FLIGHT SAFETY FOUNDATION
Aviation Mechanics Bulletin

SEPTEMBER–OCTOBER 2000

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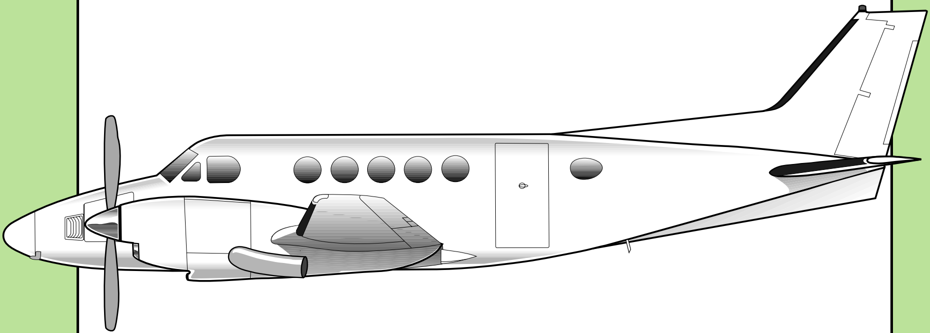

FLIGHT SAFETY FOUNDATION
1947–2000

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

September–October 2000 **Vol. 48 No. 5**

On the cover: King Air A100

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Improperly Installed Trim Actuators Blamed for Takeoff Accident

The improper reinstallation of the horizontal stabilizer-trim actuators by an inexperienced maintenance technician and the crew chief's subsequent failure to detect the mistake led to the pilots' loss of pitch control and an accident that destroyed a Beech King Air.

—

Bart J. Crotty

On June 14, 1999, the two-pilot flight crew lost control of a Beech King Air A100 during takeoff from Thunder Bay, Ontario, Canada. The Canadian-registered airplane, operated by Thunder Airlines, was beginning a commercial charter flight in day visual meteorological conditions to transport three passengers to Red Lake, Ontario. As the airplane was rotated, the copilot heard a loud clunking sound. The airplane's nose immediately pitched up to about 70 degrees. At 500 feet to 700 feet above ground level, the airplane rolled to the left, then pitched nose-down, striking soft, level ground in a level attitude, then traveling forward about 500 feet (153 meters). The cabin remained intact, and all five occupants escaped with minor injuries. Burning fuel was extinguished by aircraft rescue and fire fighting services. The aircraft was damaged beyond repair.

The aviation occurrence report by the Transportation Safety Board of Canada (TSB) said, "The flight crew lost pitch control of the aircraft on takeoff when the stabilizer-trim actuators became disconnected because they had not been properly reinstalled by the AME [aircraft maintenance engineer] during maintenance work conducted before flight."

The report said, "The crew chief responsible for the inspection did not ensure correct assembly of the stabilizer-trim actuators, which contributed to the accident."

Thunder Airlines is an approved maintenance organization (AMO), whose maintenance personnel worked on the elevator and rudder controls of the aircraft during the weekend before the accident flight. To remove the rudder, the primary horizontal pitch-trim actuator and secondary horizontal pitch-trim actuator were disconnected from the airframe. (Normally, a bracket, in the shape of a double "U" with the primary-trim motor and alternate-trim motor in the middle, is attached to the airframe and the leading edge of the stabilizer with four bolts [Figure 1, page 3]).

"After the occurrence, investigators found that the top of the actuators was not attached to the airframe," the report said. "The two bolts did not pass through the actuator holes when reinstalled — only through the attachment holes in the airframe. When the bolts were tightened during installation, they squeezed the ends of the actuators to the attachment points on the airframe. Without the actuators attached to the airframe, the stabilizer was free to rotate to a full up or [full] down position on its own."

The operator's maintenance organization was small, and therefore, the workers knew one another well. The Thunder Airlines maintenance procedures manual (MPM), approved by Transport Canada (TC), said that the aircraft (maintenance) certification authority is based on the employees' AME license, also issued by TC. Canadian Aviation Regulations (CARs) section 573.05 outlines requirements that must be met before an AME may sign a maintenance release; the associated training requirements are included in CARs 573.06.

