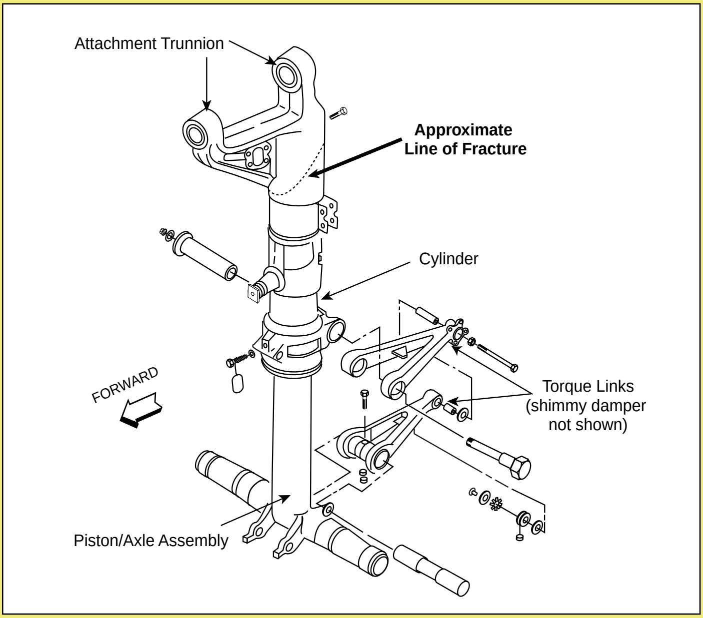
FLIGHT SAFETY FOUNDATION
Aviation Mechanics Bulletin

MAY–JUNE 1997

Fatigue Crack Leads to MD-83 Left Main Landing Gear Collapse on Rollout



FLIGHT SAFETY
FOUNDATION
1947–1997

FLIGHT SAFETY FOUNDATION

Aviation Mechanics Bulletin

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

Robert A. Feeler, editorial coordinator

May–June 1997 **Vol. 45 No. 3**

AVIATION MECHANICS BULLETIN
Copyright © 1997 FLIGHT SAFETY FOUNDATION INC. ISSN 0005-2140

Suggestions and opinions expressed in FSF publications belong to the author(s) and are not necessarily endorsed by Flight Safety Foundation. Content is not intended to take the place of information in company policy handbooks and equipment manuals, or to supersede government regulations.

Staff: Roger Rozelle, director of publications; Rick Darby, senior editor; Glenn Orthmann, editorial assistant; Todd Lofton, editorial consultant; Karen K. Ehrlich, production coordinator; Ann L. Mullikin, assistant production coordinator; and David Grzelecki, librarian, Jerry Lederer Aviation Safety Library.

Subscriptions: US$35 (U.S.-Canada-Mexico), US$40 Air Mail (all other countries), six issues yearly. • Include old and new addresses when requesting address change. • Flight Safety Foundation, 601 Madison Street, Suite 300, Alexandria, VA 22314 U.S. • Telephone: (703) 739-6700 • Fax: (703) 739-6708

We Encourage Reprints

Articles in this publication may be reprinted in the interest of aviation safety, in whole or in part, in all media, but may not be offered for sale or used commercially without the express written permission of Flight Safety Foundation's director of publications. All reprints must credit Flight Safety Foundation, *Aviation Mechanics Bulletin,* the specific article(s) and the author(s). Please send two copies of the reprinted material to the director of publications. These reprint restrictions apply to all Flight Safety Foundation publications.

What's Your Input?

In keeping with FSF's independent and nonpartisan mission to disseminate objective safety information, Foundation publications solicit credible contributions that foster thought-provoking discussion of aviation safety issues. If you have an article proposal, a completed manuscript or a technical paper that may be appropriate for *Aviation Mechanics Bulletin,* please contact the director of publications. Flight Safety Foundation assumes no responsibility for submitted material. The publications staff reserves the right to edit all published submissions. The Foundation buys all rights to published manuscripts. Payment is made to authors upon publication. Contact the Publications Department for more information.

