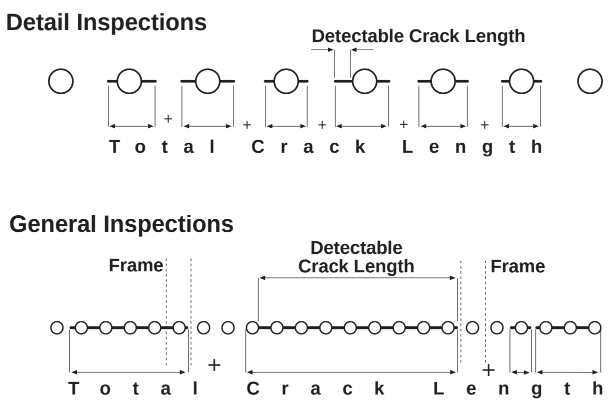
FLIGHT SAFETY FOUNDATION
Aviation Mechanics Bulletin

MARCH–APRIL 1998

Corrosion and Fatigue-crack Detection Remains Critical to the Continued Airworthiness Of Aging Aircraft

Total Fatigue Crack Length Is Equal to the Sum of All Adjacent Cracks



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

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Cover illustration: David V. Finch, structural airworthiness consultant

Corrosion and Fatigue-crack Detection Remains Critical to The Continued Airworthiness Of Aging Aircraft

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FSF Editorial Staff

As airframes grow older, accumulated fatigue and corrosion degrade their strength, but many airline-type aircraft are being flown well beyond their original design-service objectives. These aircraft were designed so that the majority of defects can be found by inspection while the aircraft is still strong enough to carry normal flight loads. Early detection of problems is made possible by a variety of technologies and by maintenance and inspection programs tailored to detect defects identified through operating experience.

Transport-category aircraft structures are currently designed to have fail-safe characteristics and to be damage tolerant. David V. Finch, structural airworthiness consultant, said, "Damage-tolerant analysis and certification specifies the inspection program that is necessary to ensure that the safe limit of deterioration or damage is not exceeded in service.

"Fail-safe design permits a limited amount of deterioration or damage before the aircraft becomes unairworthy," Finch said.[1] This design principle allows continued safe operation of an aircraft for a limited period after the aircraft has sustained in-flight damage.

Fleet design-service statistics for 13 older aircraft are summarized in Table 1 (page 2). The 13 airframes were not certificated originally to damage-tolerant criteria, but do incorporate both fail-safe and damage-tolerant features in their designs.[2]

Table 1
Fleet Statistics for Aging Large Jet Aircraft

Aircraft*	Entered Service	Design Service Objective Cycles	Active Aircraft: Number	Operational Use: Other**	Operational Use: Cargo	Operational Use: Passenger	Highest Cycles	Exceeding Service Life Objective (Number/%)	Test Supported Life Cycles (L)	Lead Aircraft Service/Test Ratio (R)
B-707 (1)	1958	20,000	58	—	—	—	36,400	42 (72%)	25,000	1.46
B-727	1964	60,000	1,179	—	—	—	77,500	13 (1%)	85,000	0.91
B-737	1968	75,000	2,691	—	—	—	92,800	27 (1%)	75,000	1.24
B-747	1970	20,000	942	—	—	—	33,900	71 (8%)	20,000	1.70
DC-8 (2)	1959	25,000	296	—	250	46	48,270	103 (35%)	70,200	0.69
DC-9	1965	40,000	855	—	165	690	104,644	740 (87%)	102,400	1.02
DC-10-30	1971	30,000	249	—	103	146	29,511	0	30,000	0.98
L-1011 (3)	1972	36,000	159	5	17	137	36,352	3 (2%)	26,250	1.38
A300B2 (4)	1974	48,000	33	—	—	33	35,573	0	48,000	0.74
A300B4-100	1975	40,000	32	—	1	31	35,085	0	48,000	0.73
A300B4-200	1975	34,000	81	1	6	74	34,000	0	48,000	0.71
BAC 1-11 (5)	1964	55,000	112	26	5	81	80,116	6 (5%)	57,000	1.42
F28 (6)	1969	90,000	9	—	—	9	89,656	0	70,000 @6.60 psi	1.28
			199	—	11	188	69,705	0	75,000 @7.45 psi	0.93

*Unless otherwise specified, aircraft models include all aircraft series manufactured prior to the date given in footnote.
**Includes special scientific and military use, a flying hospital, and corporate V.I.P. jets.

Source: Flight Safety Foundation and David V. Finch, structural airworthiness consultant

Table 1 Notes

(1) B = Boeing. Boeing Commercial Airplane Group data, Dec. 31, 1997.

(2) DC = McDonnell Douglas. Boeing–Douglas Products Division data, Dec. 31, 1997.

(3) L = Lockheed. Lockheed Martin data, Dec. 31, 1997. Seven cargo aircraft are in military tanker/freighter configuration; 50 additional airworthy aircraft are either stored or being modified. Operational use numbers are estimated.