The AME who reinstalled the trim actuators held an M4 license, TC's basic AME license, which allows maintenance personnel to sign off work on all light aircraft weighing less than 5,700 kilograms/12,500 pounds (such as the accident King Air) without formal training and endorsements and without a specific period of experience on the aircraft type or engine type.

The AME had received his M4 license about six months before the accident; he had not worked previously on a stabilizer-trim actuator. He did not receive a briefing from the inspector overseeing him (the crew chief) when he was assigned to work on the stabilizer-trim actuator, and he was not supervised during the job, although the crew chief held the stabilizer while the AME reinstalled the attachment bolts. Much of the work was done by feel,

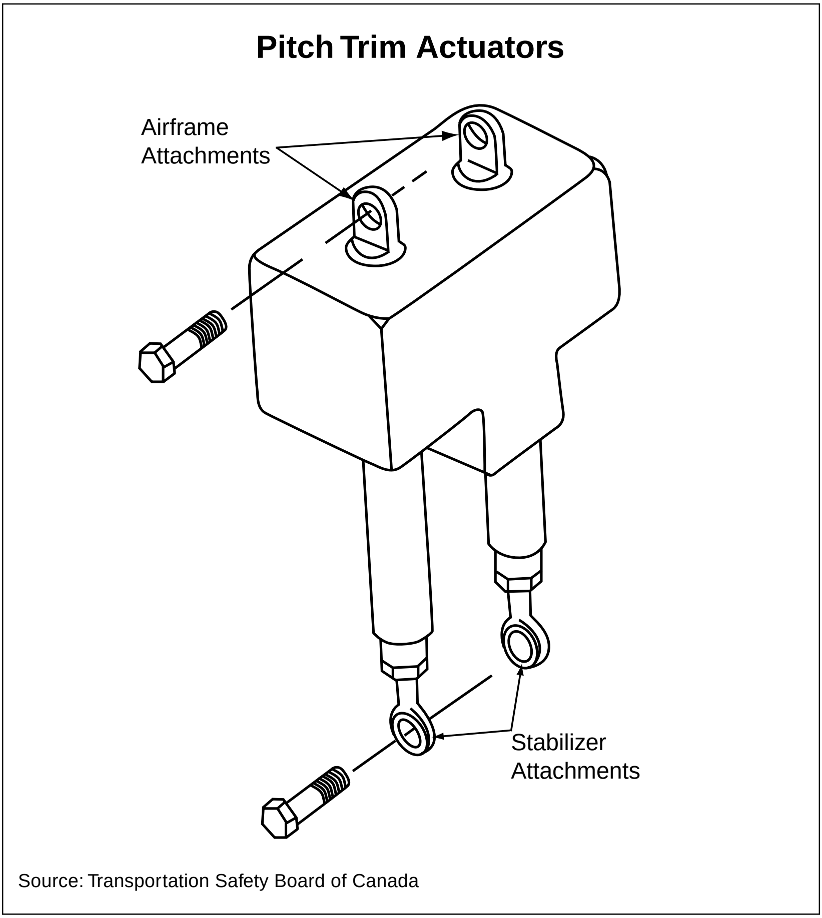


Figure 1

not by sight, the report said, "because it is difficult to see the area where the bolts had to be installed." The AME did not use a mirror as a visual aid during the installation.

The AME consulted the manufacturer's maintenance manual only to determine the appropriate torque values for the actuator attachment bolts.

The report described the installation of the stabilizer-trim-actuator system on the King Air as "a relatively simple task" and said that experienced maintenance personnel might refer to the maintenance manual only for torque values.

"However, it is common practice for an inexperienced mechanic to read the appropriate section of the maintenance manual before attempting a task for the first time," the report said. "The maintenance manual covers basic removal and installation of the actuator, but it does not cover all aspects of partial removal and installation of components. The underlying assumption is that the mechanic has knowledge sufficient to do the task and to use tools as required, or that the mechanic is under supervision of someone who has that knowledge, usually the crew chief."

After the AME completed the work, the crew chief — a senior AME who had seven years' experience and had worked on actuators in the past (but not in the previous three years to four years) — inspected the installation from the right side of the tail, through an access panel.

