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FAA Airworthiness Directives Focus on Ignition Sources in Boeing 747 Fuel Tanks

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Aviation Mechanics Bulletin

Dedicated to the aviation mechanic whose knowledge, craftsmanship and integrity form the core of air safety.

Robert A. Feeler, editorial coordinator

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FAA Airworthiness Directives Focus on Ignition Sources in Boeing 747 Fuel Tanks

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FSF Editorial Staff

The U.S. Federal Aviation Administration (FAA) has issued one Airworthiness Directive (AD) and one Notice of Proposed Rulemaking (NPRM) — a proposed AD — applicable to many Boeing 747 series airplanes to reduce the possibility of fire and explosion caused by potential ignition sources in or near fuel tanks. The AD and NPRM were prompted by the investigation following the Trans World Airlines (TWA) Flight 800 accident.

[On July 17, 1996, at 2031 hours local time, after taking off from John F. Kennedy International Airport (JFK), New York, New York, U.S., a B-747-131 exploded while climbing through 3,965 meters (13,000 feet) and broke into pieces that fell into the Atlantic Ocean near East Moriches, New York, U.S. All 230 people on board were killed.]

The FAA issued emergency AD 97-25-06 on Nov. 26, 1997, and corrected it on Jan. 2, 1998, to include language about acceptable replacement components. The AD was intended to prevent failures within the electrical motor assembly of the B-747 scavenge pump (a low-capacity pump that empties all but the last few gallons of fuel from the center wing tank [CWT, page 2]) that could result in a fuel fire in the wheel well.

The FAA issued the NPRM, a proposed AD [Docket No. 97-NM-272-AD], on Dec. 1, 1997. The proposed AD "would require installation of

components for the suppression of electrical transients and/or the installation of shielding and separation of the electrical wiring of the fuel quantity indication system (FQIS)." The proposed AD said that it was intended "to prevent electrical transients induced by electromagnetic interference (EMI) or electrical short-circuit conditions from causing arcing of the FQIS electrical wiring or probes in the fuel tank, which could result in a source of ignition in the fuel tank."

U.S. National Transportation Safety Board (NTSB) hearings (December 8–12, 1997, Baltimore, Maryland, U.S.) into Flight 800 focused on possible ignition sources for the explosion. NTSB investigators believed that an electrical fault ignited fuel and air fumes in the B-747's CWT, causing the explosion. But NTSB investigators have said that the exact explanation for the TWA Flight 800 explosion may never be known.

The NTSB investigated a number of scenarios in which excessive current to the probes that measure the fuel level in the CWT could have ignited the fuel/air fumes in the tank. These scenarios included: corrosion in the wiring in the tank caused by sulfur in the fuel; a fuel leak through the scavenge-pump connector into the main landing-gear wheel well that caused a fire; explosive vapors in the empty portion

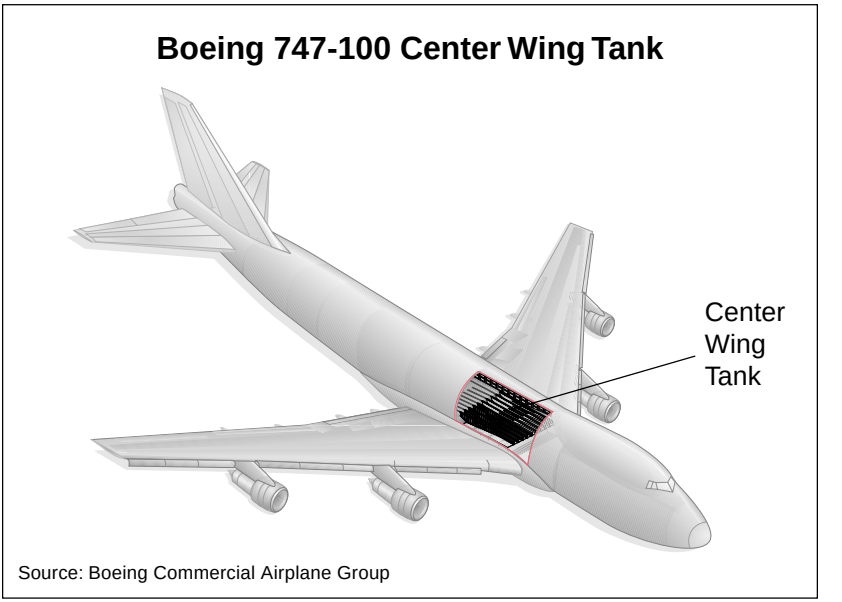


Figure 1

of the CWT; and a series of failures after an electrical short circuit somewhere else in the airplane that sent a surge of power through the low-voltage system of the scavenge pump.

The NTSB eliminated lightning, bird strikes, a bullet, a laser beam, a missile and a meteor as ignition sources. The NTSB said that the fuel pumps were not involved and that there was no sign that power cables had burned through the top of the fuel tank. There also was no evidence of static discharge, engine hot air near the tank, or fire in one of the adjacent wheel wells.

But the NTSB said that three air-conditioning packs, located directly below the CWT, were probably the heat-generating source that warmed Flight 800's kerosene-type fuel into an explosive vapor. Flight tests indicated that the temperature of the vapor in Flight 800's CWT at the time of the explosion was between 45 degrees C and 49 degrees C (113 degrees F and 120 degrees F). The B-747 had been idle on the ground, with its air conditioners operating, for approximately three-and-one-half hours before takeoff, NTSB investigators said.

To reduce the likelihood that a spark could set off an explosion, the NTSB has urged that a system be devised to inject an inert gas (thereby creating an oxygen-deficient fuel-air mixture that will not ignite) into the CWT as it is emptied.

AD 97-25-06 said, "Results of inspections on scavenge pumps removed from the center wing fuel tank of older Boeing Model 747-series airplanes indicated degradation of certain silicone insulating grommet material in electrical connectors of the pump due to the incompatibility of this material with fuel. ...

"Damage to the electrical connector, which is part of the electrical motor assembly of the scavenge pump, could cause potential failures within the electrical motor assembly of the scavenge pump. Such failures could result in leakage of fuel from the electrical connector into the main landing gear wheel well, or electrical arcing [a sustained luminous discharge of electricity across a gap in a circuit or between electrodes] within the scavenge pump motor. These conditions could result in a fuel fire in the wheel well."

The AD "requires disconnection of the electrical connector to the scavenge pump of the [CWT]," and "requires a one-time inspection to identify the part number of the electrical connector; and replacement of the pump with a new pump, if necessary."

The Jan. 2, 1998, correction said, "As published, [AD 97-25-06] contained an inadvertent omission in

reference to acceptable replacement components. … The FAA required that a replacement scavenge pump be new. However, the FAA intended that a serviceable scavange pump also be specified as an acceptable replacement component. In all other respects, the original document is correct."