(4) A = Airbus. Airbus Industrie data, Feb. 28, 1998. There are a total of 45 A300B2s, 58 A300B4-100s and 123 A300B4-200s in existence. The number of active aircraft fluctuates each month. A large proportion of the nonactive A300B4 aircraft — including more than 50 A300B4-200s — are either being converted, or are scheduled to be converted in the near future, to a cargo configuration.

(5) BAC = British Aerospace Corp. British Aerospace data, April 15, 1998. Service to 85,000 cycles has been approved.

(6) F = Fokker. Fokker Services data, Dec. 31, 1997. F100 (an F28 derivative) fatigue test data (tested to 2 x 90,000 cycles) are also used to update the F28 structural inspection program. F28 aircraft with serial numbers 11016 and up were modified to accept the higher pressure differential.

(L) Test-supported life equals full-scale fatigue test cycles on pressure fuselage x 1/2.[3] The concept of test-supported life is not accepted by all manufacturers.

(R) A value of R greater than 1.0 indicates that the full-scale tests may not offer assurance that widespread fatigue damage will not exist on the lead aircraft. Other tests and/or analysis may provide such assurance. Fatigue test specifications and procedures vary between aircraft models. Refer to manufacturer for further details.

The data in Table 2 through Table 5 (page 4) include all service-difficulty-reporting data reported to the U.S. Federal Aviation Administration (FAA) for Boeing 737s and McDonnell Douglas DC-9s during 1992 and 1993. Some of the events occurred prior to 1992, but reporting was delayed. The data in Table 2 and Table 3 show that cracking and corrosion remain significant problems in older aircraft. For the models shown, the majority of these problems occurred in the fuselage. Table 4 and Table 5 show that within the fuselage, the skins and their immediate substructures require the most attention for crack inspection and repair. Longerons, skins and floor beams require the most attention for corrosion inspection and repair problems. Although these data (Table 2 through Table 5) do not take fleet size into account, the proportion of events within a particular model line indicates that the same general problems are suffered, regardless of the aircraft's manufacturer.[4]

"[Although] entirely inadequate to decide inspection priorities by itself, the … information will be used to help ensure the proper allocation of resources to aging-aircraft-inspection issues," said Chris Smith, manager of inspection systems research at the FAA W.J. Hughes Technical Center.[4]

To maintain the structural integrity of aircraft that are flown near or past their design-service objectives,

Tables 2-5
Service Difficulty Reporting Data for Cracks and Corrosion

Table 2
Number of Airframe Cracking Incidents Reported in 1992 and 1993

	Fuselage	Wings	Empennage	Doors	Nacelles	Landing Gear
Cracks	5,247	1,451	441	570	247	213
B-737 cracks	798	68	7	67	2	1
DC-9 cracks	791	95	76	122	23	5

Table 3
Number of Airframe Corrosion Incidents Reported in 1992 and 1993

	Fuselage	Wings	Empennage	Doors	Nacelles	Landing Gear
Corrosion	9,615	1,112	303	195	70	193
B-737 corrosion	930	56	25	8	0	1
DC-9 corrosion	659	124	20	24	1	11

Table 4
Fuselage Cracking Reports

	Frames	Bulkheads	Longerons	Keel beam	Floor beams	Skins/ plates	Attachments
Cracks	949	360	532	42	270	1,048	86
B-737 cracks	149	42	57	19	64	245	6
DC-9 cracks	124	49	142	1	5	212	20

Table 5
Fuselage Corrosion Reports

	Frames	Bulkheads	Longerons	Keel beam	Floor beams	Skins/ plates	Attachments
Corrosion	645	149	1,495	109	1,340	1,402	819
B-737 corrosion	61	2	100	15	306	105	76
DC-9 corrosion	91	24	107	15	47	98	71

Source: U.S. Federal Aviation Administration many aircraft are subject to mandatory repairs and specific directed inspections to detect corrosion and fatigue cracking.

"Corrosion thinning reduces the residual strength of aircraft components, and corrosion pits are nucleation sites for fatigue cracks," said Smith. "Other detrimental effects of corrosion may include accelerated crack-growth rates and added stresses from corrosion growth in confined spaces."

Dave Chaney, manager of quality control at Polar Air Cargo, a U.S.–based Boeing 747 cargo operator, said that regarding corrosion, lap-seam joints are the greatest concern for the aircraft he maintains.

Chaney said, "Corrosion problems in a lap seam result in distortion of the aircraft surface in a way that causes 'bubbles' or 'pillows' to appear on the outer surface."[5] After these areas are identified visually, maintenance action can be taken.

Although most corrosion is detected visually, eddy-current and ultrasonic nondestructive-inspection (NDI) techniques are used for some very difficult-to-access areas and for damage assessment before corrective action is taken.