The crew chief "could not easily see the area and did not use [an inspection] mirror or other means to ensure that the work had been properly completed," the report said. "The crew chief knew the AME who had performed the work and was confident in his ability."

Together, the AME and the crew chief conducted a ground-operational check of the primary trim-control system and alternate trim-control system and determined that the stabilizer appeared to respond normally.

The report said that both the AME and the crew chief had read TC Airworthiness Notice (AN) C010, "Inspection of Control Systems," which explains CARs 571.10, the regulation that applies to engine and flight control systems inspections.[1] The AN said that the inspection must confirm the correct assembly, locking and sense of operation.

The report said, "The actions of the pilots did not contribute to the accident, nor did the weather, navigation aids or airport conditions. Apart from the improper installation of the bolts that attach the trim-actuator mechanism to the airframe, there was nothing remarkable about the condition of the aircraft."

Records showed that the pilots were certified and qualified and that the aircraft was certified, equipped and maintained in accordance with the CARs, the report said.

The report said that the AME who performed the work was "qualified but … inexperienced" and said that the inspection of his work was "carried out superficially, without close inspection from inside the tailcone or using the tools, such as a mirror, which would be standard for this type of inspection."

Table 1
Factors and Elements Involved in Individual and Organizational Maintenance Error

Code	Factor	Related Elements
C	Communications	Verbal, written, visual, direct, indirect, flight crew, work assignment, shift turnover, etc.
D	Design	Original, modification, STCs, SBs
E	Environment	Weather, lighting, indoor/outdoor temperature, noise
G	General maintenance manual, AMO	Organization or company policies, procedures, rules, requirements, issued authorizations and approvals
H	Hardware	Equipment, tools, parts, materials, GSE, etc.
I	Inspection	Preliminary, progressive, final, NDI, duplicate
L	Limitations	Weight, reach, sight, access
M	Manufacturer manuals, data	Maintenance and service, NDI, SBs, AFM, MEL, SRM, IPC, LLP
O	Organizational structure, top management	Division of or shared responsibility, support resources, quality/safety commitment, planning
P	Paperwork, record systems	Technical logbooks, forms/job cards, records, documents, etc.
Q	Quality management/audit	AMO/AOC formal programs, requirements, effectiveness
R	Regulations	Airworthiness design, maintenance organization, personnel, programs, ADs, AMO/AOC, health/environment, workplace safety
S	Supervision and middle management	Work assignment, oversight, major decision making
T	Training	Basic skills, product technical, special program requirements, initial, recurrent, records
W	Worker	Aircraft maintenance, ground support, fueling, technical administration staff, licensed, unlicensed, line, hangar, shop
X	Physiological, psychological	Stress, fatigue, drugs, alcohol, mental illness

ADs = Airworthiness directives
AOC = Air operator certificate
GSE = Ground support equipment
LLP = Life-limited parts
NDI = Nondestructive inspection
SRM = Structural repair manual
AFM = Aircraft flight manual
AMO = Aircraft maintenance organization
IPC = Illustrated parts catalog
MEL = Minimum equipment list
SBs = Service bulletins
STCs = Supplemental type certificates

Source: Bart J. Crotty

The report said, "During takeoff, when the pilot pulled the control column aft for rotation, air loads on the stabilizer caused the improperly attached trim actuators to separate from the airframe, which made the noise heard by the copilot on takeoff. The separation of the actuator from the airframe rendered normal control of aircraft pitch impossible, even though the control column was still properly attached to the elevators."

Maintenance Errors Analyzed

An analysis of the TSB aviation occurrence report suggests factors that could have influenced the events that led to the improper installation of the trim actuators and the accident. The codes appearing in the parentheses, in order of priority assigned by the author, are explained in Table 1, page 5.

- Operator management or supervisors who assigned the maintenance technician the task of reinstalling the trim actuators did not provide guidance before or during the task accomplishment (S, C, T);
- Training in the installation task assigned to the AME, who had not performed the task previously, was not provided by the AMO or required by regulations (T, R);
- The location of the unit installation was such that it was difficult to see the work area, and no mirrors or other aids were used by the AME. The manufacturer's maintenance manual did not caution personnel about this difficulty factor or advise the use of a mirror (L, M);
- The crew chief who performed the independent inspection did not use a mirror or any similar device, resulting in an incomplete inspection, and he relied heavily on his personal opinion of the AME's ability to perform the task correctly (I, W); and,
- The CARs did not require the AME to have formal type training (R).♦

[Editorial note: This article, except where specifically noted, was based on Transportation Safety Board of Canada Aviation Occurrence Report A99H0002.]