Fatigue Crack Leads to MD-83 Left Main Landing Gear Collapse on Rollout

—

FSF Editorial Staff

On April 27, 1995, a McDonnell Douglas MD-83, owned and operated by Airtours International Aviation (Guernsey), landed at Manchester (England) Airport after a routine flight from Las Palmas, Canary Islands. Touchdown was normal and both main wheels contacted the runway about the same time. During the rollout, the spoilers deployed automatically, and reverse thrust was selected. Brakes were initially applied at about 161 kilometers per hour [kph (87 knots)]. At 115 kph (62 knots), a maximum deceleration of 0.416 G was recorded by the digital flight data recorder.

As the aircraft slowed below 111 kph (60 knots), the captain joined the first officer, the pilot flying, on the brakes. Soon thereafter, there was a loud bang and the sound of tearing metal, and the left main landing gear (MLG) collapsed.

There were no serious injuries to crew or passengers. Damage to the airframe included scraping of the left wing tip, outboard flaps and slats. Several flap hinges were distorted. The primary wing structure, including the integral fuel tank, was intact.

The U.K. Air Accidents Investigation Branch (AAIB) found that the cause of the accident was the failure of the forged landing-gear oleo (hydraulic) cylinder at a point just below its attachment trunnions; that the cylinder failure resulted from a visually undetectable fatigue crack in its forward face; and that the crack began with multiple small fatigue origins associated with grit-blasting during manufacture, but had been exacerbated over time by self-sustaining vibrations of the MLG.

Although the company called for no braking above 148 kph (80 knots), unless safety dictated otherwise, the crew's actions were not found to have contributed to the accident.

The MD-80 series are short- to medium-range transport aircraft with two Pratt & Whitney JT8D turbofan engine pods mounted on either side of the rear fuselage.

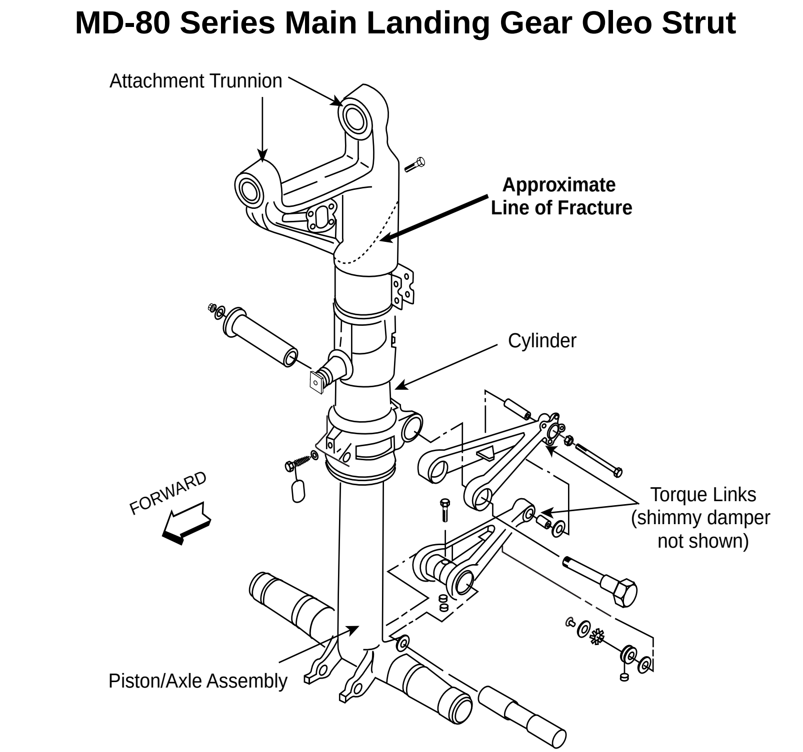
The accident aircraft's landing weight was 57,290 kilograms (126,300 pounds), which did not exceed the MD-83 maximum landing weight of 63, 277 kilograms (130,500 pounds). The aircraft was delivered in 1990, and at the time of the accident had a total of 18,236 flight hours and 6,386 landings.

The MLG for the MD-80 series is manufactured with the same forging dies as the MLG of its predecessor, the McDonnell Douglas DC-9. To allow for the greater capacity and weight of the MD-80, the MLG construction material was changed from the original "Hy-TUF" specification AMS 6418 (used in the DC-9) to ultrahigh-tensile 300M steel.