The FAA reviewed and approved Boeing Alert Service Bulletin 747-28A2206, dated Sept. 25, 1997, which described "procedures for disconnection of the electrical connector to the scavenge pump of the [CWT]."

The AD is applicable to "model 747 series airplanes having line positions 001 through 971 inclusive, certificated in any category" and "applies to each airplane identified in the preceding applicability provision, regardless of whether it has been otherwise modified, altered or repaired in the area subject to the requirements of this AD. For airplanes that have been modified, altered or repaired so that the performance of the requirements of this AD is affected, the owner/operator must request approval for an alternative method of compliance in accordance with ... this AD."

The AD, as corrected, said, "To prevent potential failures within the electrical motor assembly of the scavenge pump, which could result in a fuel fire in the wheel well, accomplish the following:

"(a) Except as provided by paragraph (b) of this AD: Within 90 days after the effective date of this AD, disconnect the electrical connector to the scavenge pump of the [CWT]; and perform a one-time inspection of the pump to identify the part number of the electrical connector; in accordance with Boeing Alert Service Bulletin 747-28A2206 ... .

"(1) If an electrical connector having the correct part number (as specified in the alert service bulletin) is installed: Prior to further flight, reinstall the electrical connector. No further action is required by this AD.

"(2) If an electrical connector having a part number other than the correct part number (as specified in the alert service bulletin) is installed: Prior to further flight, replace the scavenge pump with a new or serviceable scavenge pump with an electrical connector having the correct part number (as specified in the alert service bulletin) in accordance with the accomplishment instructions of the alert service bulletin.

"(b) If a scavenge pump with an electrical connector having the correct part number (as specified in Boeing Alert Service Bulletin 747-28A2206 ...) is not available for installation: The airplane may be operated with the scavenge pump deactivated in accordance with the provisions and limitations

specified in the FAA-approved minimum equipment list (MEL) and paragraph III.A.3 of the accomplishment instructions of the alert service bulletin."

The AD said, "Since a situation exists that requires the immediate adoption of this regulation, it is found that notice and opportunity for prior public comment hereon are impracticable, and that good cause exists for making this amendment effective in less than 30 days." The AD became effective Dec. 16, 1997.

In a second regulatory action, the FAA issued an NPRM, for a proposed AD [Docket No. 97-NM-272-AD] to "prevent electrical transients induced by electromagnetic interference (EMI), or electrical short circuit conditions, from causing arcing of the fuel quantity indication system (FQIS) electrical wiring, or probes in the fuel tank, which could result in a source of ignition in the fuel tank."

The proposed AD said that the FQIS was tested "to determine its performance in accordance with airplane electromagnetic interference (EMI) requirements. In this test, conductive debris, such as steel wool and lockwire, was used to bridge the FQIS probes to simulate debris that has been found during inspections of transport category airplanes."

The proposed AD said that results of the electrical-transient testing revealed that "excessive energy could be induced by high transient-voltage levels in the electrical wiring and probes of the fuel system." The proposed AD said that these electrical transients "may be caused in the airplane when switching electrical loads in the wiring adjacent to the FQIS wiring." These conditions, if not corrected, could "result in excessive levels of energy in the FQIS wiring and consequent potential source of ignition in the fuel tank," the proposed AD said.

The proposed AD said that recent inspections of the fuel probe wiring in B-747 fuel tanks revealed "damaged wiring insulation, which exposed the conductors inside the fuel tank. This condition, together with the introduction of induced transients or short circuit conditions, increases the likelihood for potential ignition sources in the fuel tank."

The proposed AD said, "There are approximately 650 [B-]747-100, -200 and -300 series airplanes of the affected design in the worldwide fleet." The proposed AD said that the FAA "estimates that 167 airplanes of U.S. registry would be affected by this [proposed] AD."

The proposed AD requires the "installation of components for the suppression of electrical transients and/or the installation of shielding and

separation of the electrical wiring of the [FQIS]."

The proposed AD said, "Since the manufacturer has not yet developed a modification commensurate with the requirements of this proposal, the FAA is unable at this time to provide specific information as to the number of work hours or the cost of parts that would be required to accomplish the proposed modification. ...

"However, based on similar modifications accomplished previously on other airplane models, the FAA can reasonably estimate that the modification would require 40 work hours to accomplish, at an average labor rate of [US]$60 per work hour. The cost of required parts is estimated to be $10,000 per airplane."

The FAA opened a 90-day public comment period on the wiring proposal. If the proposal is enacted, operators will have 12 months to comply. Comments must be submitted in triplicate to the Federal Aviation Administration, Transport Airplane Directorate, ANM-103, Attention: Rules Docket No. 97-NM-272-AD, 1601 Lind Ave., SW., Renton, Washington 98055-4056. Comments must be received by March 3, 1998.♦

NEWS & TIPS

International Meeting Maintenance Session Looks at Maintenance Human Factors, Unapproved Parts

Human factors and unapproved parts were primary topics in the Design and Maintenance session of the **Flight Safety Foundation 50th International Air Safety Seminar (IASS), International Federation of Airworthiness (IFA) 27th International Conference and International Air Transport Association (IATA).** The theme of the meeting was "Aviation Safety: Confronting the Future."

An updated analysis of mandatory occurrence reporting (MOR) was presented by Tony (E.A.) Ingham, chief surveyor and head of aircraft maintenance standards, Safety Regulation Group, U.K. Civil Aviation Authority (CAA). Completed in June 1997, the study identified maintenance trends during 1995 and 1996 and found 534 entries in the MOR database that had a human-error factor. Improper installation and servicing dominated the human-error factors, with ultimate causes attributed to inadequate training, inadequate supervision/inspection and inadequate management appreciation of risks.

The most dominant classifications were: equipment and furnishings (231 entries or 16.8 percent); landing gear; flight controls; doors; and engine oil. (Powerplant, engine and systems contributed 239 entries or 17.4 percent of the database.)

Improvement shown in component-overhaul errors and maintenance-recording errors was offset by an increase in installation errors, improper servicing, damage during maintenance, noncompliance with requirements and manufacturing errors, as well as lack of indication that corrective actions had been taken to eliminate the cause of an MOR.

The U.K. CAA hopes to achieve maintenance-related safety goals through integration of human factors knowledge into industry training programs and a review of "human-centered design" to identify poor design features that could induce human factors errors. Also, safety management systems (SMS) will be introduced in the United Kingdom within three years for companies that operate or maintain large aircraft for commercial air transport. The U.K. CAA will develop requirement and guidance material by December 1998, conduct industry workshops by 1999 and encourage the Joint Aviation Authorities (JAA) to adopt a similar initiative.

