorized (and legal) MMELs are those produced and distributed by FAA.

The meaning of the term *inoperative*, as used in the context of the FARs, must be understood clearly. AC 91-67, as well as the preamble of every Part 91 MEL, says:

> Inoperative means that a system and/or component has malfunctioned to the extent that it does not accomplish its intended purpose and/or is not consistently functioning normally within its approved operating limits or tolerances.

By this definition, an indicator reported as "fluctuating," a component reported as "intermittent" or a gauge reported as "sticking" must be considered inoperative. The malfunction must be corrected by a maintenance technician, or — if an MEL authorizes continued operation of the aircraft with the inoperative equipment — the operator must comply with specific instructions in the MEL for that equipment (e.g., placarding the equipment as inoperative, conducting maintenance/operational procedures and entering information in the aircraft maintenance records).

A logbook entry stating "could not duplicate on ground" is not a satisfactory response to a pilot report of an equipment malfunction that fits the definition of inoperative.

Provisions for the use of MELs by Part 91 operators were adopted by FAA in

1988, in response to petitions for exemptions from several corporate aviation departments with air carrier-type aircraft. In 1991, FAA issued AC 91-67, which discusses the MEL concept and provides guidance for operating with an MEL or without an MEL.

The advisory circular discusses the FAA's MEL-approval process step by step. Other sources of information are the *General Aviation Operations Inspector's Handbook* (FAA Order 8700.1, Chapter 58) and the *General Aviation Airworthiness Inspector's Handbook* (FAA Order 8300.10, Chapter 37). The handbooks discuss how FSDO inspectors process MEL requests.

The first step in applying for an MEL is to call the FSDO that has jurisdiction over the area in which the aircraft is based and request an appointment for a meeting. During the first meeting, the applicant likely will discuss the approval process, regulatory requirements and other issues with several inspectors (specializing in operations, airworthiness and avionics); one inspector will be assigned by the FSDO supervisor to work with the applicant as the process continues.

Before issuing a LOA that authorizes the operator to use the MMEL as the MEL for its aircraft, FSDO inspectors will discuss requirements for the procedures document with the operator. Nevertheless, the operator solely is responsible for preparing the document. AC 91-67 includes the following guidance:

> The operator should develop the [procedures document] using guidance contained in the manufacturer's aircraft flight [manual] and/or maintenance manual, the manufacturer's recommendations, engineering specifications and other appropriate sources. The operator may consult FSDO airworthiness inspectors for advice or clarification, but the operator is responsible for preparing the document.

Although FAA does not review or approve the procedures document, a ramp check or an incident investigation may result in enforcement action if the operator fails to prepare the document or does so incorrectly. (This is one reason that some operators hire consultants who specialize in developing aircraft-specific MELs and procedures documents.)

The procedures document includes supplementary information that is used in conjunction with the MEL. Descriptions of requirements for some items on an MEL are self-explanatory. For example, the BE-200 MMEL says that one static wick is allowed to be missing or broken on each wing, on each side of the horizontal stabilizer and on the vertical stabilizer.

The descriptions of requirements for other items on an MEL, however, include the following notations: "(M)" — meaning that a specific maintenance procedure must be conducted; "(O)" — meaning that a specific operations procedure must be conducted; and "as required by FAR" — meaning that the FARs have specific requirements or limitations for operation of the item.

Details on the maintenance procedures, operating procedures and FARs requirements/limitations must be included in the procedures document. Where appropriate, the procedures document should provide specific references to sections of the aircraft maintenance manual or the AFM.

For example, the BE-200 MMEL includes the following description of requirements for the electric elevator-trim system: "(M) May be inoperative provided [that] manual trim is unaffected." The notation "(M)" indicates that the procedures document includes a maintenance procedure for ensuring that operation of the manual elevator-trim system is not affected by the malfunction of the electric elevator-trim system.

After receiving approval to operate with an MEL, the operator is responsible for keeping the MEL and the procedures document up-to-date.