References

1. Transport Canada. Airworthiness Notice C010. "Inspection of Control Systems." Edition 1, Oct. 10, 1997.

About the Author

Bart J. Crotty is an airworthiness, maintenance and safety consultant and chairman of the maintenance human factors committee of the

International Society of Air Safety Investigators. He is a former U.S. Federal Aviation Administration (FAA) airworthiness inspector and trainer, a former FAA designated airworthiness representative and a former International Civil Aviation Organization airworthiness specialist. Crotty has worked for repair stations, airlines, a large aircraft manufacturer, law firms, consulting firms, a safety organization and several national civil aviation authorities. His career spans about 40 years, with about half of that time in countries other than the United States. He has an FAA airframe and powerplant mechanic certificate and a bachelor of science degree in aeronautical engineering. Crotty resides in Springfield, Virginia, U.S.

MAINTENANCE ALERTS

Modifications Recommended for Two Sperry Autopilot Systems

The U.S. National Transportation Safety Board (NTSB) has recommended that operators of Boeing 727s equipped with two models of Sperry Aerospace autopilots modify the autopilots if the airplanes fly coupled instrument landing system (ILS) Category II approaches using flap settings that are less than 40 degrees.

In a June 1, 2000, safety recommendation to the U.S. Federal Aviation Administration (FAA), NTSB cited a Feb. 9, 1998, accident involving an American Airlines B-727, which struck terrain 300 feet (92 meters) from the runway threshold at Chicago (Illinois, U.S.) O'Hare International Airport. The airplane was damaged substantially; 23 of the 122 people in the airplane received minor injuries.

NTSB said, "The approach was normal until the airplane passed through 200 feet above ground level … where the airplane started a pitch oscillation that grew in time. The airplane descended below the ILS glideslope, then climbed above it, and finally descended below it again, impacting the ground 300 feet short of the runway threshold."

NTSB said that a primary concern of the accident investigation, which had not been completed, was to determine the reasons for the pitch oscillations.

"Investigators are considering several possibilities, including flight control inputs by the autopilot," NTSB said. "Test results indicate the existence of an autopilot system anomaly that, under certain conditions, can produce undesirable pitch oscillations in the [B-727]."

Because pilots must make smaller changes in pitch to correct for glideslope deviations as an aircraft nears the runway, the sensitivity of the autopilot also must be reduced as an aircraft nears the runway. The reduction in sensitivity is called autopilot desensitization.

The autopilot on the accident airplane used a time-based desensitization process that began desensitizing during the 150 seconds after the airplane descended below 1,500 feet. Additional sensitivity changes occurred after the airplane received the middle-marker signal on an ILS approach.

The sensitivity schedule — including the 150-second desensitization period — on the Sperry Aerospace SP-150 (and on an earlier model, the SP-50) was designed to function best with approach airspeeds typically used with flap settings of 40 degrees. During the early 1980s, however, operators began landing B-727s with flap settings of 30 degrees — and with correspondingly higher airspeeds. (The accident airplane was being flown with a 30-degree flap setting.)

Sperry issued two service bulletins (SB 21-1132-121 in November 1982 and SB 21-1132-122 in February 1983) that described autopilot modifications to accommodate the higher approach speeds. One of the modifications called for reduction in desensitization time to 105 seconds. Compliance with the SBs is optional, and the modifications described in the second SB, which applied to the autopilot system on the accident airplane, had not been performed, NTSB said.

During the NTSB investigation, an American Airlines captain described a coupled ILS Category II approach made in November 1997 at O'Hare in another B-727 equipped with a time-based autopilot with a 150-second desensitization period.

NTSB said, "At about 250 feet, the crew felt a bump, and the airplane pitched up in response to being slightly below the glideslope. The airplane climbed through the glideslope and then pitched down severely to recapture the glideslope. The captain called for a go-around and … came back for another approach. When the same bump was felt again, the captain executed an auto go-around and diverted to the alternate."