IFA Executive Director John W. Saull presented a video developed by IFA to increase understanding of human error in aircraft maintenance. Such errors increasingly are cited by accident-investigation bodies as contributory causes of reportable accidents and serious incidents. Boeing Commercial Airplane Group statistics on large transport aircraft cite maintenance errors as the primary cause of about 5 percent of hull losses and a contributory cause in about 17 percent.

The video, "Every Day: A Program about Error Management in Aircraft Maintenance," illustrated that although it is impossible to eliminate human errors in maintenance, it is possible to reduce their likelihood and to lessen their consequences. The video suggested that:

- Simple things often cause problems — missing seals, lockwires, spacers and incorrectly reassembled components;
- Poor communication can cause unwanted incidents;
- Shift handovers are especially prone to communication failures;
- Abnormal or unscheduled line maintenance tasks, especially those involving operational pressures, present weaknesses that need to be understood;
- Tasks performed without detailed staged worksheets carry increased risk; and,

- Individual errors can combine to create hazards; the same task carried out by the same person on two or more systems is particularly risky.

Manuals, worksheets, training, equipment standards and inspection procedures provide a defense against failures, but it is not possible to anticipate every possible combination of circumstances. For long-term success, the video said, the safety management system must identify and remove conditions that bring about human error.

The video introduced the concept of "a just culture" that applies disciplinary action only to errors that involve negligence or irresponsibility, and encourages openness in dealing with human error of the type that can happen to even the most conscientious technicians.

Initiatives developed worldwide to contain human errors in maintenance are costly, IFA says, but savings can be enormous. Boeing calculates that a single hour of delay on the ground can result in US$10,000 in lost business and operational costs; such delays cost world industry many tens of millions of dollars each year.

To order the video and accompanying materials, or for more information, contact IFA. Telephone: 44-171-734-6840; Fax: 44-171-734-2938.

"Crash-related Equipment: The Unknown Risk," presented by Keith Joyner, customer satisfaction and quality executive, Lucas Aerospace, focused on flight safety–critical equipment removed from salvaged aircraft wreckage that finds its way back into operational service.

The typical route for recertification of such equipment begins with aircraft insurers releasing the wreckage for salvage and "recovery" of parts that may qualify for reuse in flight operations. Once recertified, the equipment can be offered for sale on the surplus trading market; nevertheless, the integrity of some recertifications may not stand up to scrutiny.

Lucas Aerospace exposure to a situation involving unidentified accident-related equipment resulted in adoption of enhanced control procedures and support from the European Association of Aerospace Industries (AECMA). A code of practice, developed by AECMA's European Equipment Product Support Committee (EEPSC), targets eradication of uncontrolled surplus trading transactions and encompasses generic guidelines for dealing with aircraft accident- or incident-related equipment.

"Inevitably, any approach to stop the recycling of equipment salvaged from aircraft wreckage [will attract] the charge of protectionism by the [original equipment] manufacturers

[OEMs]," said Joyner. He urged suppliers and buyers to protect themselves and appealed for better cooperation among OEMs, insurers, traders, operators and regulators to control aircraft wreckage and prevent the unsafe and expensive flow of damaged parts.

Also on the panel were Sarah MacLeod, executive director, Aeronautical Repair Station Association (ARSA), who spoke about unairworthy parts, i.e., parts lacking proper identification or certification; and Richard Komarniski, president, Grey Owl Aviation Consultants, who provides human factors training courses. Executives Tony Nunn and Simon Witts of Air U.K. Engineering discussed human-factors awareness and training at all levels of their busy, third-party operation. Challenges for the future include Joint Aviation Requirements (JARs) Part 145 accountability, attracting the next generation of aviation professionals and the need to provide adequate training.

FAA Lists Certificated Mechanics, Certification Field Offices

The U.S. Federal Aviation Administration (FAA) has published the following Advisory Circulars (ACs):

- **AC 65-13R,** *FAA Inspection Authorization Directory.* The AC provides yearly updated listings of certificated mechanics who hold inspection authorizations within the state, U.S. possession or territory in which they are located. To order, send check or money order for US$23.00 to: New Orders, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15270-7954 U.S.
- **AC 20-126F,** *Aircraft Certification Service Field Office Listing.* The AC provides the nearest points of contact for information on issuance of type certificates and supplemental type certificates and changes, as well as issuance of production and/or airworthiness approvals. To order, write to: U.S. Department of Transportation, Subsequent Distribution Office, Ardmore East Business Center, 3342 Q 75th Avenue, Landover, MD 20785 U.S.
- **AC 120-69,** *Use of CD-ROM Systems.* The AC provides guidance on the use of CD-ROM systems for preservation and retention of the maintenance portion of a U.S. Federal Aviation Regulations (FARs) Part 121, 129 or 135 certificate holder's manual. To order, write to: U.S. Department of Transportation, Subsequent Distribution Office, Ardmore East Business Center, 3342 Q 75th Avenue, Landover, MD 20785 U.S.

Bird Strike Committee USA Hosts Meeting About "Practical Wildlife Control Techniques"

The Bird Strike Committee USA will hold its eighth meeting, on the theme "Practical Wildlife Control Techniques for Airports," June 16–18 at the Burke Lakefront Airport (BKL), Cleveland, Ohio, U.S.

Presentations will feature wildlife-control techniques, new technologies, land-use issues such as landfills and wetlands, engineering standards and habitat management.

"The meeting will emphasize hands-on demonstrations and activities (e.g., grass-height plots, bird capture/scare techniques, bird biology, telemetry) during a field trip to BKL, a nearby gull colony and surrounding areas," said the meeting announcement.

For more information, contact: Betsy Marshall, USDA/APHIS/WS, 6100 Columbus Avenue, Sandusky, OH 44870 U.S. Telephone: (419) 625-0242; Fax: (419) 625-8465.

Upcoming Maintenance Events

- **Aeronautical Radio Inc. (ARINC)** will hold its annual Avionics Maintenance Conference (AMC) on March 30–April 2, 1998, in Memphis, Tennessee, U.S. The AMC's objective is to promote reliability and reduced operating cost in air transport avionics by improving maintenance and support techniques through the exchange of technical information.

  For more information, contact: Larry Carpenter, ARINC. Telephone: (410) 266-4116; Fax: (410) 266-2047.

- **The Professional Aviation Maintenance Association (PAMA)** has announced that its Symposium, PAMA '98, will be held in conjunction with the **National Air Transportation Association (NATA)** convention and the Aviation Services and Suppliers SuperShow (AS^3), which combine the former PAMA and NATA trade shows. The 1998 event will take place April 1–3 at Bartle Hall, Kansas City, Missouri, U.S.

  For more information, contact: PAMA (note new address and phone), 636 Eye Street NW, Suite 300, Washington, DC 20001 U.S. Telephone: (202) 216-9220; Fax: (202) 216-9224.