When the MD-83 MLG gear is extended, suspension and damping are achieved by an oleo-pneumatic cylinder and piston (Figure 1, page 3). Torsional/lateral motion is prevented by a shimmy dampener (not shown). The cylinder, including the trunnions, is a single forging of 300M steel, as is the piston, which incorporates the axle. A critical cross-section occurs about 46 centimeters (18 inches) below the centerline of the landing-gear trunnion, where a reduction in cylinder-wall thickness is found. The report said that McDonnell Douglas considered that the cross-section met normal stress requirements, and that its position close to the top of the leg provided an additional "breakaway" safeguard against wing-tank rupture in runway-overrun situations.

Brakes on the MD-83 comprise an electronic antiskid system controlling conventional hydraulic brakes with steel discs. When operating properly, signals from speed sensors on each main wheel signal the antiskid control unit when a skid is imminent. The control unit responds by reducing hydraulic pressure to that wheel's brakes. As the wheel accelerates again, hydraulic pressure is reapplied, but to a lesser degree. This cycle repeats until the brake pressure adjusts for maximum braking without a skid.

A review of the aircraft's technical records revealed no unscheduled maintenance on the MLG of the accident aircraft. But one crew report in June 1991 said that brake pressure showed 3,200 pounds per square inch



Source: U.K. Air Accidents Investigation Branch

Figure 1

(PSI)–3,300 PSI during initial taxi; and, when the brakes were first applied, the MLG experienced a "savage snatch/[shudder]," after which the brake pressure dropped into the normal 2,500 PSI–3,000 PSI range. Brake pressures and cylinders were checked subsequently and reported to be normal.

Landing gear are affected by two kinds of vibrations: (1) transient vibrations, which are caused by bumps in the runway or sudden changes in braking and are usually benign; and (2) self-sustaining vibrations, which are persistent, have very high amplitudes and are capable of damaging the aircraft. Gear walking is in the second category.

When brakes are applied, the MLG flexes rearward; when the hydraulic pressure is relieved by the antiskid system, the MLG leg springs forward. This action rapidly accelerates the wheel, signaling the antiskid system to reapply the brakes. This causes the wheel to flex rearward again, and so on.

Gear walking is "a dynamic coupling of the characteristics of the antiskid system and the natural fore-and-aft frequency of the MLG leg," the report said, "and can be additionally affected by such factors as tire pressures and bleed condition of the brake system hydraulics ... [74 kph (40 knots)] is the known 'critical' condition at which [gear] walking can occur."

The component that failed on the MLG was the left-hand cylinder. Inspection revealed a crack five millimeters (0.19 inch) long by 1.25 millimeters (0.049 inch) deep on the front face of an otherwise typical cylinder. According to the report, the crack almost certainly was not detectable visually.

On first examination, the fracture seemed to have the characteristics of brittle overload fracture. Closer examination revealed the presence of a small, brown, crescent-shaped area that resembled a pre-existing defect. A metallurgist identified the defect as characteristic of fatigue, and said that, though relatively small, it was probably responsible for the failure of the left MLG leg. It was not possible to perform a striation count, which might have revealed the number of stress cycles over which the fatigue crack had developed.

Mathematical tests using data supplied by McDonnell Douglas concluded that, during the accident landing, the touchdown did not contribute to the subsequent failure of the cylinder, but that heavy braking on rollout created stresses approaching two-thirds of the maximum stress for the material.

Stress analysis commissioned by the AAIB based on recorded flight data substantiated these findings, indicating that the failure of the left MLG cylinder was not precipitated in any way by the operating crew's execution of the accident landing; and that even though the subsequent braking effort fell within the McDonnell Douglas definition of "heavy," an uncracked cylinder should have been capable of withstanding an almost limitless number of such brake applications without failure.