In the safety recommendation, NTSB said that FAA should:

- Require operators of B-727s equipped with SP-50 and SP-150 autopilots to perform the modifications described in the service bulletins if the B-727s are used for coupled ILS Category II approaches at flap settings that are less than 40 degrees;

- Develop operating limitations for SP-50 and SP-150 autopilots on coupled ILS approaches that are "appropriate for the desensitization schedules used by these autopilots, so that every possible desensitization schedule has a corresponding set of operating limitations. The limitations should address approach flap settings and airspeeds specifically and should also consider tolerances on winds, capture altitudes, glideslope angles and/or other parameters that could adversely affect autopilot performance and safety of flight";

- Advise all operators of B-727s equipped with SP-50 and SP-150 autopilots to inform their pilots, maintenance personnel and engineering personnel of the risks of conducting coupled ILS approaches at airspeeds that are inconsistent with the autopilot's desensitization schedule;

- Review the certification of all autopilot systems that use time-based desensitization schedules and develop operating limitations needed for use of the autopilots on coupled ILS approaches; and,

- Advise operators of aircraft equipped with autopilot systems that use time-based desensitization schedules to inform their pilots, maintenance personnel and engineering personnel of the risks of coupled ILS approaches at airspeeds that are inconsistent with the autopilot-desensitization schedule and to "notify the operators that [FAA] has been asked to develop operating limitations for the use of these autopilots on coupled approaches that will ensure that the approaches are conducted in a manner consistent with the design of the autopilot."

FAA said that officials expected to identify "an appropriate course of action" by October 2000 and to issue bulletins to request that operators of air carriers with time-based desensitization autopilots inform their pilots, maintenance personnel and engineering personnel of the risks of conducting coupled ILS approaches at airspeeds inconsistent with the autopilot desensitization schedule.

ATSB Warns Against Painting of Engine-cooling Fans

The Australian Transport Safety Bureau (ATSB), citing damage to a Kawasaki 47G3B-KH4 helicopter, has recommended that the Civil Aviation Safety Authority (CASA) alert all aircraft maintenance technicians to "the potentially detrimental effects of painting [aircraft] engine-cooling fans."

The helicopter received substantial damage during an autorotational landing at Moonee Estuary in New South Wales, Australia, on April 6, 1995. The pilot attempted the landing after hearing a loud cracking sound and feeling restriction through the cyclic control. Investigation revealed that several engine-cooling fan blades had fractured and had separated from the fan assembly and that the collective control rod had been damaged when it was struck by a released blade. Analysis of the cooling-fan fractures revealed that a two-blade segment of the fan separated because of fatigue cracks and that a single-blade segment separated because of excessive stress at the blade root.

The Bureau of Air Safety Investigation, which preceded ATSB, issued an initial report on the occurrence in 1996. The report was revised in April 1999 because of new information from the helicopter manufacturer. A subsequent ATSB analysis of the failure of the engine-cooling fan determined that the fatigue cracking that resulted in separation of the two-blade segment was a result of "variations in the surface condition of the fan, in the highly stressed regions, from the fans that have been tested during type certification; and … variations in the alternating stresses created during operation from those anticipated during design."

The fan's surface had been shot peened, and areas around the bolt holes had been abraded, ATSB said.

"The resistance of a component to fatigue is sensitive to surface finish," ATSB said. "Abrasion of a shot-peened surface would be expected to reduce the resistance to fatigue."

The fan also had been painted. In correspondence with ATSB, Kawasaki said that fans should not be painted. Company maintenance and overhaul instructions, revised in 1979, contained no specific instructions relating to the painting of engine-cooling fans.

ATSB said that fan vibration may result in significant variations in loading and that one damaging form of loading is created by fan resonance, which would lead to rapid fatigue failure. Stiffness of the fan assembly is critical, and one factor that affects stiffness is establishment of the required clamping force in each fan-assembly bolt.

"Clamping forces established by the applied-torque method will be affected by the frictional torque of nut self-locking features," ATSB said. "The tightening instructions included in … Kawasaki service bulletin KSB-BELL-305 do not indicate whether the final torque includes, or should be adjusted for, any frictional torque effects."