- **The Society of Automotive Engineers (SAE)** 1998 SAE Advances in Aviation Safety

Conference & Exposition will be held April 6–8, 1998, in Daytona Beach, Florida, U.S. This event addresses technical aspects of aircraft design, maintenance and operations in the context of aviation safety.

For more information, contact: Jim Brahney, SAE; Telephone: (412) 772-7131; Fax: (412) 776-0002.

- **Transportation Systems Consulting Corp.** will hold a seminar and workshop on Aircraft Maintenance and Reliability, March 10–13 at New Orleans, Louisiana, U.S. The seminar will teach the Maintenance Steering Group 3 (MSG-3, a task force including representatives of airlines, manufacturers and regulatory authorities) analysis process used to develop and maintain modern, cost-effective maintenance programs and includes Revision 2 (published Sept. 12, 1993), accepted by the U.S. Federal Aviation Administration, as it is applied to systems, powerplants and structures. Workshops will cover reliability and aging-aircraft issues. For more information, contact: Transportation Systems Consulting Corporation, 35111 U.S. 19 North, Suite 101, Palm Harbor, FL 34684 U.S. Telephone: (813) 785-0583; Fax: (813) 789-1143.

U.S. House of Representatives Holds Hearing on Non-U.S. Aircraft Repair Stations

The House Aviation Subcommittee of the U.S. House of Representatives held a hearing in November 1997 on legislation that would hold non-U.S. repair stations and their personnel to the same standards as U.S. stations, and would allow the U.S. Federal Aviation Administration (FAA) to revoke the license of any non-U.S. repair station using substandard or unauthorized parts. The FAA testified that it shares many of the goals of the legislation. Nevertheless, the agency believes these goals can be achieved through a planned update of current regulations clarifying that all significant elements of domestic repair station regulations are to be applied evenhandedly to non-U.S. and U.S. repair stations. Similar legislation has been introduced in the U.S. Senate.

Network Bombardier Aircraft Service Center Opens in Europe

A joint venture of Lufthansa Technik and Bombardier Business Aircraft, Lufthansa Bombardier Aviation Service Center (LBAS) has opened its doors for business. The first facility of its kind outside the United States and the only one in Europe, LBAS will be servicing the business jets of

Canadian airplane manufacturer Bombardier's customers from Europe and North America. Certification of the facility by the FAA is expected in February 1998.

The Center is located at Berlin (Germany)-Schoenefeld Airport at the Lufthansa Technik facility, which since 1991 has been operating as a maintenance and overhaul center for Boeing and Airbus jets. LBAS currently has 22 employees, but hopes to generate 100 high-skill secure jobs as the number of business jets increases in Europe.

LBAS will provide maintenance, repair and overhaul facilities for some 160 Learjet and widebody Challenger business jet aircraft currently in use. Bombardier's new ultralong-range business jet Global Express, currently undergoing flight tests, will be serviced there also.

Maintenance Program Keeps Concorde Young at 20

British Airways' Concorde service between New York, New York, U.S., and London, England, reached its 20th anniversary on Nov. 22, 1997. The aircraft are expected to remain operational another 20 years.

Because of the Concordes' supersonic cruising speed and limited routes, their flight hours, landings and takeoffs total less than 25 percent of the equivalent for a subsonic passenger jet of the same number of calendar years. Each British Airways Concorde flies an average of three hours a day, compared with more than 13 hours a day for a Boeing 747-400 and more than seven hours a day for a Boeing 757. Their condition today is comparable to that of four-year-old subsonic aircraft.

All of British Airways' seven Concordes have been dismantled, repaired and rebuilt to ensure that they remain in nearly mint condition.

Regular corrosion checks form part of one of the industry's most robust maintenance programs. But flying through the atmosphere at 2,172 kilometers per hour (1,350 miles per hour), twice the speed of sound, a Concorde generates enough heat to dry any moisture that accumulated in the aircraft's structure on the ground, and which, on subsonic aircraft, would normally facilitate corrosion.

A program funded by the airline, in consultation with the U.K. Civil Aviation Authority and its French counterpart, the Direction Générale de l'Aviation Civile, is being carried out by the Concorde's manufacturers — British Aerospace and Aérospatiale — to predict the Concorde's life expectancy.

The original life-expectancy indications for the aircraft were deduced in 1983 after subjecting a specimen aircraft to 21,000 flight cycles. All Concordes in the British Airways fleet have completed less than 7,000 flight cycles.

The British Airways Concorde fleet has undergone a US$10 million refurbishing as well, updating the aircraft's interior design, cabin lighting, audio in-flight entertainment systems and galleys to the latest styles and standards in anticipation of another two decades of passenger service flying across the Atlantic in about the same time that it takes to drive from Washington, D.C., U.S., to New York.

Boeing Expands Digital Services

Boeing Commercial Airplane Group now offers services that will give maintenance technicians access to digitized maintenance data and help reduce the need for paper- and microfilm-based information systems.

Under agreements with major jet-engine manufacturers, Boeing will provide their maintenance information over the Boeing On-Line Data (BOLD) service. Digitized versions of the engine makers' shop manuals, illustrated parts catalogs and service bulletins for selected engine types will be accessible to airlines via BOLD, along with other Boeing maintenance data that are already available through the on-line service.

The BOLD databases are accessed in real time on standard computer workstations linked to private, high-speed, wide-area-network providers. For an annual fee, engine manufacturers and other suppliers can use the network to distribute their data, rather than developing and managing their own on-line systems.

Boeing's digitized maintenance information documents will be viewed in the portable document format (PDF), which is compatible with any computer platform.

Boeing also announced that its software product, the Portable Maintenance Aid, which is now available to operators of Boeing 777 and Boeing 747-400 aircraft, has been expanded to include all in-production Boeing models. The software, which contains time-critical maintenance information and is structured to help in troubleshooting, can be loaded into a laptop computer and used in maintenance operations.

A hand-held digital information device that will help ground crews systematically manage airplane turnarounds also has been proposed.♦

FAA and Industry to Improve Engine Inspections

The U.S. Federal Aviation Administration (FAA) will require improved methods and technology to detect potential defects in aircraft engines. Working in partnership, government and industry have agreed to use enhanced inspections for certain high-energy rotating engine components. The initiative is based on an extensive analysis conducted by the FAA and industry on the historical causes of engine-related accidents.

On Sept. 30, 1997, the FAA and international aviation industry experts involved with the manufacture, operation, maintenance, repair and inspection of turbofan engines met and agreed to:

- Implement enhanced inspection requirements that would improve the effectiveness of current engine inspection programs; and,

- Begin, on a priority basis, improved inspections by the first quarter of 1998.

The major turbofan engine manufacturers were to submit to the FAA a plan to incorporate the instructions for enhanced inspections into the maintenance and overhaul manuals for each engine model.