The FOEB for each aircraft type meets periodically to review the MMEL and to consider revisions suggested by others within the FAA (e.g., FSDO inspectors), by the manufacturer and by operators. The meetings typically occur frequently after an aircraft is certified and become less frequent as the aircraft accumulates time in service.

Section 22 of AC 91-67 describes how an operator can submit a petition to the FSDO to have newly installed equipment added to the MMEL. One important but often-overlooked provision is that an operator who petitions FAA for an MMEL revision is permitted to operate the aircraft with that equipment added to the MEL while the FSDO, the FOEB and possibly the AEG consider the requested MMEL revision. Until the FAA acts on the petition, the operator can treat the item as if it were on the MMEL and develop operations-and-maintenance procedures as appropriate.

When a FSDO issues a LOA, the FSDO adds information about the operator and the operator's aircraft to a master list of authorized MEL operators. The master list is maintained at the FAA's Mike Monroney Aeronautical Center in Oklahoma City, Oklahoma. When an MMEL is revised, the center mails postcards to the affected operators, notifying them of the revision and advising that they have 30 days to incorporate the revision in their MELs and to include necessary information in their procedures documents. The operators can obtain copies of revised MMELs from their FSDOs or from the FAA Web site.

Because the operator solely is responsible for ensuring that its MEL is up-to-date, the operator should confirm with the FSDO that the company and all the aircraft for which it has obtained MEL approval are included on the master list. Periodic checks of MMEL revision status on the FAA Web site also are prudent; the site includes a list that shows the revision number and revision date for each MMEL.

The requirements for *when* inoperative equipment must be repaired differ for commercial operators and general aviation operators. Each item on an MMEL is assigned a repair category; the repair categories apply only to commercial operators. For example, a Category A item must be repaired according to the time interval specified by the MEL in the remarks section for that item. A Category B item must be repaired within three days; a Category C item within 10 days, and a Category D item within 120 days.

Compliance with the requirements of the repair categories is not mandatory for Part 91 operators. Instead, the preamble to each MMEL contains the following guidance for general aviation operators:

> The MMEL is intended to permit operations with inoperative items of equipment for the minimum period of time necessary until repairs can be accomplished. It is important that repairs be accomplished at the earliest opportunity in order to return the aircraft to its design level of safety and reliability. Inoperative equipment in all cases must be repaired, or inspected and deferred, by qualified maintenance personnel at the next required inspection.

The preamble also says that when equipment is found to be inoperative, an entry must be made in the aircraft maintenance records to show whether the equipment was repaired or the repair was deferred in accordance with the MEL.

Operating under the provisions of an MEL requires some effort. Nevertheless, the effort likely will be rewarded when a Part 91 aircraft, which otherwise would be grounded because of inoperative equipment, can continue to be operated — albeit temporarily — under the provisions of an MEL.♦

## Notes

1. The National Business Aviation Association (NBAA), in *NBAA Business Aviation Fact Book 2002*, said, “The terms *business aircraft* and *corporate aircraft* often are used interchangeably

because they both refer to an aircraft used to support a business enterprise.” NBAA said that the U.S. Federal Aviation Administration (FAA) defines business transportation as “any use of an aircraft (not for compensation or hire) by an individual for transportation required by the business in which the individual is engaged.” NBAA said that FAA defines corporate/executive transportation as “any use of an aircraft by a corporation, company or other organization (not for compensation or hire) for the purposes of transporting its employees and/or property, and employing professional pilots for the operation of the aircraft.”

2. International Civil Aviation Organization (ICAO). International Standards and Recommended Practices (SARPS). *Annex 6 to the Convention on International Civil Aviation: Part I, International Commercial Air Transport — Aeroplanes*. Chapter 1, “Definitions.”