ATSB said, "It is clear that there are significant differences in the surface and assembly of the engine-cooling fan fitted to (the accident airplane) when compared to the stated requirements of the helicopter manufacturer. Each difference would be expected to have a detrimental effect on the resistance of the fan to fatigue failure through changes in either the component's fatigue strength or alternating stress magnitude and frequency."

ATSB recommended that CASA alert maintenance personnel to potential problems that may result from painting engine-cooling fans and to "the detrimental effects that may be created in critical components by the abrasion of surfaces during general cleaning or cleaning in preparation for nondestructive inspection."

ATSB also recommended that Kawasaki Heavy Industries clarify bolt-tightening instructions in service bulletin KSB-BELL-305 to establish whether "an allowance should be made for the frictional torque effects of self-locking nuts."

Broken Door Pin Causes Depressurization on Turboprop

During a flight, crewmembers on a Beech King Air C90 heard a bang, then observed a loss of cabin pressure. Emergency procedures were followed, and the airplane was landed safely.

Subsequent inspection revealed that the clevis pin (part no. 131323-2C15) that was used as the pivot for the latch hook on the upper cabin door (part no. 100-430075-601) was broken. Phase-3 inspection requirements include inspection of the clevis pin. The incident occurred five months before a Phase-3 inspection was due.

A report submitted to the U.S. Federal Aviation Administration suggested that the cabin-door latching mechanism be examined during all maintenance inspections.

Elevator Trim Problem Reported in Cessna Citation

The pilot of a Cessna 550 Citation observed during approach to landing that the elevator electric trim was unresponsive. The manual elevator trim wheel turned freely but had no effect on elevator trim settings; the control was heavy and difficult to move, the pilot said.

A subsequent investigation revealed that a control cable was detached and lying in the bottom of the aircraft, said a report submitted to the U.S. Federal Aviation Administration (FAA). A maintenance technician found that the elevator trim-system cable forward-attachment chain-master link (part no. C419175) had dislodged and was in the bottom of the aircraft, along with the attaching hardware. The report submitted to FAA did not discuss a cause of the chain master-link failure.♦

Fatigue Meter Monitors Aircraft Structural Stress

AMETEK fatigue meter uses a micromachined accelerometer and solid-state electronics to collect data about the stresses experienced by an aircraft during flight, the manufacturer said.

The meter, which weighs two pounds (0.9 kilogram), has a serial data port to allow ground personnel to upload aircraft-configuration information and to download usage information for more than 300 flights.

For more information: AMETEK Aerospace Gulton-Statham Products, 1644 Whittier Ave., Costa Mesa, CA 92627 U.S. Telephone: +1 (949) 642-2400, ext. 324.

Clear Acrylic Sheets Provide Thermal Shock Resistance

Aerospace-grade ACRYLITE GMS acrylic sheet and ACRYLITE 249 acrylic sheet are optically clear, lightweight, thermal shock-resistant materials for use in aircraft glazing, the manufacturer said.

CYRO Industries' ACRYLITE GMS sheet is certified to meet or exceed military specification MIL-P-5425E and is intended for aviation windshields, wing-tip lenses, instrument panels and dust covers. ACRYLITE 249 sheet is certified to meet or exceed military specification MIL-P-8184F (Type II, Class 2) and has increased resistance to crazing, solvent attacks and water absorption. ACRYLITE 249 is intended for a variety of aerospace and ground-vehicle transparencies.

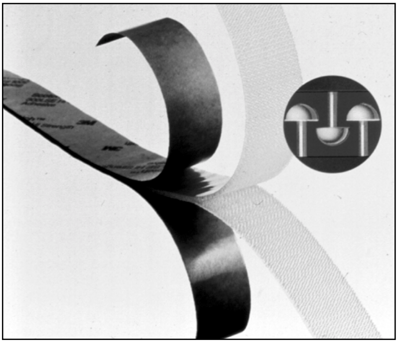
For more information: CYRO Industries, 100 Enterprise Drive, Rockaway, NJ 07866 U.S. Telephone: (800) 631-5384 (U.S.), (800) 268-4743 (Canada), +1 (973) 442-6000.