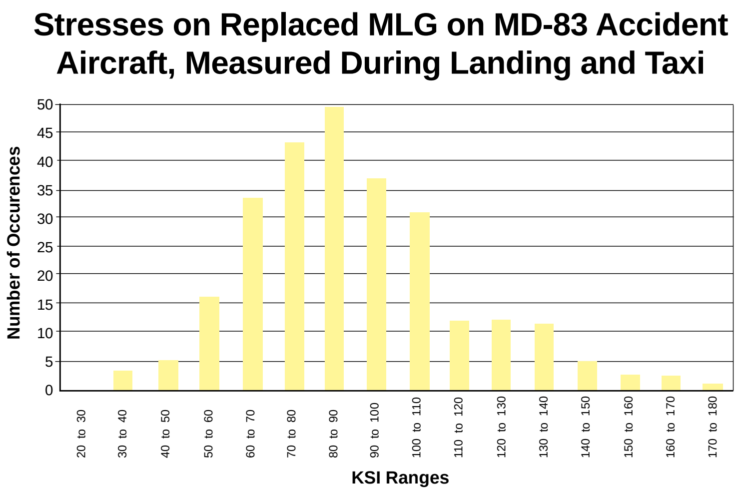
The root cause of the fracture, the report said, "was multiple fatigue origins associated with the rough and uneven surface finish on the outside of the cylinder." These surface flaws were the result of grit-blasting to prepare the steel surface of the cylinder for high-current density cadmium plating. Small particles of aluminum oxide, the grit-blasting agent, were found trapped in surface folds beneath the cadmium plating, and there were microscopic fatigue cracks apparently growing from some of the sharpest and deepest folds.

The weakness generated by grit-blasting was likely to have been increased early in the aircraft's life by gear walking.

Figure 2 shows in-service MLG stress during landing and taxi of the MD-83, as measured by gauges fitted to the replaced left landing-gear strut of the accident aircraft. "The data … show that stresses on the MLG were within the expected values," the report said, "apart from two excursions into the 160–180 KSI range."

Instrumented flight tests were also made by McDonnell Douglas using a McDonnell Douglas MD-87, whose MLG is forged from the same dies as the MLG on the MD-83. The purposes of the test were to measure actual stresses on the MLG of a test aircraft and to evaluate the effectiveness of restrictors placed in hydraulic lines to suppress gear walking.

The MD-87 test aircraft underwent a variety of landing and braking cycles at typical aircraft weights. The tests determined that even rapid and heavy application of the brakes did not — in the absence of gear walking — generate stresses outside the expected range. When pronounced gear walking was induced in the test aircraft, stresses reached levels which, the report said, were "potentially

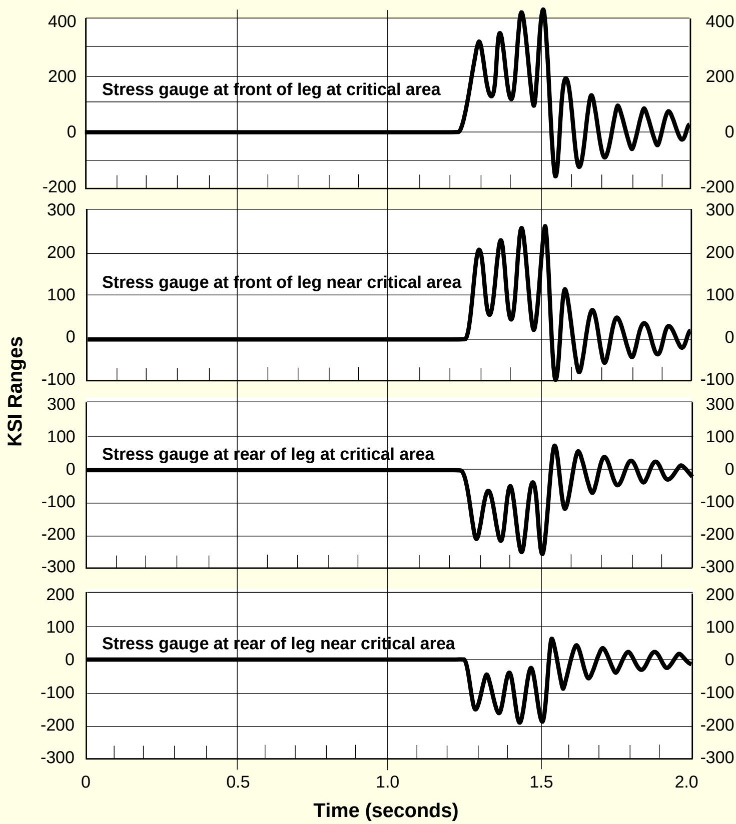


KSI = Thousands of pounds per square inch MLG = Main landing gear

Source: U.K. Air Accidents Investigation Branch

Figure 2

Stress on Test MD-87 MLG During Induced Gear Walking



KSI = Thousands of pounds per square inch   MLG = Main landing gear

Source: U.K. Air Accidents Investigation Branch

Figure 3

catastrophic." The tests also demonstrated that restrictors in hydraulic lines are successful in inhibiting gear walking.