3. ICAO. SARPS. *Annex 6: Part 1*. Attachment G, “Minimum Equipment List (MEL).”

4. ICAO SARPS. *Annex 6: Part I*. Chapter 6, “Aeroplane Instruments, Equipment and Flight Documents,” 6.1.2.

5. NBAA. *NBAA Business Aviation Fact Book 2002*: 21.

6. Transport Canada (TC). Civil Aviation Regulations (CARs) Part VI, *General Operating and Flight Rules*. Subpart 5, *Aircraft Requirements*. Part 605.10, “Unserviceable and Removed Equipment — Aircraft Without a Minimum Equipment List.”

7. TC. CARs Part VI. Subpart 5. Part 605.09, “Unserviceable and Removed Equipment — Aircraft With a Minimum Equipment List.”

8. FAA. Federal Aviation Regulations Part 91, *General Operating and Flight Rules*. Part 91.213, “Inoperative Instruments and Equipment.”

9. FAA. Advisory Circular 91-67, *Minimum Equipment Requirements for General Aviation Operations Under FAR Part 91*. June 28, 1991.

## About the Author

*Robert A. Feeler has been a certified aircraft maintenance technician since 1952 and has served in senior management positions at two U.S. airlines. A frequent contributor to* Aviation Mechanics Bulletin, *he was appointed editorial coordinator of the publication in 1991. Feeler also served as manager of Flight Safety Foundation (FSF) safety audit programs from 1992 through 1999, when he participated in developing the FSF*

*Q-Star Charter Provider Verification Program and was appointed program administrator.*

## Further Reading From FSF Publications

FSF Editorial Staff. "MEL Revised After Depressurization Incident." *Flight Safety Digest* Volume 20 (July 2001): 21–22.

Arbon, E.R.; Mouden, L. Homer; Feeler, Robert A. "The Practice of Aviation Safety." *Flight Safety Digest* Volume 20 (June 2001): 18–19.

Hessburg, Jack. "Analysis of Airworthiness Describes Conformity, Safety as Key Elements." *Aviation Mechanics Bulletin* Volume 48 (March–April 2000).

FSF Editorial Staff. "Learjet Strikes Terrain When Crew Tracks False Glideslope Indication and Continues Descent Below Published Decision Height." *Accident Prevention* Volume 56 (June 1999).

FSF Editorial Staff. "Faulty Instrument, Poor Judgment Bring Down Convair Turboprop." *Accident Prevention* Volume 49 (July 1992).

Pope, John A. "Special Inspection of Commuters." *Accident Prevention* Volume 46 (August 1989).

# MAINTENANCE ALERTS

## FAA Recommends Inspections of JT8D-200 High-pressure Compressor Front Hubs

The U.S. Federal Aviation Administration (FAA) has recommended inspections of Pratt & Whitney JT8D-200 series high-pressure compressor (HPC) front (C-8) hubs because cracks have been found on some hubs.

In a special airworthiness information bulletin (NE-02-22) issued March 26, 2002, FAA said that cracks have been found on 16 hubs at the interface of the C-8 hub and the stage 8 to stage 9 spacer.

"The cause of the cracking appears to be fretting-induced fatigue," FAA said. "The fretting is believed to be the result of spalling [the breaking off of surface material caused by internal stress] of the PWA-110 coating in the spacer-hub interface as a result of normal relative motion between the hub and the spacer. The spalled coating material, trapped between the hub and spacer, produces high contact stresses [that] result in the fretting and, ultimately, cracking of the hub."

In each instance, cracks have been found on configurations in which PWA-110 coating has been used on the spacer and nickel cadmium coating has been used on the hub (the configuration used since 1987 in production of JT8D-217C and JT2D-219 HPCs).

The cracks typically have been found on HPCs with more than 13,000 cycles in service since new or since the last HPC overhaul.

"The cracks appear in the aft face of the hub between the 9 [o'clock] to 11 o'clock [position] and 1 [o'clock] to 3 o'clock position adjacent to the tie-rod holes," FAA said. "The clock position on the tie-rod hole is defined by viewing the hub from the aft facing forward with 12 o'clock located on the tie-rod hole circumference nearest the OD [outside diameter] of the hub."