Reclosable Fasteners Secure Airplane Seat Cushions

3M's Dual Lock low-profile, reclosable fasteners are designed for items that must be repositioned or accessed frequently, including airplane seat cushions, the manufacturer said.

The fasteners are thin, lightweight, clear and flexible. When the fasteners are pressed together, thousands of "mushroom heads" interlock. No special tools are needed to remove the reclosable fasteners. Dual Lock low-profile, reclosable fasteners are available in widths of 1 inch (2.54 centimeters) and

5/8 inch (1.59 centimeters) and in rolls of 25 yards (23 meters) and 50 yards (46 meters).



Dual Lock low-profile, reclosable fasteners

For more information: James & Co., 135 John E. Carroll Ave. E., South St. Paul, MN 55075 U.S. Telephone: (800) 362-3550 (U.S.) or +1 (651) 737-6501.

Video Monitoring Screen Can Be Worn Like Eyeglasses

EYE-TREK glasses allow users to conduct remote visual inspections using a video display that is worn like eyeglasses, the manufacturer said.

Images seen on EYE-TREK are brighter than images produced by conventional concave mirror optics, and they can be used even in brightly lighted areas, said the manufacturer, Olympus Industrial Products Group. EYE-TREK uses an optical technology that allows high-resolution images to be produced within the face-mounted display.

EYE-TREK glassses

For more information: Olympus Industrial Products Group, Two Corporate Center Drive, Melville, NY 11747-3157 U.S. Telephone: (800) 446-5260 (U.S.) or +1 (516) 844-5888.

Solvent Offers High-flash-point Safety

C/D Solv HFP combines deep cleaning and high-flash-point safety for use in areas where flammability is a concern, said the manufacturer.

C/D Solv HFP contains no 1,1,1-trichloroethane, chlorofluorocarbons or other chlorinated solvents, is not ozone-depleting and is safe for use on most plastics and metals, said the manufacturer, STS. The solvent can be used to clean and degrease terminals, motors, gears, machine parts, generators, switches, chains, electromechanical devices, pumps, and other items.

For more information: STS, P.O. Box 949, Amarillo, TX 79105-0949 U.S. Telephone: (800) 807-3761 (U.S.) or +1 (806) 372-1068.

Flaw Detector Designed For Use in Potentially Explosive Areas

Krautkramer's USM 23EX portable ultrasonic flaw detector has been designed for use in potentially explosive atmospheres.

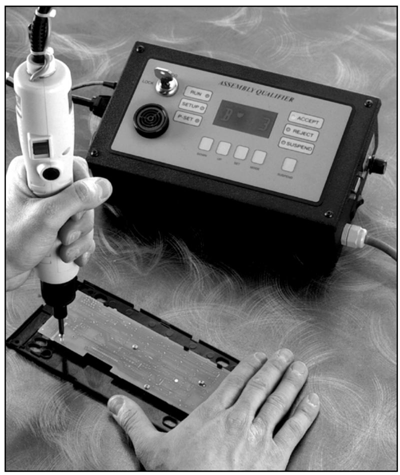
Compatible straight-beam, angle-beam and dual-element probes certified for testing in potentially explosive atmospheres also are available, the manufacturer said. Six C-size alkaline batteries provide internal power; an external power supply is available for use in nonexplosive atmospheres.

For more information: Krautkramer Branson, 50 Industrial Park Road, Lewistown, PA 17044 U.S. Telephone: +1 (717) 242-0327.

Device Monitors Installation of Fasteners

A quality-control device has been designed to monitor the installation of screws and other fasteners to ensure correct assembly.

ASG, a division of Jergens, said that its Assembly Qualifier connects to push-to-start or lever-start electric drivers and to lever-start air-powered drivers. The device counts screws and verifies the torque of installed fasteners. If screws are omitted or if they are over-torqued or under-torqued, the device stops the operation until corrective action is taken.



Assembly Qualifier

For more information: ASG, 15700 South Waterloo Road, Cleveland, OH 44110-3898. Telephone: +1 (216) 486-6163.

Rivet Tool Kit Includes Ergonomic Hand Rivet Tool

A rivet tool kit that includes an ergonomic hand rivet tool has been introduced for maintenance technicians who often work away from toolboxes or tool cribs, said the manufacturer, Emhart Fastening Teknologies.