Figure 3 depicts actual MD-87 test results. The four charts show stress readings against time for landing roll-out. In the top chart, the stress gauge was fitted to the front of the leg at the critical (crack) area. As can be seen, gear walking was induced at about 1.3 seconds. It lasted for less than half a second, but during that time, stress on the MLG leg reached four times normal levels. The second chart shows the same data for a gauge slightly displaced from the critical area. The bottom two charts depict the results from gauges located at the rear of the leg.

The report said, “The aircraft manufacturer was clearly aware of the ‘gear walking’ phenomenon on the MD-80 series prior to the accident investigation, but was apparently unaware of the high stresses generated by ‘gear-walk mode 2,’ which is defined as a violent event with stress levels of [272 KSI] or more ... .”

As a result of this accident, and in view of the possibility that occurrences of gear walking may have gone unrecorded, the U.S. Federal Aviation Administration (FAA) and McDonnell Douglas required inspections of MD-80 series aircraft to check for cracking of the MLG cylinder in a critical area.

Alert Service Bulletin (ASB) MD-80-32A286, issued by McDonnell Douglas on Sept. 11, 1995, called for magnetic-particle and fluorescent dye-penetrant crack detection on the MLG cylinders on all MD-80 series aircraft. FAA Airworthiness Directive (AD) 95-22-06, effective Nov. 8, 1995, made the requirements of ASB MD-80-32A286 mandatory for all aircraft on the U.S. register.

AD 96-01-09 subsequently mandated the fitting of in-line hydraulic restrictors on all MD-80 series aircraft MLG.

The AAIB report recommended that the FAA review its AD 95-22-06 to consider requiring repeat inspections, — even after restrictors have been installed — of landing gear that was ever operated without restrictors.

The accident report also recommended that the FAA and the U.K. Civil Aviation Authority coordinate a study to develop surface treatment for highly loaded, high-tensile steel components that will achieve fatigue resistance and surface protection without introducing surface stress-raising features.♦

Editorial Note: This article is derived from Aircraft Accident Report 1/97 (EW/C95/4/2), *Report on the Accident to Douglas Aircraft Company MD-83, G-DEVR at Manchester Airport on 27 April 1995*, prepared by the Air Accidents Investigation Branch (AAIB), U.K. Department of Transport, Defence Research Agency, Farnborough, Hampshire, GU14 6TD, England.

Airframe & Engine Maintenance/Repair Conference Set for Vancouver

The Society of Automotive Engineers Inc. (SAE) will bring together an estimated 400 attendees and 25 exhibitors for its Airframe & Engine Maintenance/Repair Conference & Exposition (AEMR) on Aug. 6–10, 1997. Vancouver, British Columbia, Canada, will be the location; the exact venue has not yet been set.

Topics to be discussed at the conference will include continued airworthiness, nondestructive testing systems and equipment, advanced plating, and metal-finishing equipment and services.

For further information, contact: SAE Professional Development, 400 Commonwealth Drive, Warrendale, PA 15096-0001 U.S. Telephone: (412) 772-7148; Fax: (412) 776-4955.

FAA Considers Changing Aircraft-mechanic Training Requirements

The U.S. Federal Aviation Administration (FAA) is considering (1) replacing the present airframe and powerplant (A&P) license with an aircraft maintenance technician (AMT) license; and (2) requiring an additional year of training to qualify for the transport (AMT-T) rating.

Under the new system, earning the equivalent of two-year A&P will take three years. Nevertheless, current holders of A&P certificates would automatically become AMT-Ts.

Other changes under consideration include instituting biannual (every two years) renewal of certificates and recurrent training.

FAA Proposes One Record-keeping Standard for All Aircraft

A soon-to-be-released U.S. Federal Aviation Administration (FAA) Notice of Proposed Rulemaking (NPRM) is expected to require a single record-keeping standard for all U.S.-registered aircraft owners and operators, regardless of what U.S. Federal Aviation Regulations part the aircraft operates under (Part 91, 121 or 135).

One intended benefit of the proposed change would be more accurate projections of maintenance needs and downtime. Another anticipated benefit would be more efficient maintenance record keeping, which could facilitate the sale of aircraft.

At the time of this writing, there is no firm release date on the NPRM.