FAA said that a related field management plan would be developed and incorporated into an airworthiness directive (AD). Until the AD is issued, FAA recommended that operators, repair stations and principal maintenance inspectors take the following actions:

- Perform a full compressor overhaul, at the next engine-shop visit, of engines with high-risk criteria and develop a schedule for early removal of the highest-time engines;
- Review current C-8 hub fluorescent magnetic particle inspection (FMPI) techniques to ensure that they establish the correct magnetic field for detecting cracks in the areas identified as susceptible to cracking;
- Implement focused visual inspections and FMPI inspections of the susceptible areas;
- Report inspection findings to the manufacturer; and,
- Be aware of further manufacturer recommendations.

## Open Cowl Door Separates From A320 Engine Nacelle, Strikes Horizontal Stabilizer

An Airbus A320 was accelerating through takeoff rotation speed ($V_R$) at McCarran (Las Vegas, Nevada, U.S.) International Airport when the outboard forward cowl door on the no. 1 (left) engine separated from the engine nacelle and struck the horizontal stabilizer. The flight crew flew the airplane to the departure airport and conducted a normal landing. The airplane received minor damage; none of the 152 people in the airplane was injured.

The U.S. National Transportation Safety Board, in its final accident report, said that the probable cause of the accident was "the failure of the mechanic to refasten the cowling door prior to returning the aircraft to service."

An investigation revealed that the cowl door had separated from the engine nacelle and that there were a 10-inch (25-centimeter) cut in the landing-gear door and three holes in the lower surface of the left horizontal stabilizer. Each hole was about two inches (5.1 centimeters) wide and eight inches (20 centimeters) long. The report said that the cowling-door "hold-open rod" had penetrated the lower skin and spar web of the horizontal stabilizer. The opposite (inboard) cowl door and the area where the two doors hinge were damaged but remained attached to the engine nacelle. The cowl door "over-center" latches on the inboard door were latched, and the hooks were intact and undamaged. On the outboard door, the latch receptacles — which were painted red — also were undamaged.

The report said that the flight was the first after maintenance personnel had conducted a remain-overnight check the previous night.

The accident report said that the check had been conducted "during hours of darkness. The … check required that the cowling doors be opened; however, the mechanic performing the work reported that the cowl doors were closed and relatched about 0530–0600 during hours of daylight. In the morning, the aircraft was handed over from the maintenance graveyard [overnight] shift to the day shift. Maintenance items remained to be completed in areas of the aircraft other than the no. 1 engine. The takeoff [in which] the cowing separated was the first flight following return to service."

## Under-reporting of R22 Flight Time Cited in Failure of Main-rotor Blade

A Robinson R22 Beta helicopter was being flown in a cattle-herding operation in Australia when, at 200 feet above ground level, the helicopter developed a lateral vibration. The pilot lost control of the helicopter, which then struck the ground. The helicopter was destroyed; the pilot received fatal injuries, and a passenger received serious injuries.

The Australian Transport Safety Bureau (ATSB) said, in its final report on the July 29, 2000, accident, that the main-rotor mast assembly separated in flight, damaging the engine firewall and the two fuel tanks. One main-rotor blade separated from the main-rotor hub. The blade, which fractured at the blade-root fitting, was found 105 meters (345 feet) from the accident site. ATSB said that the failure resembled a 1990 accident in which a blade on an R22 helicopter used in herding operations had exceeded its service life. Investigation of the 1990 accident revealed that there had been a fatigue crack in the main-rotor-blade root fitting and that the main-rotor blade had exceeded its retirement time by at least 257.2 operating hours. (In that accident, authorities said that the hours recorded in the helicopter logbook apparently were not the helicopter's actual operating hours and that there was a manufacturing anomaly in the main-rotor blade that related to load transfer through the rib-root fitting. After the accident, the manufacturer took action to eliminate the anomaly.)