"Of all the flaws in airframe structure, cracks are perhaps the most serious," said Smith. "Fortunately they are also the best understood. The severity of a crack is directly related to its length and generally its length is directly related to its detectability.[4]

"As [an] aircraft ages, these [directed] inspections become increasingly more problematic: inaccessible areas, multiple failure modes and unique structure all complicate the inspection. Many of these inspections will be even more difficult if the repeat interval forces operators to perform the inspections at other than a regularly scheduled heavy-maintenance check."[6]

Widespread fatigue damage (WFD) — the simultaneous presence of cracks of sufficient size and density at multiple points within the airframe such that the damage tolerance of the structure is compromised — and multiple-site damage (MSD) — the simultaneous presence of multiple fatigue cracks in a single structural element — are primary concerns for aging aircraft structures.[7]

Research and development of new technologies for NDI have been conducted at the FAA Technical Center, which is currently the primary sponsor of a team of U.S. universities and laboratories serving as the FAA's Airworthiness Assurance Center of Excellence (AACE). The team includes Iowa State University, Ames, Iowa; Ohio State University, Columbus, Ohio; Sandia National Laboratories, Albuquerque, New Mexico; Arizona State University, Tempe, Arizona; and the University of California, Los Angeles, California.

Some of the corrosion and fatigue-crack inspections that are today conducted visually or with eddy-current or ultrasonic NDI equipment will be enhanced by new technologies that can quantify corrosion damage and can "see" deeper into the structure.

New NDI and nondestructive-evaluation (NDE) technologies under development at AACE include pulsed eddy-current devices that use a wide bandwidth to allow a single probe and a single measurement to provide information across a broad frequency range. This allows technicians to detect corrosion in lap splices and to detect hidden cracks deep in the material.[8]

Infrared (IR) thermal-wave imaging, developed at the Center for Aviation Systems Reliability, Wayne State University, Detroit, Michigan, U.S., uses flashlamps to create pulsed surface heating. Synchronous IR video imaging of the surface temperature forms short-lived images (two seconds to three seconds) of areas greater than (0.09 square meter) one square foot. These images highlight subsurface conditions such as skin corrosion and disbonded doublers or tear straps. This technique is capable of measuring corrosion-thinning material losses of less than 2 percent.[8]

Also under development are superconducting quantum-interference devices (SQUIDs) for detection of hidden cracks. These eddy-current devices operate at a very high sensitivity and low frequency, allowing them to penetrate (15 millimeters) 0.6 inch of multilayered aluminum and identify fatigue cracks less than (one millimeter) 0.04 inch in length, and material losses of less than 5 percent.[8]

The U.S. National Aeronautics and Space Administration (NASA) Airframe Structural Integrity Program (NASIP) is also developing NDI equipment. NASIP projects include thermographic-imaging techniques for rapid scanning of large skin areas to detect disbonds and wall thinning at lap joints, automated ultrasonic scanning devices that use embedded neural networks to detect disbonds, and self-nulling eddy-current probes. These probes have demonstrated reliable detection of cracks as small as (0.81 millimeter) 0.03 inch in the top layer of aircraft skin under rivet heads. Cracks as small as (1.52 millimeters) 0.06 inch in a second skin layer can be detected.[9]

As the new technologies demonstrate highly reliable results using fewer hours per inspection, they will be used by operators.

The FAA Airworthiness Assurance NDI Validation Center (AANC) at Sandia National Laboratories validates new and enhanced inspection, maintenance and repair processes and techniques.

Chris Smith said that more than 80 percent of the inspections on large transport-category aircraft are visual inspections. On smaller transport aircraft the ratio is even greater.[4]

The AANC has studied the reliability of visual inspections. A total of 23 aircraft inspectors from a variety of transport and commuter operators participated in an experiment. Each spent two days at the AANC performing a variety of tasks specific to his or her areas of expertise. In addition to inspecting real aircraft, all participants were asked to inspect simulated lap-splice specimens with well-characterized cracks.

Among other things, results from the study showed that for a suite of tasks, performance levels were task-specific. An inspector who did well on one task did not necessarily do well on others. Failure to identify cracks during the search component of the inspection caused more poor performance than did errors in judgment when the inspector was required to decide whether to call an indication a crack or not. Results of the study are applicable to a large class of visual-inspection tasks. The AANC said that these results showed that most inspectors could benefit from search-procedures training. The study also showed that an increase in crack length did not always equate to a higher probability of detection. Results indicated that calculations of the probability of crack detection based on crack length are valid only for specific inspection tasks and conditions of inspection.[8]

Prior to the recognition of the problems associated with WFD and MSD, each fatigue crack was viewed as a discrete event. Nevertheless, when multiple cracks are present, as with WFD and MSD, significant reduction in the residual strength of the aircraft can occur prior to crack detection. When WFD and MSD are present, the total length of the fatigue crack at the time of detection is equal to the total length of all adjacent individual cracks (Figure 1, page 8). WFD and MSD occur on both small and large scales and affect both general and detailed inspections. When WFD and MSD are present in older airframes, significant reduction in residual strength can occur prior to detection of fatigue cracking.[7]

Finch said that Figure 1 indicates that "if MSD is sufficiently invasive — if, for example there are crack origins in a fuselage skin on both sides of a frame or doubler — then these structural features will not prevent the formation of a continuous multiple-bay crack."