Aircraft Maintenance Safety Course for Managers and Supervisors Scheduled

The Southern California Safety Institute will offer Aircraft Maintenance Safety, a course for maintenance managers or supervisors and safety managers, on Oct. 27–31, 1997, in Albuquerque, New Mexico, U.S.

The course focuses on basic accident prevention on the flight line and in the hangar and maintenance shop. Regulatory and administrative requirements and environmental issues are also addressed.

Topics will include hangar and maintenance shop safety; occupational safety and health; right-to-know requirements; environmental protection; storage and handling of hazardous materials; regulatory requirements; and safety program administration. There will be 36 hours of classroom instruction, and students will receive a textbook, lecture outlines, additional reference material and a certificate of completion.

For more information, contact: Southern California Safety Institute, 3838 Carson Street, Suite 105, Torrance, CA 90503-6705 U.S. Telephone: (310) 540-2612; Fax: (310) 540-0532.♦

MAINTENANCE ALERTS

Twin-turbocharged Cessnas Remain Vulnerable to Exhaust-system Failures

In-flight exhaust failures in twin-turbocharged Cessnas, a problem first addressed by U.S. Federal Aviation Administration (FAA) Airworthiness Directive (AD) 75-23-08 in 1975, have increased in recent months, perhaps because of the long service life of existing exhaust-system components.

Exhaust-system failure in twin-turbocharged Cessnas can trigger a chain of events that leads to engine fuel starvation or a fuel-fed fire that burns through the front wing spar and causes the wing to fail. Cessna owners or maintenance technicians should conduct a careful visual inspection and pressure test of the aircraft's exhaust system.

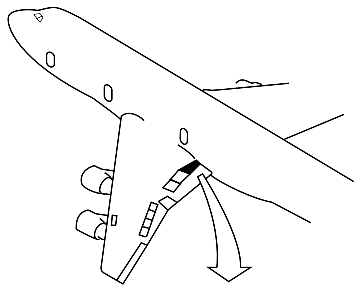
Faulty Repair of B-747 Wing-panel Honeycomb Cells Results in Unscheduled Landing

During the climb phase of a Boeing 747-236B flight from London, England, to Delhi, India, the flight crew noticed a moderate airframe vibration that began when the flaps were raised from five degrees to one degree. The vibration continued when the flaps were raised from one degree to zero degrees, became "slight" after flaps-up, and returned to moderate as the aircraft passed through 8,083 meters (26,500 feet) at Mach 0.83. The vibration reduced once again after the plane leveled off at 8,235 meters (27,000 feet), and the speed was reduced to 574 kilometers per hour (310 knots) indicated airspeed.

The captain decided to dump fuel and return to Heathrow Airport, London, where the landing was uneventful.

An inspection of the aircraft revealed that a large section of the left-wing trailing-edge upper inboard panel had broken away (Figure 1). This panel is sometimes referred to as the "flying panel" because it is deflected upwards

Boeing 747 Trailing-edge Wing Panel Lost on Accident Flight



Source: U.K. Air Accidents Investigation Branch

Figure 1

into the slipstream while the flaps are being retracted. The panel is constructed of fiberglass skin around a DuPont Nomex® honeycomb core that is impregnated with phenolic resin to form a strong, lightweight and rigid material that is used in aircraft panels, flaps and control surfaces. The panel is supported by a torsion bar that is rigged to pull down on the panel when the flaps are fully retracted, thus providing an aerodynamic seal between the flaps and the panel.

Damage included a large tear and several minor tears on the upper surface of the fore (inboard) flap. Detaching panel fragments had caused minor scuffing on the center and outboard flaps and on the fuselage paint aft. Beneath the panel, one of the torsion-bar struts had failed from overloading.

Damage Resulted From Partially Filled Honeycomb

Examination of the recovered panel indicated that the failure had begun in the bond between the upper skin and the core and that the failure was associated with previous repairs. A closer examination of the section of the panel containing the repairs showed a spanwise wrinkle in the upper fiberglass skin, caused by a partially filled region of the honeycomb.

Filler had apparently been added to that region of the honeycomb, but had not penetrated to the full depth of the honeycomb cells. A subsequent repair had been made involving a honeycomb insert. But no attempt had been made to join the inserted plug to the surrounding core. All repairs had been carried out using cold-setting adhesives.