Over the past 10 years, engine reliability has improved steadily as technology advances have cut the failure rate of high-energy rotating components by approximately 50 percent. Nevertheless, the FAA forecasts that commercial aircraft operations will continue to increase by 3 percent to 5 percent per year, which may increase the total number of engine failures unless action is taken to further reduce the failure rate.

FAA Orders Modifications to Older B-737s

The FAA has ordered modifications and more frequent inspections of 33 U.S.-registered Boeing 737s. Emergency Airworthiness Directive (AD) 97-22-07, effective Nov. 12, 1997, accelerates inspections and modifications first ordered in 1994 when cracks, which ultimately could cause a rapid decompression of the aircraft, were found in fuselage skin-panel lap joints, the area where one fuselage skin panel overlaps another.

The inspection program affects 17 aircraft having more than 60,000 flight

cycles. The modification program affects 16 aircraft that have more than 70,000 flight cycles; airlines have already completed the modification on seven of the 16 aircraft.

"FAA's continued emphasis on aging-aircraft issues has led to the identification of cracking in the fuselage skin of certain 737s," said FAA Administrator Jane Garvey. "The modification which was developed not only corrects these problems, but will prevent any future problems in this area."

The 1994 AD (94-25-05), which called for an extensive inspection and repair program as well as a modification to the upper skin of the lap joint, was successful both in repairing this area and preventing further damage to the upper skin.

During the FAA's continued monitoring of this area, the agency received reports of cracks found in the lower skin of the lap joint, which prompted the new AD. Consequently, the FAA is immediately requiring the modification of the lower skin lap joints for aircraft exceeding 70,000 flight cycles. This must be accomplished as a preventive measure regardless of whether cracks have been found. Modifications, expected to cost between US$30,000 and $95,000 per aircraft, ultimately will be required of all B-737 aircraft after they reach 70,000 flight cycles.

The inspection program, affecting aircraft with more than 60,000 flight cycles, reduces the time between inspections from every 3,500 flight cycles to every 1,200 flight cycles. The program also requires the repair of any cracking. For those aircraft with more than 70,000 flight cycles, the inspection time has been reduced to within the next 100 flight cycles. The inspection program is estimated to cost between US$14,100 and $37,140 per aircraft, per inspection cycle.

Airlines currently operating B-737 aircraft with more than 60,000 flight cycles include AirTran Airways, Aloha Airlines, Aviateca, Sierra Pacific Airlines, Southwest Airlines and Vanguard Airlines. There are an additional 34 aircraft operating in the worldwide fleet that have reached 60,000 flight cycles as well as four aircraft in the non-U.S. fleet that have in excess of 70,000 flight cycles. The FAA planned to notify the appropriate airworthiness authorities to alert them to this AD.

For more information, contact: Gregory L. Schneider or Nenita K. Odesa, Aerospace Engineers, Airframe Branch, ANM-120S, FAA, Transport Airplane Directorate, Seattle Aircraft Certification Office (ACO), 1601 Lind Avenue, SW, Renton, Washington, U.S. Telephone: (425) 227-2028 or (425) 227-2557; Fax: (425) 227-1181.

Other Recent ADs Require Attention

- **AD 97-21-04.** Airbus Model A300B4-620, -622, -622R and A300C4-620; and Model A310-221, -222, -322, -324 and -325 series airplanes; equipped with Pratt & Whitney turbofan engines; on which Airbus Modification 10399 or 10400 has not been accomplished; certificated in any category: Requires flow checks of the hydraulic-pump drain system to ensure that the system is not clogged, and correction of any discrepancy. Also requires replacement of the existing seal of the accessory gearbox with a new, improved seal assembly.

  The amendment was prompted by reports indicating that hydraulic fluid had contaminated the engine-oil system as a result of failure of the seal of the hydraulic-pump shaft. Actions specified are intended to prevent clogging of the hydraulic-pump drain system, which could cause failure of the seal of the hydraulic-pump shaft and subsequent contamination of the engine-accessory gearbox oil, a condition which could result in an in-flight engine shutdown.

  A flow check should be performed and repeated at intervals not to exceed 500 flight hours until the required modification is accomplished. Within 12 months after the effective date of the AD (Nov. 24, 1997), the existing seal of the green hydraulic-system gearbox should be replaced on both engines with a new, improved seal assembly in accordance with the AD. Accomplishment of this replacement terminates the repetitive flow-check requirements for this AD.

  For more information, contact: Tim Backman, Aerospace Engineer, Standardization Branch, ANM-113, FAA, Transport Airplane Directorate, 1601 Lind Avenue, SW, Renton, Washington 98055-4056 U.S. Telephone: (425) 227-2797; Fax: (425) 227-1149.

- **Emergency AD 97-20-01.** Boeing 747 series airplanes having line numbers 1 through 500 inclusive, equipped with Pratt & Whitney Model JT9D-3, -7, or -7Q engines, or having line numbers 202, 204, 232 or 257, equipped with General Electric Model CF6 series engines, on which the strut/wing modification has not been accomplished in accordance with Boeing Alert Service Bulletin 747-54A2159, Nov. 3, 1994; or 747-54A2158, Nov. 30, 1994: Requires repetitive

inspections to detect cracks, corrosion or damage of the lower-spar fitting body and lug, and corrective actions, if necessary. The AD was prompted by reports of fatigue cracking in the lower-spar fitting lug on the no. 3 pylon and in the lower-spar fitting body, which could result in failure of the strut and separation of the engine from the airplane.

An earlier AD (AD 95-20-05) required repetitive inspections for cracking in the inboard strut-to-diagonal brace attach fittings, and repair or replacement, if necessary; nevertheless, the FAA has since received reports of fatigue cracking in the lower-spar fitting lug on the no. 3 pylon and in the lower-spar fitting body beyond the inspection area specified in AD 95-20-05.

The airplane on which the lower-spar fitting lug was cracked had accumulated 12,734 flight cycles, with 64,537 flight hours. The lower-spar fitting with the cracked lug had accumulated 1,078 flight cycles from the previous inspection required by AD 95-20-05. The lower-spar fitting with the cracked body had accumulated less than 1,000 flight cycles from the previous inspection required by AD 95-20-05.

Subsequent to the finding of this new cracking, the manufacturer issued, and the FAA reviewed and approved, Boeing Service Bulletin 747-54-2062, Revision 8, dated Aug. 21, 1997, giving procedures for repetitive detailed visual and ultrasonic inspections to detect cracks, corrosion or damage of the lower-spar fitting body and lug, as applicable, and replacement, if necessary; and providing procedures for replacement of the lower-spar fitting with a new steel lower-spar fitting, which eliminates the need for the repetitive inspections.