ATSB said in its report on the 2000 accident that the helicopter's hour meter showed that the helicopter had 2,124.6 hours total time in service (TIS). The last recorded maintenance was a 100-hour inspection completed 25 days before the accident; maintenance records said that the helicopter was released to service at 2,102.4 hours. No flight entries were recorded after the inspection. The ATSB said that its review of helicopter records "suggested [that] the helicopter operating hours were being under-reported." The report said that the pilot's logbook showed that, in the 90 days before the accident, the pilot had flown the accident helicopter for 95.6 hours. The recorded TIS of the separated main-rotor blade (part no. A016-2) was 1,995.5 hours; the logbook said that the blade had accumulated 1,299.9 hours TIS when it was installed in the accident helicopter more than two years before the accident. The manufacturer said that the mandatory retirement time of the main-rotor blade was 2,200 hours TIS.

"The under-reporting of helicopter flight time probably resulted in an actual service life of the failed main rotor blade in excess of the manufacturer's stated limits," the report said. "There has been a history of … failures of the R22 main-rotor blade during its evolution. Those events have led to a series of modifications to address the anomalies discovered. Exceeding the service life of a dynamic component such as a main-rotor blade will exacerbate the possibility of undetected catastrophic component failure."

## Excessive Grease on Brush Seals Suspected in Loss of Aileron Control

A Learjet 35A was being flown on an emergency medical services flight in British Columbia, Canada, from Vancouver to Terrace. After takeoff, while being flown through Flight Level 290 (approximately 29,000 feet) with the autopilot engaged, the aircraft turned right with five degrees of bank. The flight crew disengaged the autopilot and tried to stop the right turn, but the ailerons could not be moved.

The incident report by the Transportation Safety Board of Canada (TSB) said that, as the flight crew used various control inputs to try to move the ailerons, the bank angle increased to about 20 degrees. Then, as the crew applied force to the ailerons, full aileron control returned.

An investigation revealed that the airplane had been parked outdoors for several hours during a heavy rain with a surface temperature of 8 degrees Celsius (46 degrees Fahrenheit). The freezing level was 5,000 feet.

"Because of the nature of the malfunction and the environmental conditions, and because the malfunction cleared up in the air, freezing of the controls was suspected," the report said. "The aileron brush seals were examined by [the operator's] maintenance personnel shortly after the aircraft landed. Excessive amounts of water and traces of ice were observed in the brush seals. The seals were cleaned, dried and relubricated. The aircraft was reexamined two days after the incident; the brush seals were visibly worn and matted, and some of the drainage channels were distorted."

The report said that a review of service difficulty reports and information from the manufacturer revealed that similar incidents of Learjet aileron-control problems occur about once a year. In each occurrence, the airplane was "thoroughly soaked" with water, then was flown into freezing temperatures; in every occurrence the suspected cause of the problem was frozen aileron brush seals. (Brush seals are installed to prevent aileron buzz at high speeds.)

When brush seals are worn and matted, drainage channels in the brush seals — located about every inch (2.5 centimeters) — no longer allow passage of water.

The operator's maintenance procedures called for the seals to be "cleaned with a dry, clean cloth and then lubricated with a silicone-based grease every 300 hours," the report said. "The practice was to be generous with the grease."

The report said that the Learjet 35A maintenance manual said that greasing should not be excessive because too much grease can block the drainage channels; nevertheless, the manual did not say how much grease was considered excessive and did not establish criteria for replacing worn seals or damaged seals.

As a result of the occurrence, the operator reduced the lubrication interval from 300 flight hours to 100 flight hours and the manufacturer was revising maintenance manuals for all Learjet airplanes to include more complete lubrication instructions and inspection criteria for worn brush seals or damaged brush seals.

## Blocked Wheel-well Drain Lines Blamed for Aileron-control Problem

A Boeing 767-200 was in cruise at Flight Level 390 (approximately 39,000 feet) on a transcontinental flight in the United States from New York, New York, to San Francisco, California. The center autopilot and the autothrottles were engaged. The captain said that the autopilot made an uncommanded disconnect.