It was concluded by the U.K. Air Accidents Investigation Branch (AAIB) that the failure was the result of a localized change in stiffness in bending caused by the filler in the core. It is probable that pieces of the panel detached after the aircraft became airborne, and that additional minor damage occurred as the flaps were retracted and the forward edge of the flap was brought into contact with the broken trailing edge of the panel.

Panel Repaired In Accordance With Manual

The airline stated that prior to September 1995 the panel had been repaired in accordance with the Boeing *Structural Repair Manual (SRM)*. In October 1995, a design deviation authority (DDA) was granted, which allowed the aircraft to remain in service with a crack that had appeared from the *SRM*-based repair. [DDA is a U.K. Civil Aviation Authority (CAA)-approved procedure that permits the airline to design and implement repairs that constitute minor deviations from the aircraft manufacturer's process or drawings.] Under the DDA, the crack was marked with ink, to check for any further propagation, and was taped to prevent moisture entry. The DDA also called for reinspection of the panel every 190 flight hours and repair of the crack in December 1995.

An additional DDA was issued on Oct. 9, 1995. It called for a temporary repair of the delamination that had occurred around the original repair, as well as the cracking. The additional DDA also called for a check of the repair every 540 flight hours and terminating action in December 1996, which introduced a redesigned and strengthened panel.

Deviations from *SRM* Were Discontinued

As a result of this incident, a special check was instituted by the carrier to inspect and repair, as required, all trailing-edge flying panels of all of its B-747 aircraft. Aircraft with *SRM*-based repairs were to be inspected within one month; all other aircraft were to be inspected as soon as possible. Deviations from the *SRM* concerning the panel were discontinued and the *SRM* was amended to permit no cracks.

The airline also publicized the problem of the damaged panels in its in-house technical newsletter and, considering that panel damage could also result from maintenance personnel walking on the panels during inspection and servicing, had all panels placarded “No Step.”♦

NEW PRODUCTS

Hand-held Printer Aids Wire Identification

A product upgrade designed to improve the production speed and legibility of labels for wires in complex electrical, telecommunications, electronic and pneumatic systems has been introduced by Brady USA Inc.

The I.D. PRO™ Plus, an outgrowth of I.D. PRO, is a portable, hand-held printer that can be used in marking wires and cables in the shop, and for preprinting labels for applications including quality assurance, maintenance, calibration and asset identification.

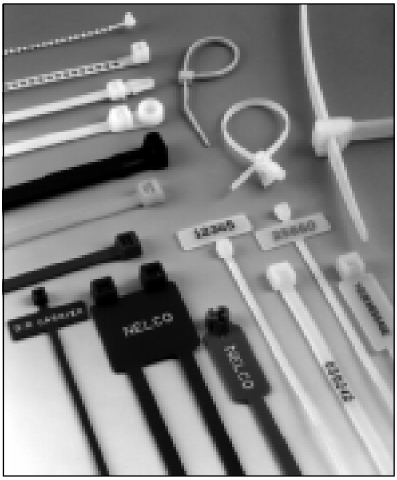
The I.D. PRO Plus can print on rolls of three widths: 1.3 centimeters (0.5 inch), 2.5 centimeters (one inch) and 3.8 centimeters (1.5 inches). A self-adjusting print head allows printing on self-laminating vinyl, cloth and heat-shrinkable tubing. The unit weighs 0.7 kilograms (1.6 pounds).

The I.D. PRO Plus is said to improve on the I.D. PRO by:

- Increasing the print speed by 43 percent;
- Improving print quality and adding a boldface option;
- Providing automatic label serialization that automatically advances label numbers by one digit in a series preset by the user; and,
- Allowing eight lines of variable text.

For further information, contact: Brady Response Center, P.O. Box

3064, Cedar Rapids, IA 52406 U.S. Telephone: (800) 216-8396 (United States and Canada); (414) 358-6600.



Nelco Products cable ties

Cable Ties Offer Customized Identification or Warnings

Nelco Products Inc. has introduced cable ties that can provide permanent identification, or a message such as a warning, on the cables to which they are attached. The ties are custom made from a wide variety of materials, including standard, flame-retardent, ultraviolet-stabilized type-66 nylon and chemical- and radiation-resistant Tefzel®. The ties are available in a range of standard and fluorescent colors, in lengths from 7.6 centimeters to 1.5 meters (three inches to 4.8 feet) and are offered in standard, releaseable, screw-mount, push-mount, beaded, ladder and marker tags in one-, two- and three-tie versions.