For more information, contact: Tamara L. Dow, Aerospace Engineer, Airframe Branch, ANM-120S, FAA, Transport Airplane Directorate, Seattle Aircraft Certification Office, 1601 Lind Avenue, SW, Renton, Washington 98055-4056 U.S. Telephone: (425) 227-2771; Fax: (425) 227-1181.

- **AD 97-19-12.** Pratt & Whitney (PW) Models JT8D-1, -1A, -1B, -7, -7A, -7B, 9, -9A, -11, -15, -17, and -17R turbofan engines with fourth-stage low-pressure turbine (LPT) hubs, identified in PW Alert Service Bulletin (ASB) no. A6274, revision 1, dated Dec. 9, 1996. These engines are installed on but not limited to Boeing 727 and 737 series, and

McDonnell Douglas DC-9 series aircraft. The AD is intended to prevent fourth-stage LPT blade failure caused by hub cracking, which can result in an uncontained engine failure and damage to the aircraft.

Effective Nov. 18, 1997, fluorescent-penetrant inspection (FPI) and eddy-current inspection (ECI) of affected fourth-stage LPT hubs for cracks should be performed in accordance with the PW ASB. This action should be taken each time the hub is removed from the module and has been debladed. Any cracked fourth-stage LPT hub should be removed from service and replaced with a serviceable part.

For more information, contact: Pratt & Whitney, Publication Department, Supervisor Technical Publications Distribution, M/S 132-30, 400 Main Street, East Hartford, CT 06108 U.S. Telephone: (860) 565-7700; Fax: (860) 565-4503.

Suspected Unapproved Parts and Procedures Alerts Released

The U.S. Federal Aviation Administration (FAA) Suspected Unapproved Parts Program Office has released the following alerts:

- Brown Aviation Supply, Jacksonville, Florida, U.S., has manufactured an undetermined quantity of aircraft and engine parts (seals, grommets and gaskets) without having FAA design or production authority. Affected are general aviation aircraft and Bell helicopters. For more information, contact: FAA Manufacturing Inspection Office, Campus Building, Suite 2-150, 1701 Colombia Avenue, College Park, GA 30337 U.S. Telephone: (404) 305-7330; Fax: (404) 305-7333.

- Scrap parts for Pratt & Whitney JT9D and Rolls-Royce RB211-22B and -535 engines were stolen from a repair facility. The parts were awaiting mutilation at the time of the theft. There may be an attempt to sell these parts on the open market. The FAA seeks information concerning the discovery of these parts from any source, the means used to identify the source and the actions taken to remove them from aircraft and/or stock. Contact: FAA Flight Standards International Field Office, Gatwick, England. Telephone: 44-1293-573933; Fax: 44-1293-573992.

- An unapproved procedure was accomplished on certain parts of the nose steering assemblies of Fokker F-27 aircraft. A staking

procedure was used to aid in retention of the planetary-gear pins and the dowel pins contained in the housing assembly during the repair or overhaul of the housing assembly. This unauthorized procedure contributed to a nosegear-up landing by an operator. The component overhaul manual calls for oversizing the holes and installing larger pins, rather than this staking procedure. The steering assemblies that could incorporate this procedure are identified by part nos. 893477 and 893477-01. The housing assemblies are identified by part nos. 891808 and 893970-01. There are indications that more than one company used this unauthorized procedure. It should be determined if these housing assemblies have been received or installed. If stake marks are apparent around the gear-pin and dowel-pin holes, further inspection or review of the maintenance records is recommended to ascertain that the approved oversizing procedure had been accomplished subsequent to the unapproved staking procedure. For more information, contact: FAA St. Louis Flight Standards District Office (FSDO), 10801 Pear Tree Lane, Suite 200, St. Ann, MO 63074 U.S. Telephone: (314) 429-0209; Fax: (314) 429-6367.

- Certain rotor blades installed on, but not limited to, Robinson R-22 helicopters were improperly repaired. The discovery was made during an accident investigation involving two fatalities. The tail-rotor blade assembly, part no. A029-1, had been improperly repaired by Cherry Air Specialties, also known as CAS International, previously located in Torrance, California, U.S., and presently in Buckeye, Arizona, U.S. Further investigation indicated that the repair company also may have altered the total time-since-new information in the component life historical records and serviceable tags of the above tail-rotor blade assembly and other main-rotor blade assemblies along with their associated drive components.

  Examination of other documents, as well as a signed statement from the individual under investigation, have revealed possible evidence of additional improper maintenance practices on other helicopter makes and models. All in-stock and installed main-rotor blades, tail-rotor blades and associated drive components should be inspected to determine if any were received from Cherry Air Specialties or CAS International. If so, those items should be checked for evidence of unapproved repairs or

alterations and should include a review of the component's life historical record to substantiate its authenticity. For more information, contact: FAA Long Beach Flight Standards District Office (FSDO), 5001 Airport Plaza Drive, Suite 100, Long Beach, CA 90815 U.S. Telephone: (562) 420-1755; Fax: (562) 420-6765.

- Investigation of Quality Engines Inc., John's Island, South Carolina, U.S., and Standard Aircraft Inc., Belmont, North Carolina, U.S. (not affiliated with Standard Aero Inc.), occurred after numerous customers complained of poor workmanship, failure to meet standards and premature failures on overhauled Teledyne Continental Motors and Avco Lycoming engines and engine accessories. The investigation determined that the above-named facilities may have been involved in aircraft engine overhauls that were contrary to the U.S. Federal Aviation Regulations (FARs).

  Discrepancies in engine and accessory overhaul records indicated that work was not performed in accordance with accepted industry standards and the performance requirements of FARs Part 43.

  Current manufacturers' overhaul manuals and illustrated parts catalogs were not available; replacement parts did not meet minimum service limits requirements; accessories were overhauled by noncertificated repair facilities (for example, repairs performed by automotive electric shops that did not have current aircraft overhaul manuals); some nondestructive testing (NDT) work was done by a noncertificated facility and components were approved for return to service by a mechanic who had no formal training in NDT procedures; engines were returned to service without proper documentation of work accomplished, service instructions, bulletin compliance and airworthiness directive compliance.

  If work was accomplished by the above-named companies, the part or component should be inspected and checked for serviceability and conformity and all documentation should be carefully reviewed for authenticity. If an engine experienced major problems such as complete engine failure, premature accessory failure, low cylinder compression, burned valves, piston failure, metal in the oil screen, engine-overheating indications and other indications of improperly performed work,

contact the FAA Flight Standards District Office (FSDO), 4700 Yorkmont Road, Room 2003, Charlotte, NC 28208 U.S. Telephone: (704) 344-6488; Fax: (704) 344-6485.