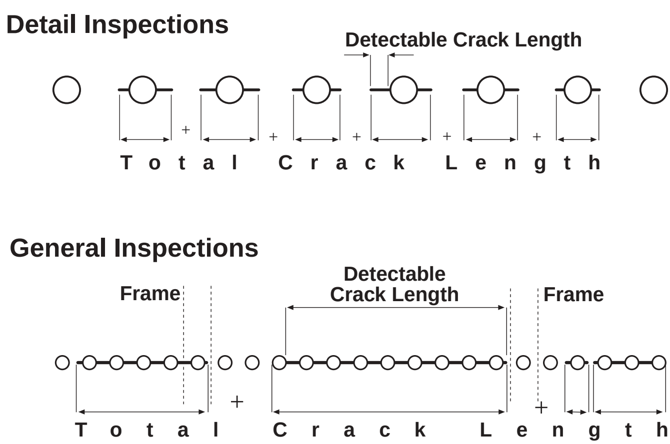
Finch also said that the presence of WFD "reduces the probability that critical conditions will be found during routine work or will be revealed, prior to complete failure, by malfunctions such as severe fuel leaks or difficulty in maintaining cabin pressure."[1]

Current industry standards rely on a damage-tolerant approach to structural integrity, whereby direct inspection is used to maintain a minimum standard of structural strength. Continued airworthiness depends in great part on the ability and actions of the inspector.

"Damage-tolerant inspection is crucially dependent on the standards of the operator and the performance of his inspection staff," said Finch.

Finch stressed the importance of the judgment of the maintenance technician in the identification of WFD with the following example. If a maintenance technician discovers cracks in a number of adjacent stringer-end fittings, the cracked fittings could be repaired and the aircraft could be returned to service. But this solution may be inadequate and could have catastrophic results if the problem is widespread and similar but less-developed and harder-to-detect cracking is also present in other fittings.

Total Fatigue Crack Length Is Equal to the Sum of All Adjacent Cracks



Source: David V. Finch, structural airworthiness consultant

Figure 1

The inspector's responsibility is to recognize that the presence of cracks in adjacent stringer-end fittings might be the first indication of a WFD problem and to investigate whether the phenomenon is widespread.[7]

Finch said, "It is the inspector who comes face to face with the aircraft and who must appreciate the need to alert the engineer to a … dangerous condition."[7]♦

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Bird Strike Committee USA Meeting Set

The eighth meeting of the Bird Strike Committee USA, whose theme will be "Practical Wildlife Control Techniques for Airports," will be held June 16–18 at Burke Lakefront Airport, Cleveland, Ohio, U.S.

Presentations will include papers and demonstrations about wildlife-control techniques, landfills, wetlands and habitat management. Emphasis will be on demonstrations and activities.

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

Nondestructive Testing Newsletter Published

NDTimes features an illustrated article about guided-wave ultrasonics in its spring/summer 1998 issue. Other articles discuss corrosion inspection, new probes and new flaw detectors from the manufacturer of nondestructive testing (NDT) equipment.

Free copies of the full-color, eight-page publication can be obtained from Krautkramer Branson Inc., 50 Industrial Park Road, Lewistown, PA 17044 U.S. Telephone: (717) 242-0327; Fax: (717) 242-2606.

JARs Added to AV-DATA 2000 CD-ROM

The European Joint Aviation Requirements (JARs) have now been added to the AV-DATA 2000 CD-ROM produced by IHS TransPort Data Solutions.

AV-DATA 2000 is described as the world's largest and most comprehensive electronic aviation-information resource. The disk includes the full texts of U.S. Federal Aviation Regulations (FARs), Notices of Proposed Rulemaking (NPRMs), Airworthiness Directives (ADs) and other technical documents. In addition, AV-DATA 2000 features Flight Safety Foundation publications from 1993 through 1996.

Contact IHS TransPort Data Solutions, 15 Inverness Way, Englewood, CO 80112 U.S. Telephone: (303) 858-6325; +(303) 397-2485 (outside the United States); Fax: +(303) 858-6710.

IATA Offers Aircraft Maintenance and Engineering Management Course

The International Air Transport Association (IATA) Learning Centre has announced a five-day course in aircraft maintenance and engineering management. The course will be conducted Aug. 24–28 in Miami, Florida, U.S.

"Managers need to learn how to capitalize on the improved efficiencies and cost reductions that can be obtained, while at the same time maintaining quality, safety and staff motivation," said IATA.