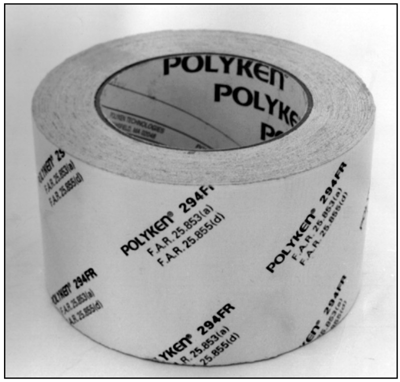
The POP PowerLink 30 Rivet Tool Kit includes the PowerLink 30 rivet tool and 200 POP brand blind rivets and rivet washers. Nose pieces and a wrench to change them are stored in the handle. The PowerLink 30, which is designed to enable users to set rivets with less fatigue, has handles that are equipped with soft grips and are contoured to fit the user's hand.

For more information: Peter Femiak, distributor marketing manager, Emhart Fastening Teknologies, 510 River Road, Shelton, CT 06484 U.S. Telephone: +1 (203) 925-3176.

Adhesive Seals Liner Seams in Aircraft Cargo Bays

Polyken 294FR cargo tape uses a rubber-based adhesive to seal fiberglass liner seams in aircraft cargo bays, said the manufacturer, Tyco Adhesives.

When the pressure-sensitive tape is removed, virtually no residue remains on the cargo panel, the manufacturer said. The tape is manufactured in compliance with U.S. Federal Aviation Regulations Parts 25.853 and 25.855.



Polyken 294FR Cargo Tape

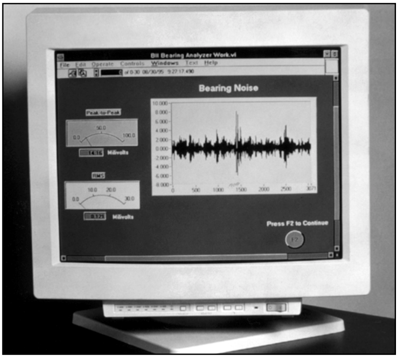
For more information: Tyco Adhesives, 1400 Providence Highway, Norwood, MA 02062 U.S. Telephone: (800) 248-7659 ext. 6231 (U.S.) or +1 (781) 440-6231.

Instrument Analyzes Working Condition of Bearings

Bearing Inspection's Model BA-96-1 precision bearing analyzer is designed to evaluate working surfaces of anti-friction engine bearings and accessory bearings.

The device uses standard personal computer technology to measure mechanical vibrations that result in bearing noise, the manufacturer said.

During a test, a bearing is operated to generate a noise signal, which is compared to acceptance criteria. The comparison is used to evaluate the condition of a bearing, including working surfaces and wear.



Bearing Inspection's Precision Bearing Analyzer

For more information: Bearing Inspection, 4422 Corporate Center Drive, Los Alamitos, CA 90720-1570 U.S. Telephone: +1 (714) 484-2400.

Gauge Measures Thickness of Precision Metal Parts

The StressTel TM1 D Plus precision thickness gauge measures the thickness of precision machined and formed metal components. The gauge has a measurement range of 0.01 inch to 1 inch (0.254 millimeter to 25.4 millimeters) and is compatible with several transducers, the manufacturer said.

The gauge has a weather-resistant keypad, high and low alarm limits with a flashing annunciator and a function that displays the positive or negative difference between the thickness measurement and a preset value.

For more information: StressTel, 2790 West College Ave., State College, PA 16801-2605 U.S. Telephone: +1 (814) 861-6300.

Device Provides Digital Readouts for Magnetic Sensor Products

Honeywell's HMD5000 Hand Held Display is designed to provide digital readouts for the company's HMR3000 Digital Compass and HMR2300 Smart Digital Magnetometer.

When connected to the Digital Compass, the HMD5000 displays heading, pitch, roll and status information, the manufacturer said. When connected to the Smart Digital Magnetometer, the device displays magnetic field readings and related information. The device is powered by a 9-volt battery.

For more information: Honeywell International, 12001 Highway 55, Plymouth, MN 55441 U.S. Telephone: +1 (763) 954-2692.♦