For general information on any of the above announcements, contact the FAA Suspected Unapproved Parts Program Office, AVR-20. Telephone: (703) 661-0581; Fax: (703) 661-0113.♦

NEW PRODUCTS

Bimetallic Transition Joints Have Strong Metallurgical Bond

Custom-engineered Bimetallic Transition Joints are available from Nuclear Metals Inc. (NMI). They are designed for use in applications where clamps or fittings would be subject to failure or where space or weight considerations would present a problem.

NMI Bimetallic Transition Joints combine metals such as titanium and stainless steel to form a seamless metallurgical bond that is stronger than the weaker metal. Custom fabricated in sizes from 1.6 millimeters (0.062 inch) to 10.16 centimeters (four inches) outside diameter (OD), the transition joints take the place of mechanical fasteners that are subject to failure from vibration and pressure cycling.

NMI Bimetallic Transition Joints are said to be unaffected by severe thermal or pressure cycling and do not leak when tested at on a helium mass spectrometer.

For more information, contact: Nuclear Metals Inc., 2229 Main Street, Concord, MA 01742 U.S. Telephone: (508) 369-5410; Fax: (508) 369-4045.

Bimetallic Transition Joints from Nuclear Metals Inc.

System Detects Lost Tools Through Magnetic Sensing

FOD Technology Group has developed a detector system that determines a lost tool's location by an audible signal, even through the skin of the aircraft. An aid to solving chronic FOD (foreign object damage) problems, the Aeroprobe™ system pinpoints lost tools that are a hazard in aircraft operations or during hangar maintenance.

Use of the system requires that a tool must be sensitized by the system's activator. The tool is permanently magnetized with a slight magnetic field as it is passed over the activator. A validator display shows the strength of the tool's magnetic field. (Tools containing little or no ferrous material may not be detectable, because they cannot be magnetized. According to the manufacturer, such objects can be made detectable by affixing a metal plug or label.) After sensitization, if a tool is missing, the detector and probe are used to determine its location.

FOD Technology Group Aeroprobe™ tool detector system

The sensing probe is lightweight and small enough to fit into confined areas. Powered by rechargeable nickel-cadmium batteries, detector and probe also have a backup power source of standard nine-volt batteries. The system can be strapped to the operator's waist in a water-resistant carrying case; a clear vinyl cover allows the detector's dial to be monitored without removing the unit from the case, and a storage pocket holds the probe when it is not in use.

The manufacturer reports that the system requires minimal training.

For more information, contact FOD Technology Group Inc., P.O. Box 1057, Rohnert Park, CA 94927 U.S. Telephone: (800) 648-0656 (United States and Canada); (707) 584-1955; Fax: (707) 584-1955.

It Takes a MADMAN To Track Document Revisions

Israel Aircraft Industries (IAI) has developed Manual Amendment

Distribution Monitoring and Notification (MADMAN), a computer application to control and distribute technical literature received from manufacturers and regulatory authorities. MADMAN keeps track of documents that are purchased with an updating service and manages the monitoring and distribution of amendments and revisions. It also tracks missing amendments and failure to return dispatch-received notices.

To accomplish this, the basic literature is entered into the MADMAN database. When new amendments or revisions are received, the amendment data are recorded and the literature is dispatched along with a dispatch notice generated by the application. After the recipient amends the book or manual, the dispatch notice is signed and returned. The database is designed to be secure, updated continuously and operated either in a large networked environment or on smaller systems.

MADMAN makes possible the automation of the following operations:

- Entering new manuals, books and documents with keywords;
- Defining and updating manual or amendment recipient information;
- Searching by keyword, manufacturer, part number or other identification number;
- Recording amendments;
- Notifying recipients who do not acknowledge receipt of dispatched material;
- Computerizing acknowledgment of receipt of dispatched material;
- Production of amendment claim and status reports for manufacturers;
- Archiving data that is no longer considered active, to make search and retrieval of data more efficient; and,
- Ensuring security through password-controlled entry.

For more information, contact Israel Aircraft Industries, Technical Information Center, Department 4416, 70100 B.G. International Airport, Israel. Telephone: 972-3-935-8555; Fax: 972-3-935-5052.

Thermal Transfer Printer Produces Bar Codes

A Raychem Corp. portable thermal transfer printer produces durable, high quality marks on heat shrinkable tubing in the maintenance shop. The TMS-101TT™ produces its bar codes, graphics, logos and marks without being connected to a personal computer or an alternating current (AC) power source.

The print head works by heating microscopic pixels that instantly transfer the coating from ribbon to label, creating images with greater legibility, permanence and clarity than dot matrix or impact printers. Labels produced with the new printer and TMS System Six® products meet military specifications for mark permanence and resistance to solvents.

The TMS-101TT printer produces labels on Raychem's standard System Six heat shrinkable sleeves for marking wire, cable, hoses, tools or test equipment, and works with Raychem's TMS-SCE® and Readyprint® marking sleeves in standard sizes. The flattened sleeves are designed to be fed automatically through the printer and are supplied in a ladder configuration for easy removal.

The printer measures 20 centimeters (7.9 inches) wide by 23 centimeters (8.9 inches) deep and 13.5 centimeters (5.32 inches) tall, and weighs 1.8 kilograms (four pounds). An optional 3.4-kilogram (7.5-pound) sealed lead acid battery with a thin, four-centimeter (1.6-inch) profile can be attached to the bottom of the printer for up to 14 hours of printing time in the field. The printer features a memory cartridge and keyboard, and uses DOS-based software for data entry.

The printer also can operate with a laptop computer for downloading information from a mainframe computer.

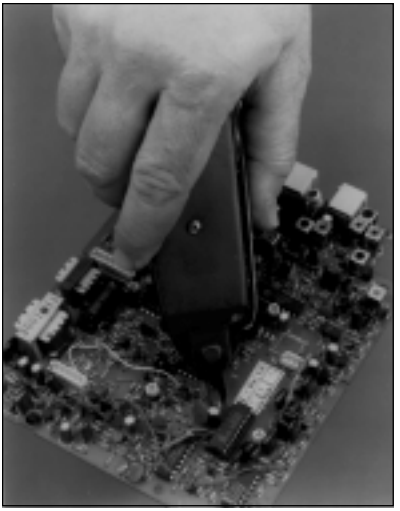
Raychem TMS-101TT™ thermal transfer printer

When connected to a computer it operates with Windows®-based software.

For more information, contact: Raychem Corp., 300 Constitution Drive, Menlo Park, CA 94025 U.S. Telephone: (800) 926-2425 (United States and Canada); (650) 361-3860; Fax: (650) 361-5579.

Pneumatic Cutters Are Vibration-Free

Compact, vibration-free pneumatic cutters, available from Xuron Corp., are said to be comfortable to hold and easily actuated by a light touch from the thumb or forefinger. Manual



Xuron Model 590 Micro-Pneumatic™ Cutters

squeezing, which can lead to repetitive-motion disorders, is avoided.