Course content will include:

- Airline business strategies and their impact on maintenance and engineering;
- Base maintenance: process improvement, housekeeping, manpower efficiency, specialization, work organization, advantage of scale and troubleshooting;
- Line maintenance: on-time performance, operation control center, troubleshooting and the no-fault ramp;
- Outsourced maintenance; and,
- Human-factors programs and regulatory systems.

Contact IATA Learning Centre, 5200 Blue Lagoon Drive, Suite 690, Miami, FL 33126 U.S. Telephone: +(305) 264-4255; Fax: +(305) 264-8088.

Gulfstream II, III Maintenance Refresher Training Scheduled

FlightSafety International will provide one-week refresher courses for the Gulfstream II and Gulfstream III airframe and powerplant technician. The courses are described as "heavy systems review focused on technical updates, designed for the client [who] has been away from the aircraft or has not attended courses regularly."

Gulfstream II refresher courses begin June 15, July 13 and Aug. 10. The June 15 and Aug. 10 courses will be conducted in Savannah, Georgia, U.S.; the July 13 course will be conducted on Long Island, New York, U.S.

Gulfstream III refresher courses for alternating current (AC) aircraft are scheduled to begin June 8, July 13, Aug. 17 and Aug. 31. The June 8 and July 13 courses will be conducted in Savannah; the Aug. 17 course will be conducted on Long Island; and the Aug. 31 course will be conducted at St. Louis, Missouri, U.S.

Gulfstream III refresher courses for direct current (DC) aircraft begin June 15, July 20, July 27 and Aug. 10. The June 15 and July 20 courses will be held in Savannah; the July 27 course will be held in St. Louis; and the Aug. 10 course will be held in Atlanta, Georgia, U.S.

Contact FlightSafety International, 301 Robert B. Miller Rd., Savannah, GA 31408. Telephone: +(912) 644-1000; Fax: +(912) 644-1096.

Presentations and Workshops on Aircraft Material and Logistics Scheduled

The Aircraft Material and Logistics Management Seminar/Workshop will be held July 14–17 in Tampa, Florida, U.S.

The presenter, Transportation Systems Consulting Corp. (TSC), says, "The core sessions of the [seminar] examine material and logistics from a management, planning, inventory-control, cost-performance, procurement and logistics-analysis standpoint."

The seminar is described as "a unique blend of presentations, workshops and a forum/query session aimed at stimulating audience interest and involvement." A two-volume, 950-page manual to accompany the seminar will be provided to attendees.

Six workshop sessions with as many as five separate topics running concurrently in each session will supplement the seminar. TSC says, "This seminar is designed for an international audience and recognizes that English may not be the first language of some of the attendees."

Contact Transportation Systems Consulting Corp., 35111 U.S. 19 North, Suite 101, Palm Harbor, FL 34684 U.S. Telephone: +(813) 785-0583; Fax: +(813) 789-1143.♦

MAINTENANCE ALERTS

Misrouted B-747 Aileron Cable Breaks

As a Boeing 747 taxied for takeoff at Brisbane (Australia) International Airport, the left outboard aileron deflected uncommanded to a full-down position.

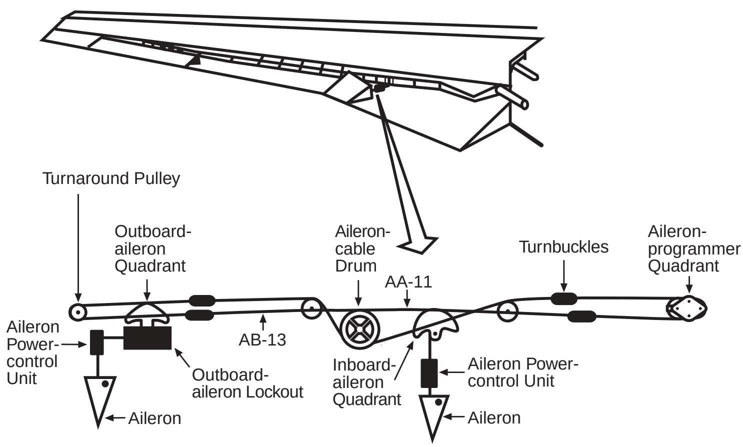
The Australian Bureau of Air Safety Investigation (BASI) determined that one of the left aileron cables (AA-11) that connect the inboard aileron quadrant to the aileron-cable drum was broken. Cable AB-13, an adjacent cable that connects the aileron-cable drum to the outboard-aileron quadrant via a turnaround pulley, was frayed. Signs of wear consistent with abrasion by an aileron-control cable were found on the aileron-cable drum's forward guide pin.

The B-747 ailerons are controlled by a cable-loop system and hydraulic actuators. When the cockpit control wheel is moved, the aileron cables routed along the rear spar of the wings move, providing control inputs to inboard and outboard aileron power-control units (PCUs; Figure 1.)