The final accident report by the U.S. National Transportation Safety Board (NTSB) quoted the captain as saying that when he took control of the airplane, "the control wheel was jammed in the straight-and-level position." About 15 pounds (6.8 kilograms) of force was applied to free the control wheel. The flight crew declared an emergency and diverted the flight to Chicago (Illinois) O'Hare Airport, where a normal landing was made. The autopilot and autothrottles were not engaged for the remainder of the trip.

The initial examination of the airplane revealed no anomalies related to the aileron-control problem. A subsequent inspection, however, revealed debris obstructing the wheel-well canted-pressure deck-drain lines.

The report said that Boeing Service Bulletin (SB) 767-51A0020 had recommended changes in the drain system to "help ensure that fluid entering the canted-pressure-deck area will be drained out of the airplane and not leak into the wheel-well area, where it could freeze on the aileron-control cables or the landing-gear doors during flight."

Before the SB was issued, three operators had reported accumulations of ice on the aileron-control cables.

The SB said, "In two of the instances, the ice on the aileron cables caused the control wheel not to move when on autopilot. The autopilot was disengaged, and the pilot had to operate the aileron system manually. Higher-than-normal control-wheel-input force was required to free the cables and restore normal aileron control. The ice buildup on the aileron-control cables was attributed to fluid from the sloping pressure deck leaking into the wheel well and freezing."

The incident report said that the changes in the drain system described in the service bulletin had not been implemented on the incident airplane. Rain had been reported in New York for several hours before the airplane's departure.

# Faulty Installation Cited in In-flight Propeller Separation

On July 25, 2000, about 80 minutes after departure from Destin–Fort Walton Beach Airport in Destin, Florida, U.S., the pilot of a Cessna 421A Golden Eagle in cruise flight at 12,000 feet felt a slight vibration and observed the right propeller separate from the airplane. The pilot declared an emergency and diverted the flight to Jackson (Mississippi, U.S.) International Airport, where he conducted an uneventful landing. The six people in the airplane were not injured.

An inspection of the airplane by a U.S. Federal Aviation Administration airworthiness inspector revealed that the right propeller assembly had separated completely from the engine. (The propeller assembly was found more than three months after the accident.) The inspection also revealed that the upper surface of the leading edge of the right horizontal stabilizer had been crushed, that the outboard section of the horizontal stabilizer had been displaced about 35 degrees down and that there were compression wrinkles on the bottom skin of the right horizontal stabilizer. There was a hole in the top of the crankcase of the right engine, and five fractured studs were found in the engine compartment area. Nuts were attached to all five studs, and spacers were attached to three studs; three other spacers had separated from the nuts but were found in the engine compartment area.

"Examination of the fracture surface of the no. 1 propeller [assembly] revealed features typical of overstress separation," the U.S. National Transportation Safety Board said in the final accident report. "Crack arrest lines indicative of fatigue cracking [were] noted on all the fracture surfaces of all eight [propeller-mounting] studs. Contact damage and deformation [were] noted to the end of all the spacers adjacent to the mounting flange of the propeller gear. Four of the recovered seven spacers were later determined to be damaged, which shortened their length to less than the specified length. Only two of the eight fractured studs … extended the minimum distance beyond the nut specified by McCauley Propeller Systems."

The report said that an annual inspection had been conducted on the airplane on Jan. 5, 2000, and that both propellers had been removed during the annual inspection for compliance with an airworthiness directive. The propellers later were replaced for economic reasons, the report said.

"At the time the mechanic signed off the annual inspection, neither propeller was installed," the report said. "An entry in the right-engine logbook with the same date as the annual inspection indicates that a 'zero-time' propeller was installed. The replacement propellers were overhauled on Feb. 3, 2000, and installed by a mechanic other than the mechanic who performed the annual inspection on an unknown date after overhaul."

At the time of the accident, the airplane had accumulated about 50 flight hours since installation of the right propeller.

The report said that the probable cause of the accident was the "inadequate installation of the right propeller by the mechanic for his failure to properly torque the eight nuts, resulting in fatigue failure of the studs and separation of the right propeller." The investigation also found that the mechanic used uncalibrated torque wrenches and an outdated service manual.