Xuron Model 590 Micro-Pneumatic™ Cutters feature Micro-Shear cutter blades with patented bypass edges that cut cleanly and are designed to fit comfortably in the palm of a hand. The air-powered cutters produce no recoil and less than 60 decibels absolute (dbA) of noise, and weigh only 170 grams (six ounces).

Using a pressurized, inflated internal bellows, Xuron Model 590 Micro-Pneumatic Cutters are 14 centimeters (5.5 inches) long by four centimeters (1.5 inches) wide by 15.2 millimeters (0.6 inch) thick. Suitable for flush-cutting soft wire up to 1.27 millimeters (0.05 inch), they are available in a standard model with or without a lead retainer and a low-profile unit with a relieved head for easier access in high-density areas.

For more information, contact: Xuron Corp., 60 Industrial Park Road, Saco, ME 04072 U.S. Telephone: (207) 283-1401; Fax: (207) 283-0594.

Transport Engine Stand to Job Site

Red Barn Machine Inc. has introduced an Allison Engine Stand for the Allison 250-C18, -C20, -C28, -C30 and -C47 series turbine engines. Developed for shop or field use, the stand with wheel system can be disassembled into a very small package, transported to the job site and reassembled quickly. It is also said to be ideal for shop use because of its ruggedness and ability to be disassembled and stored while not in use.

The engine is placed between the stand uprights, and can then be rotated 360 degrees for removal and installation of components. Wheels are 7.62 centimeters (three inches) in diameter. Four swivel casters with brakes allow for safe and easy movement of the stand around the shop.

The frame is constructed from heavy-duty steel tubing and electrostatic coated for long life.

Red Barn Machine Inc.
Allison Engine Stand

A heavy-gauge aluminum drip pan is also available.

For more information, contact: Red Barn Machine Inc., 4681 Isabelle Street, Eugene, OR 97402 U.S. Telephone: (541) 344-9953; Fax: (541) 344-3863.

Vinyl Temporary Notes Stick to Work Surfaces

Seton Identification Products has introduced Industri™-Notes that stick to and conform to almost any surface, even dirty tools, and readily accept pen, pencil or marker writing. Created specifically to stick to nonpaper surfaces such as metal, glass, concrete, cork, wood, cloth, computer screens, plastic and textured or dirty surfaces, the 19.4–square centimeter (three–square inch) notes are made of industrial strength, repositionable vinyl.

For more information, contact: Seton Identification Products, Dept. YCS, P.O. Box 819, Branford, CT 06405, U.S. Telephone: (800) 243-6624; Fax: (800) 345-7819.

Ultrasonic Flaw Detector Upgraded

NDT Systems Inc. has upgraded its Quantum QFT hand-held ultrasonic flaw-detection instruments. New features in the Quantum QFT200 include a color-coded, sealed-membrane keypad that offers single-stroke direct access to the most commonly used features, "Gain," "Range" and "Delay"; user-definable option keys; a new menu structure divided into six logical groups so as to minimize searching time; built-in help screens for each menu function; and a built-in tilt stand.

The liquid crystal display (LCD), 12 centimeters (4.8 inches) by six centimeters (2.4 inches), provides superior visibility in bright sunlight or dark areas.

The QFT200 weighs 1.4 kilograms (three pounds), including internal batteries. Each battery lasts up to seven hours on a single 1.75-hour charge. Two batteries are included, as well as battery charger, cables, carrying case, setup and data-transfer program,

personal computer (PC) interconnect cable and operator's manual.

For more information, contact: NDT Systems Inc., 15751 Graham Street, Huntington Beach, CA 92649 U.S. Telephone: (800) 455-4638 (United States and Canada); (714) 893-2438; Fax: (714) 894-2602.

Hearing Protector Is Foldable, Flexible for Convenience and Comfort

Dalloz Safety has expanded its Bilsom® hearing protection line with its new PerCap™ hearing protector. The unit, which uses a folding headband design for easy storage in a pocket when not in use, has a noise reduction rating of 21.

The PerCap is said by the manufacturer to offer several benefits:

- A lightweight, ergonomically shaped headband for maximum comfort, conforms to various head shapes and sizes;
- The headband rotates and the ear pods have a swivel attachment to facilitate wearing in under-the-chin, over-the-head or behind-the-head positions; and,
- Replaceable, dermatologically safe, molded polyurethane foam pads reduce equipment costs and eliminate ear-canal infections caused by hearing protectors.

Dalloz Safety PerCap™ hearing protector

The Bilsom PerCap is said to be suitable for situations in which using hearing protectors must coincide with wearing ear muffs. The unit meets applicable U.S. and Canadian safety standards and its visible headband makes compliance checks easier.

For more information, contact: Dalloz Safety, Second and Washington Streets, P.O. Box 622, Reading, PA 19603-0622 U.S. Telephone: (610) 376-6161; Fax: (610) 371-7725.

Portable White-light LED Has 100,000-hour Lifespan

A portable illumination source that uses a light-emitting diode (LED),

introduced by Ledtronics Inc., is said to give 16 times longer life from a set of AA batteries than a conventional incandescent-bulb flashlight.

Although a full-spectrum (white) LED was thought to be virtually impossible to devise, the hand-held FlashLED™ features three LEDs that emit a pure white light. The LEDs have a typical lifespan of 100,000 hours and a lower power requirement than an incandescent bulb, which significantly lengthens battery life. The FlashLED is said to be rugged because its LEDs are less subject to breakage from shock, temperature or aging than the delicate filament of a conventional bulb.

FlashLED™ from Ledtronics Inc.

For more information, contact: Ledtronics, 4009 Pacific Coast Highway, Torrance, CA 90505 U.S. Telephone: (310) 534-1505; Fax: (310) 534-1424.♦

Upcoming Safety Seminars and Meetings

Managing Aviation Safety — Back to Basics
10th annual European Aviation Safety Seminar (EASS)
Amsterdam, Netherlands • March 16–18, 1998

Safety Outside the Box
43rd annual Corporate Aviation Safety Seminar (CASS)
Hartford, Connecticut, U.S. • May 6–7, 1998

Aviation: Making a Safe System Safer
Joint meeting of the Flight Safety Foundation 51st annual International Air Safety Seminar (IASS), International Federation of Airworthiness 28th annual International Conference, and International Air Transport Association
Cape Town, South Africa • Nov. 16–19, 1998

Contact: Joan Perrin, director of marketing and development
Flight Safety Foundation
601 Madison Street, Suite 300, Alexandria,VA 22314 U.S.
Telephone +(703) 739-6700 Fax: +(703) 739-6708

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March 16–18, 1998

Managing Aviation Safety

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Amsterdam, Netherlands

10th annual European Aviation Safety Seminar (EASS)

Flight Safety Foundation

For information contact:

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Visit our World Wide Web site at http://www.flightsafety.org