Each wing has two AA and two AB aileron-cable assemblies, one inboard and one outboard. The inboard AA cable connects the aileron-programmer quadrant to the aileron-cable drum. The inboard AB cable connects the aileron-programmer quadrant to the inboard-aileron PCU. The outboard AA cable connects the outboard-aileron quadrant to the aileron-cable drum, and the outboard AB cable connects the outboard-aileron quadrant to the aileron-cable drum via a turnaround pulley.

The aileron-cable drum is a four-slotted pulley that provides a closed cable loop to the inboard aileron even if the outboard segment malfunctions.

Aileron Wing Control Cable System
Boeing 747



Source: U.S. National Transportation Safety Board

Figure 1

The aileron-cable drum guide pin ensures that all four cables remain in the correct pulley slots at all times.

BASI found that two aileron-control system decals, which are affixed to the aircraft in strategic locations to give instructions and diagrams for routing the cables, were installed in incorrect locations. The decal for the aileron-cable drum's inboard mounting brackets at wing station (WS) 767 was installed on the outboard mounting bracket at WS 780, and vice versa.

BASI found that in the past, a similar B-747 aircraft had an aileron cable replaced when the cable was frayed down to a single strand. This aircraft also had the two decals transposed.

At the request of the U.S. National Transportation Safety Board (NTSB), a U.S. operator randomly inspected its B-747 aircraft for decal transpositions. One aircraft with interchanged decals was found.

According to Boeing, transposed decals result in incorrect installation information at the aileron-cable drum and may lead to incorrect cable routing. Engineering drawings detailing decal installation instructions were reviewed and found to be correct. Undelivered B-747s (production line numbers 1130 and up) were checked at the Boeing factory. No incorrect decal installations were found.

BASI reviewed records and found that eight airplanes from various operators have had cable-installation decals incorrectly installed.

Boeing Service Letter 747-SL-27-98-A issued May 6, 1991, addresses incorrect installation of aileron-control cable decals at WS 1336.97, and suggests that operators check applicable drawings to ensure that cables are properly installed.

Boeing told the NTSB that it will release a service bulletin to recommend that operators of B-747s with production line numbers lower than 1130 check aircraft for (1) correct routing of aileron-control cables on the aileron-cable drum located at WS 776.98 and (2) correct installation and replace, as required, the aileron-cable decals at WS 767 and WS 780. The NTSB recommended that the U.S. Federal Aviation Administration (FAA) issue an airworthiness directive requiring these inspections.

Boeing's In-Service Activities Report 96-02-2711-10 (747) details cable-wear problems found in three other aircraft. Each of these airplanes had misrouted cables at the aileron-cable drum, but no information about proper installation of the decals was provided. In each case, the misrouted cable chafed on the forward most guide pin on the aileron-cable drum.

BASI concluded that the aileron-control cable was misrouted on the aileron-cable drum, and that decal transposition can lead to misalignment of the aileron-control cables during installation.

Inadvertently Drilled Hole Causes Hydraulic-pressure Loss

A turboprop business aircraft lost all hydraulic pressure during flight. After the pilot executed a safe landing, investigation found that a leak occurred in the power-pack area aft of the left engine. The night before the incident, a leak had been investigated by the maintenance crew. After the incident, a small hole was found in the outboard half of a hydraulic line in the power-pack area. A maintenance technician, while removing some damaged screws on the exterior panel, had inadvertently drilled through the panel, drilling a no. 40 hole in the outside half of the hydraulic line. The technician's lack of attention to the penetration depth of the drill caused the hydraulic line to be damaged.

Beech 18 Accident Linked to Undertorqued Lock Nut

The no. 4 cylinder on the right engine of a Beech 18 failed in flight. The pilot was unable to maintain the published rate of climb for single-engine operation. The aircraft struck trees and the pilot was seriously injured. The Transportation Safety Board of Canada found that the torque on the lock nuts for the valve-adjustment screw on the failed cylinder had not been checked with a torque wrench when the valve clearance was adjusted. Over time, engine vibration caused the nut to back off and eventually caused the cylinder failure. The exhaust-valve lock nut was found detached after this accident. Other lock nuts on the same engine were also found to be undertorqued.♦

NEW PRODUCTS

Extend Pneumatic-tool Life with Oil-lubricant Attachment

The Pneugard Oiler by LA-MAN Corp. adds a lubricating-oil mist to the pressurized air that powers pneumatic tools. The result, according to the manufacturer, is improved performance and service life for the tools.

A flexible (1.2-meter to 1.8-meter) four-foot to six-foot air hose, installed between the Pneugard Oiler and the tool, eliminates vaporized oil in the Pneugard exhaust outlet, which could otherwise turn acidic and attack internal system components.

The Pneugard Oiler has a maximum airflow capacity of 20 standard cubic feet per minute and a maximum pressure of 150 pounds per square inch gauge. The device is available with a transparent Lexan lubricant reservoir that permits the oil level to be monitored visually.

Pneugard Oiler by LA-MAN Corp.