Nelco custom ties are priced according to style, size and imprinting requirements. For further information, contact: Nelco Products, 77 Accord Park Drive, Norwell, MA 02061 U.S. Telephone: (800) 346-3562 (United States and Canada); (617) 871-3115; Fax: (617) 871-3117.

New Tool Box Has Sliding Trays for Small Parts, Storage Compartment For Bulky Items

The new Hand Box with Sliding Trays by Sears Craftsman® provides storage for both small parts and bulky tools. The product provides 20,795

Hand Box with Sliding Trays by Sears Craftsman®

cubic centimeters (1,269 cubic inches) of storage space in a lightweight plastic box that Sears says is durable and chemical-resistant.

Trays at the top of the storage compartment slide open, allowing a clear view of their contents. Tray dividers are removable for flexibility, and hinged covers on the trays secure the contents when the box is moved. Below the trays is a bulk storage area for larger tools or items.

For more information, contact: Sears, 3333 Beverly Road, BC-118B, Hoffman Estates, IL 60179 U.S. Telephone: (847) 286-7079.

Lift Tables Use Shop Air

Presto Pneumatic Lift Tables use shop air rather than hydraulic cylinders, motors, pumps, fluids and seals to provide vertical travel and tilt of the table top. Capacities of the tables range from 454 kilograms to 3,629 kilograms (1,000 pounds to 8,000 pounds), and tables can be equipped with hand, foot or pedestal controls. The compressed-air lifting system employed is the Firestone Airstroke Actuator.™

The manufacturer of the tables, Lee Engineering Co., states that the absence of hard wiring makes the table relatively easy to install. Use of shop air eliminates the need for hydraulic maintenance.

Presto Pneumatic Lift Table

For further information, contact: Dianna Cole at Lee Engineering Co. Inc., 505 Narragansett Park Drive, Pawtucket, RI 02861 U.S. Telephone: (401) 725-6100; Fax: (401) 728-7840.

LEDs Get Out of the Red

For a long time, red was the only daylight-visible color available in light-emitting diodes (LEDs). Because of recent advances in technology, LEDs are now available in virtually all colors of the spectrum — according to Ledtronics Inc., manufacturer of LEDs — and are ideal replacements for conventional filament bulbs in many uses. Maintenance shop applications might include status-indicator lights, control panels, signs, emergency annunciators and displays.

LEDs have several advantages over conventional bulbs. They last much

New LED applications from Ledtronics

longer: 100,000 hours or more. They use a fraction of the power required for conventional bulbs. And their solid-state design allows them to withstand shock, vibration and frequent switching without harm. Because the light's inaccessibility would make changing a bulb almost impossible, rear window–mounted taillights on today's automobiles are LEDs.

The efficiency of LEDs is apparent in applications requiring color. White light from an incandescent bulb must be filtered so that only the desired part of the spectrum — red, green or amber, for example — can get through. Some 90 percent of available light energy is thus wasted. LEDs deliver 100 percent of their energy as light.

LEDs emit a focused beam of a single wavelength (color) in a single direction. But multiple arrays for LEDs can now project light in the same three-dimensional pattern as incandescent bulbs.

Ledtronics offers several thousand LED products with a variety of light bases and sizes. For more information, contact: Ledtronics Inc., 4009 Pacific Coast Highway, Torrance, CA 90505 U.S. Telephone: (310) 534-1515; Fax: (310) 534-1424.

Videotapes Demonstrate Aircraft Tire Maintenance

Tire Flight Plans, a videotape package about aircraft tire maintenance

Videos teach aircraft tire maintenance

and servicing, has been released by Goodyear Tire & Rubber Co. The first of the two 15-minute videos is titled "Selecting, Mounting and Inflating Aircraft Tires"; the second video is titled "Operating Conditions, Inspections and Demounting."

The videos, which are available in both NTSC and PAL formats, also examine selecting tires that are compatible with various aircraft and runway conditions; knowing when to remove a tire from service; and performing a thorough wheel-assembly inspection.

For more information, contact: Jim Pickering, Goodyear Aviation Products, Dept. 798, 1144 East Market St., Akron, OH 44316 U.S. Telephone: (330) 796-6306; Fax: (330) 796-6535.♦

BLANK
INSIDE
BACK
COVER

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