## Noncompliance With AD Cited in Engine Failure

A Piper PA-31-350 Chieftain was being flown in cruise flight near Boulder City, Nevada, U.S., on July 23, 2000, when the pilot of the on-demand passenger flight heard a loud popping sound and observed a surge in the left engine.

The pilot flew the airplane toward lower terrain, intending to land the airplane at the closest airstrip. His attempts to restart the engine failed, and he conducted checklists to shut down the engine and feather the propeller. With one engine operative, the airplane did not maintain altitude, and the pilot conducted an emergency landing on a beach at Lake Mead National Recreation Area. During the rollout, the airplane struck rocks and the nose landing gear and the left-main landing gear collapsed. The pilot and nine passengers were not injured.

An inspection of the left engine revealed a fractured fuel-injector line for the no. 6 cylinder injector nozzle. When the fractured fuel-injector line was replaced with a serviceable fuel-injector line and the engine was operated, the engine met all specifications. The inspection revealed no support clamps on the fuel-injector line between the manifold and the injector nozzle. Support clamps were found on injector lines to the five other cylinders.

The operator said that the engine had been inspected July 14, 2000, 23 operating hours before the accident.

The accident report by the U.S. National Transportation Safety Board said that Airworthiness Directive (AD) 93-02-05 had been issued June

14, 1993, to require compliance with Textron Lycoming Service Bulletin (SB) 342A. The AD and the SB required replacement of any fuel-injector line without clamps to support the line at specific clamping points and repeated inspection of the fuel injector lines between the fuel manifold and the injector nozzle to detect cracks, dents or other indicators of unserviceable wear.

The report said that the probable cause of the accident was "the fatigue fracture and separation of the no. 6 cylinder fuel-injector line due to the company maintenance personnel's failure to comply with an [AD]."♦

## NEWS & TIPS

### Castellated Locknuts Produced in Variety of Materials, Finishes

SPS Technologies castellated locknuts are available in hex configuration and 12-point configuration, in a variety of materials and finishes for use in commercial aircraft and military aircraft and other applications, the manufacturer said.

*Castellated Locknuts*

The locknuts are available in sizes from 0.190 inch (4.826 millimeters) in diameter to two inches (51 millimeters) in diameter and often are used with cotter pins for additional locking assurance, the manufacturer said.

For more information: SPS Technologies, 301 Highland Ave., Jenkintown, PA 19046-2692 U.S. Telephone: +1 (215) 572-3718.

### Electric Drive System Powers Ground-support Equipment

The Ecostar 80 V Electric Drive System powers battery-operated airport baggage-handling carts and battery-operated tugs, said the manufacturer, the Electric Drives Group of Ballard Power Systems Electric Drives and Power Conversion Division.

The Ecostar 80 V system includes an integrated drive-axle assembly, an 80-volt alternating current controller, a brake-pressure transducer, an electronic accelerator pedal and an integrated display gauge with a battery state-of-charge readout, the manufacturer said. A version of the Ecostar 80 V system can drive conventional axles or power the pump in hydraulically driven systems, and a dual-motor version can be used in higher-power applications.

For more information: Ballard Power Systems, 9000 Glenlyon Parkway, Burnaby, BC V5J 5J9 Canada. Telephone: +1 (313) 248-5395.

*Portable Air-conditioning Unit*

## Portable Unit Provides Temporary Cooling

The Moving Cooler portable air-conditioning unit provides temporary cooling of aircraft maintenance facilities and other areas, said the manufacturer, Skil-aire.

The Moving Cooler isolates the condenser and evaporative air streams to improve operating efficiency in producing cooler air, which is directed toward specific areas by two flexible cold-air outlets up to 10 inches (25 centimeters) in diameter and up to two feet (0.6 meter) long. The unit, which operates on casters, can be moved easily and fits through standard doorways. The Moving Cooler is available in five cooling capacities between one ton (0.9 metric ton) and five tons (4.5 metric tons).