Contact LA-MAN Corp., 700 Glades Court, Port Orange, FL 32127 U.S. Telephone: (800) 348-2463 (United States and Canada); +(904) 304-0411; Fax: +(888) 905-2626.

MSDSs Archived on CD-ROM

Material safety data sheets (MSDSs) for more than 200,000 brand-name and generic chemicals are available on a CD-ROM from SOLUTIONS Software Corp. The manufacturer says that the CD-ROM, which contains a database developed by the U.S. government, is the largest and most extensive compilation of MSDSs available.

Environmental reporting assist file (ERAF) and registry of lists (ROL) databases are included on the CD-ROM.

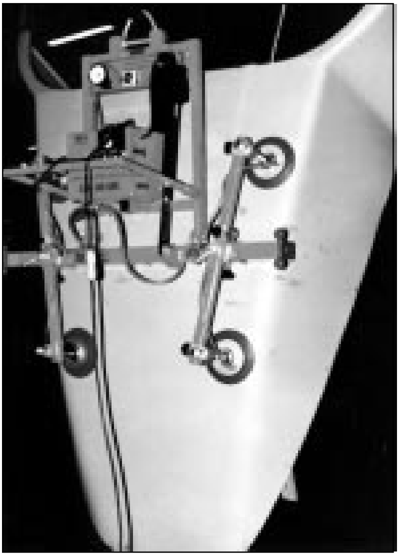
Fully indexed MSDSs, each containing 238 data fields, can be searched by name or partial term. Results can be printed and exported to ASCII or dBASE III files.

System requirements are a CD-ROM drive, MS-DOS 3.3 or higher, or a DOS session under Windows® 95, Windows NT or IBM OS/2. The program requires 20 megabytes (MB) to 46 MB disk space.

Contact SOLUTIONS Software Corp., 1795 Turtle Hill Road, Enterprise, FL 32725 U.S. Telephone: +(407) 321-7912; Fax: +(407) 321-3098.

Powered Tilters and Rotators Simplify Heavy Lifting

Anver Powered Tilters and Rotators are vacuum lifters that, in combination with a hoist, allow one person to lift, tilt or rotate large parts without recourse to ropes, straps, hooks and slings. The products allow one operator to move or position parts faster and less expensively than through traditional methods, according to the manufacturer.



Powered Tilters and Rotators by Anver

The lifters are designed around lightweight frames and vacuum cups that can be designed for manipulating loads, particularly molded plastic or fiberglass, between (23 kilograms and 4,536 kilograms) 50 pounds and 10,000 pounds. Anver Powered Tilters and Rotators are available in electrically or pneumatically powered models or manual models. The frame, cross-beams, vacuum-cup placement and design, and material can be tailored to the user's needs.

Contact Anver Corp., 36 Parmenter Road, Hudson, MA 01749 U.S. Telephone: (800) 654-3500 (United States and Canada); +(978) 568-0221; Fax: +(978) 568-1570.

English/Metric Conversion Software Makes Calculation Easy

U-Convert-It™ English/Metric Conversion Software instantly converts thousands of measurement types from English to metric and vice versa. The Windows®-compatible application eliminates the need to consult reference tables and perform calculations by hand.

U-Convert-It™ by Conversion Software

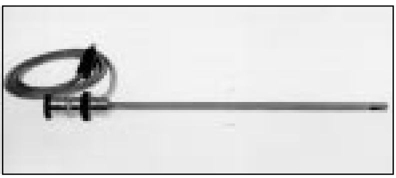
Categories of conversions include linear, area, density, volume and many others. Results of the operations by U-Convert-It can be electronically pasted directly into documents, drawings and spreadsheets.

The software includes a "unit swap" button that automatically substitutes one type of units for another.

Contact Linda Mazzarini, Venmark International, 148 Linden St., Suite 105, Wellesley, MA 02181 U.S. Telephone: +(781) 237-5860; Fax: +(781) 237-5862.

Borescope Throws More Light on the Subject

A new (14-millimeter) 0.55-inch outside diameter borescope by Circon ACMI uses an internal active-illumination bundle to improve lighting around the lens through which the objective is viewed. The technique is said by the manufacturer to result in a brighter, clearer image.



Borescope by Circon ACMI

The borescope's optical case is laser-welded to provide a precision finish, with the unit's body made of aluminum and stainless steel for corrosion resistance. The borescope can withstand temperatures up to (160 degrees C) 320 degrees F and resists leakage in fuel oil or water.

The unit can adapt to video equipment for documentation.

Contact Circon ACMI, 300 Stillwater Avenue, Stamford, CT 06902-3640. Telephone: (800) 325-7107 (United States and Canada); +(203) 357-8300; Fax: +(203) 328-8717.

Thermoplastic Rubber Hose Accommodates Long-term Flexing

Hi-Tech Hose Inc. offers a wire reinforced thermoplastic rubber hose that is said to outlive two-ply neoprene fabric hose under conditions requiring continual flexing.

