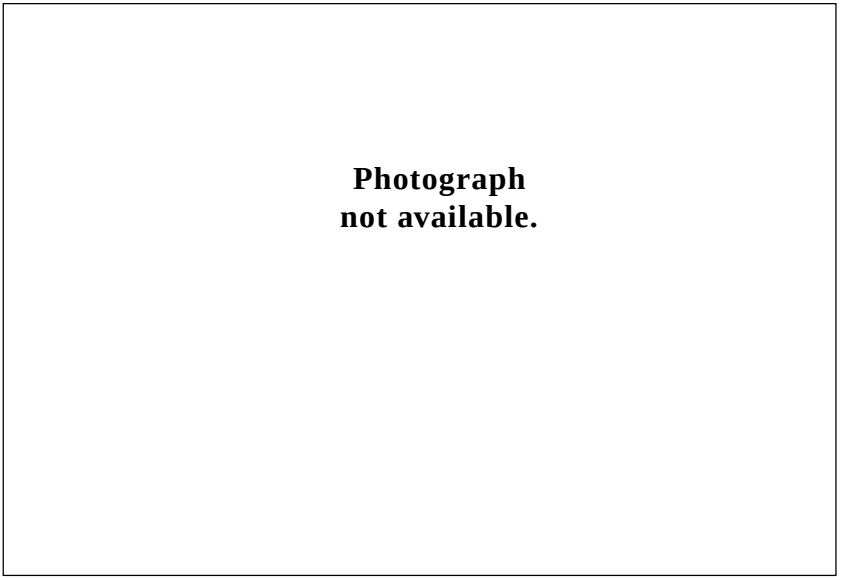


Technician uses ultrasound detector in the contact mode with metal probe waveguide attached. (Photographs courtesy of UE Systems Inc.)

Put Some Ears in Your Toolbox

Passive detectors of sounds outside of the human hearing range can provide the aviation technician with another means of locating "mystery" leaks and noises.

Every mechanic has at least one magnifying glass in his toolbox to improve his visual ability to detect a defect, but how many have a tool to enhance their ability to "hear" a defect. Developments in electronic technology have now been applied to sonic devices which enable the technician to hear and even see, sounds which are normally beyond the limits of human hearing, sometimes called "ultrasounds."

Ultrasound detection devices should not be confused with "ultrasonic inspection" units. Ultrasonic inspection units create sound waves which are transmitted into and through the material being inspected. Defects which may be present in the material will "deflect" the sound waves and any such deflections can be visually displayed on a cathode ray tube (CRT).

Ultrasound detection units do not create the sounds, but rather pick up sounds which are so faint or in frequency ranges beyond the capability of human hearing, and amplify or transpose them so that a technician can hear them or see an indication of them on a meter. Pretty fancy, but what can you use it for? Lots of things.

The sensitivity of these devices is such that they can literally detect the sound of an eyelid "winking" from several yards across a crowded room. Not too useful to a mechanic perhaps, but if it can detect sounds such as that, the practical applications in aircraft maintenance are numerous. Battery powered and about the size of a soldering gun, the typical ultrasound detection unit can be used anywhere with great flexibility. Weighing just under one kilo (2 pounds), the unit is also safe to use in any environment because it does not create any sparks or harmful electric currents.

Photograph not available.

Scanning for fuselage leaks with an ultrasound detector.

Operating Principles Of Ultrasound

Audible sound waves are long; they penetrate walls and machine parts, and are reflected from other surfaces. It is, therefore, difficult to trace them to their sources. Ultrasonic sound waves, conversely, are extremely short and travel in straight lines. They cannot penetrate solids, although they do filter through the tiniest of openings. These properties of ultrasonic sound waves leave ultrasonic detectors largely unaffected by audible sounds and can be used even in the noisiest environments.

The units are used in either a scanning or in a contact mode. In the scanning operation (cover photograph), the operator hears ultrasounds through earphones, and gauges the intensity by the deflections of the analog meter attached to the unit,

while scanning the suspect area with the pickup end of the device. In the contact mode (page 1 photograph), a metal probe is attached to the detector which is placed in direct contact with the unit or point of suspected leak, much the same as a physician's stethoscope. Some technicians may even recall using a long-handled screwdriver in this manner.

Some ultrasound detection units have a frequency adjustment dail which provides the cabability to tune freqencies from 20 khz to 100 khz. An accessory device used with the system is a sound generator about the size of a pack of cigarettes, which can be placed inside of a compartment, the area closed up, and the detector then used from outside to scan the exterior for any sound waves escaping through minute openings. This feature can be very useful for checking door fits and seals, etc. without having to pressurize an aircraft.

Other Applications For Testing

Leaks of "Invisible Gases"

Leaks in pneumatic, vacuum, and oxygen lines and components have always been very difficult to locate. Ultrasound detection provides the capability to detect very minute leaks, even at low pressures, in such systems. The use of a liquid leak amplifier (bubble fluid) enables the precise location of small leaks with ease and safety because the operator need not place his hands or ears in close proximity to the suspect point of a high-pressure leak in a noisy environment.

Internal Fluid Leakage

Internal leakage through a shutoff or check valve, or even fluid leakage around seals, has always been difficult to detect without the use of sophisticated flow benches and/or removal and replacement of components. With the metal probe attached, the ultrasound unit enables the operator to "listen to the component" while it is installed and operating in its normal system. Comparison of a suspect unit with one known to be within tolerance enables the operator to evaluate what an acceptable leak rate sounds like.

Component Actuation

The closing of a relay or actuation of a solenoid-operated valve can also be easily detected with the ultrasound probe and earphones. Miniature relays that often are mounted in close proximity to each other can reliably be checked to see if they are closing or opening when called for. Although this procedure does not confirm that the electrical contacts are "good,"

the ability to confirm a relay's action can be a tremendous aid to trouble-shooting.