For more information: Skil-aire, 1100 Wicomico St., 6th Floor, Baltimore, MD 21230 U.S. Telephone: +1 (410) 625-7545.

## Software Diagnoses Equipment Faults

SmartSignal, a provider of equipment-condition-monitoring software, has developed the eCM 2.0 software package to detect and diagnose impending equipment faults before the equipment fails, the manufacturer said.

The software provides early warning information about deteriorating conditions in aircraft equipment, including bleed-valve leaks, high-pressure-turbine failures and high-pressure-compressor failures, enabling operators to perform predictive maintenance. The software package also allows operators to incorporate into the software their own information about engine-failure modes.

For more information: SmartSignal, 4200 Commerce Court, Suite 102, Lisle, IL 60532 U.S. Telephone: +1 (630) 245-9000.

## Custom-built Tools Meet Special Needs

Wright Tools has begun producing custom-built hand tools developed according to customer specifications, the manufacturer said.

*Custom-built Hand Tools*

The hand tools are made after a customer completes a request form to provide a description of the tool or a sketch, and provides information about the desired size, application, finish and torque.

For more information: Wright Tool, 633 West Bagley Road, Berea, OH 44017 U.S. Telephone: (800) 321-2902 (U.S.) or +1 (440) 234-1812.

## Compact Reels Prevent Power Cords From Tangling

Shoreline Reels for power cords and hoses store up to 100 feet (31 meters) of cord or hose and prevent them from becoming tangled, said the manufacturer, TDI Products.

The reels, designed for use in aircraft hangars, are available in several

*Compact Hose Reel*

versions to hold 50-amp power cords, 30-amp power cords, 15-amp power cords and water-supply hoses. The power cords or hoses spool off the reels and can be retrieved using an electrically powered motor.

For more information: TDI Products, 740 South 10th St., Jacksonville, FL 32250 U.S. Telephone: +1 (904) 242-0742.

## Repair Kits Restore Damaged Threads

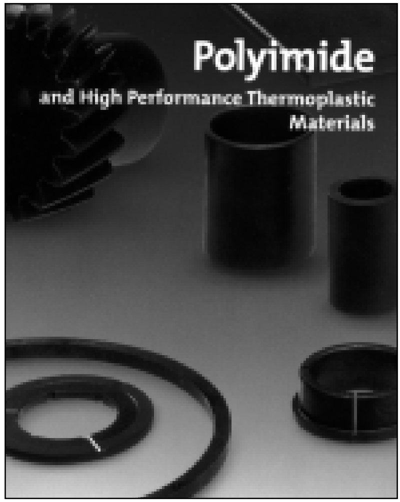
Kato Fastening Systems' thread-repair kits can be used to repair and overhaul stripped threads or damaged threads using helical coil inserts, the manufacturer said.

The Kato-Kits are available in a variety of sizes, and each kit includes tanged inserts, a high-speed steel screw thread insert (STI) tap and a threaded insertion tool.

For more information: Kato Fastening Systems, 11836 Fishing Point Drive, Suite 400, Newport News, VA 23606 U.S. Telephone: +1 (757) 873-8980.

## Thermoplastic Materials Maintain Critical Properties at All Temperatures

Meldin polyimide and engineered thermoplastic materials are available in custom-molded machined components and stock shapes for machining, said the manufacturer, Saint-Gobain Performance Plastics.




*Meldin Polyimide Thermoplastic Materials*

Meldin materials retain their critical properties at temperatures ranging from cryogenic to 600 degrees Fahrenheit (F; 315 degrees Celsius [C]) and may be used intermittently at temperatures as high as 900 degrees F (482 degrees C), the manufacturer said. Meldin materials are strong, rigid and self-lubricating and have applications in many areas, including aircraft and aerospace power systems.

For more information: Saint-Gobain Performance Plastics, 150 Dey Road, Wayne, NJ 07470-4699 U.S. Telephone: +1 (401) 253-2000.♦