Wire-reinforced Thermoplastic Rubber Hose by Hi-Tech Hose Inc.

Hi-Tech RFH Hose is manufactured without solvents, chemicals, glues or adhesives that could make it vulnerable to extreme temperatures or exposure to fumes, even those as corrosive as fumes from sulfuric acid, acetone and toluene. The hose remains serviceable during repeated flexing for more than 1,000 hours and tens of thousands of cycles, according to the manufacturer.

The product is listed as being capable of operating at a temperature range of (–51 degrees C to 135 degrees C) –60 degrees F to 275 degrees F. Inside diameter widths available range from (five centimeters to 50 centimeters) two inches to 20 inches.

Contact Hi-Tech Hose Inc., 7 Opportunity Way, Newburyport, MA 01950 U.S. Telephone: (800) 451-5985 (United States and Canada); +(978) 462-8888; Fax: +(978) 465-1955.

Laser Unit Measures Cleanliness of Hydraulic And Lubricant Fluids, Jet Fuel

The PFC 200 Portable Particle Counter by Pall Aeropower Corp., designed to serve in aviation predictive-maintenance programs, uses a laser beam to calculate the presence of contaminating particles in system fluids.

Particles in fluids under inspection are sized and recorded as the fluid flows past and the contaminant particles interrupt the laser beam. The laser light is said to offer advantages compared with white light, including more accurate particle sizing, longer service life and less sensitivity to vibration.

The PFC 200 has three sampling modes: high pressure, for sources at 50 pounds per square inch (psi) to 5,000 psi; low pressure, for sources less than 50 psi; and bottle sampling. Particle-counting sizes range from two microns to 100 microns.

PFC 200 Portable Particle Counter by Pall Aeropower Corp.

Sample identification and sampling parameters can be entered on the PFC 200's microprocessor using a keyboard, or for greater speed and consistency via bar codes. The unit includes bar code–generating software. Results of the particle sampling can be viewed on a liquid-crystal display, printed or transferred to a personal computer.

Contact Pall Aeropower Corp., 5775 Rio Vista Drive, Clearwater, FL 33760-3114 U.S. Telephone: (800) 933-3111 (United States and Canada); +(813) 539-8448; Fax: +(813) 539-8449.

Mounted Points Break Edges Without Changing Points

Rex-Cut® Mounted Points can provide controlled metal removal on cast and machined parts without changing the part geometry and can grind, deburr and finish in one step. The points are made of multiple layers of nonwoven cotton fiber and abrasive grains pressed and bonded into a variety of shapes, sizes, grits and bonds. This construction is said to eliminate the chatter associated with stone and carbide burrs and allow smooth, controlled grinding of aluminum, stainless steel, mild steel, titanium and other highly alloyed items.

Contact Rex-Cut Products Inc., 960 Airport Rd., P.O. Box 2109, Fall River, MA 02722 U.S. Telephone: +(800) 225-8182; Fax: +(800) 638-8501.

Software Manages Tool-crib Data

Brady*TRAXX*™ Tool Crib Manager is a PC-based tracking system designed to identify, track and manage tools and consumable items. The software divides information use and retrieval into check-out and check-in, receipts, reports, inventory viewing, and bar-code labeling. It can also provide information on maintenance and calibration schedules, tool-rental dates and overdue-item identification, and cost tracking.

Tool Crib Manager is compatible with Windows® 3.1, 95 and NT, and Windows for Workgroups. The software includes printer drivers for most conventional dot-matrix, laser and ink-jet printers as well as many thermal printers. It is compatible with all Brady thermal transfer printers, and optional label printers are available. Hardware recommendations include a 486 or better microprocessor, 16 megabytes (MB) RAM and 12 MB hard-disk space.

Contact Brady USA Inc., Identification Solutions Division, P.O. Box 2131, Milwaukee, WI 53201-2131 U.S. Telephone: +(414) 358-6600.♦

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Disaster Response Planning Workshop for Business Aviation

June 18–19, 1998
Atlanta Airport Hilton and Towers
Atlanta, Georgia, U.S.

Who Should Attend?

- Department managers (flight, maintenance, scheduling and administration);
- Flight safety managers;
- Corporate safety/disaster response managers;
- Corporate security managers;
- Human resource/personnel managers;
- Public relations/communications managers;
- Risk/insurance and financial managers; and,
- Administrative managers.

Why Should You Attend?

- Develop your own disaster response plan—now!;
- Update your current disaster response plan (at least every other year);
- Increase the number of people in your department with skills and expertise in disaster response (one or two aren't enough);
- Improve corporate managers' understanding of the unique issues involved in an aviation-related disaster (you'll want all the help you can get); and,
- Help your department's staff after a nonaviation disaster (automobile accident, fire or act of violence).

For more information, contact: Joan Perrin, Flight Safety Foundation
Telephone: +(703) 739-6700, ext. 109 • Fax: +(703) 739-6708

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