Tire Pressure Leaks

Nitrogen leaks of inflated tire and wheel assemblies can be detected by scanning the bead seat areas and the valve stem fitting with ease. Cuts or indications of sidewall damage can also be checked for indications of leakage while installed or in the shop.

Pressurization Leaks

Ultrasound equipment can be used in two ways in searching for, or confirming the lack of, pressure vessel leaks. Prior to the recent ban on smoking for flights within the United States, the nicotine stains evident from a leaking seam or fastener were an aid to detecting external leakage. Now however, external leakage may no longer be so visibly evident, and more sophisticated techniques are required. If it is convenient to pressurize the aircraft, the ultrasound unit can be used to scan all suspect areas. The turbulence created as air flows through any leak generates "white noise" with strong ultrasonic components that are readily picked up by the detector.

In instances where actual pressurization is impractical, the battery powered sound generator can be placed inside the aircraft and all doors and windows secured. Any openings which would allow the escape of air will also permit the sound waves generated by the device to be detected.

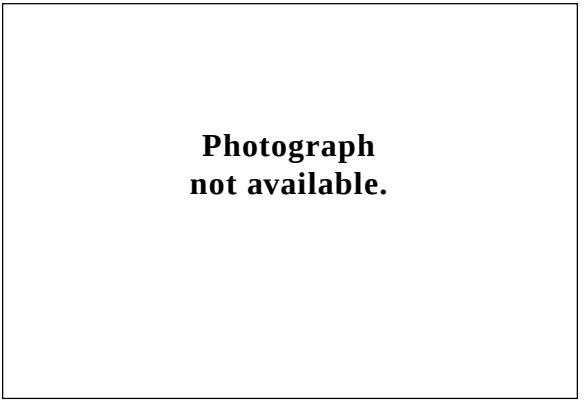
Cabin door and window seal leaks, improperly sealed structures, excessive leakage at cable or wiring pass-through seals, or leaks around the seals of anything else that protrudes through the pressure vessel are readily detected by ultrasonic scanning.

State-of-the-Art Applications

The increasing use of composites and the attendant need for repair of composite components presents a growing application for ultrasound detection equipment. Many composite repairs require "vacuum bagging" of the repair in order to apply uniform pressure and assure proper bonding by eliminating all possible air from the laminations. The ability to scan the perhaps irregular and complex areas sealed by the vacuum bag provides the technician with a valuable aid to assure the quality of the repair.

Another current technology application is with full motion aircraft

simulators which have become as complex as the aircraft themselves in many instances. The maintenance of the numerous actuators and systems associated with these simulators has spawned a whole new profession as the use of simulation has proliferated. The use of ultrasound detection to troubleshoot and repair simulator systems has proven to be a great timesaver to operators of these training systems.



An ultrasound sound generator can be placed inside an aircraft cabin to check integrity of door and inspection panel seals from outside.

Operator Technique And Training

Ultrasound detection equipment is relatively simple and easy to use. Suppliers normally provide general operating and use instruction for buyers of their equipment.

Training agencies, such as Flight Safety International, are including the use of ultrasound detection devices in their courses for maintenance technicians. Special applications like checking for vacuum leaks in composite repairs are included in their courses.

Potential uses and applications of this growing technology are only limited by the imagination of the technician. The enhancements to aircraft safety through finding and repairing small defects before they can affect airworthiness, while allowing the technician to work in a safe and secure environment, are worthy of consideration by any operator. ♦

NEWS & TIPS

Aviation Computer Science Course Developed

Embry-Riddle Aeronautical University (ERAU) Daytona Beach, Florida, U.S., recently announced a new aeronautical emphasis addition to the present computer science curriculum leading to a B.S. degree. Dr. Iraj Hirmanpour, chairman of the com-

Photograph not available.

puter science department stated, "It's just not enough to have a basic computer science degree anymore. The market's tough. Employers are much more selective now."

In order to give ERAU graduates an edge on the annual 40,000-plus computer science graduates in the United States, the school has added the aeronautical focus to integrate a computer science curriculum with aviation applications and practical experience. Starting in August 1990, students in the computer science program must take 12 credit hours in aeronautical science. These new requirements give students a comprehensive look at the inner workings of high technology in aviation.

The expanded program also will require students to perform projects relating to real problems in aviation or aerospace. For instance, students in artificial intelligence may write systems to train air traffic controllers. Along with these highlights, the curriculum will adopt ADA as the primary programing language. ADA is the official language of the U.S. Department of Defense and is also used in the U.S. Federal Aviation Administration (FAA) Advanced Automation System and National Aeronautics and Space Administration (NASA) space station activities.

The aim of this innovative addition to the computer science program is to improve the employment outlook for ERAU graduates. The school estimates that these students will require much less training time by future employers in the aviation community.

Adjustable Wrenches An Aviation No-No

A perennial caution around aircraft maintenance is one that concerns the use of the ubiquitous adjustable open end wrench. Although a few of these can replace entire sets of fixed-size tools, and they are handy to turn a piece of hardware on automotive

gear, ramp equipment and other non-aircraft applications, they can lead to unsafe conditions when used for aviation.

Close examination of an adjustable wrench reveals why it can lead to trouble. The moving, thumb-adjustable jaw must have a certain amount of play in it to allow ease of adjustment, but this also allows that jaw to rock from side to side and permits both jaws to grip the hardware away from the shoulder and mar it. This can scratch and gouge the nut or bolt as well as remove the protective coating and lead to corrosion. Many failed aircraft nuts and bolts have revealed that the cause was corrosion that began at such a marred area. If a bushing or a bearing rides on the shaft of the marred bolt, then the inner race can be permanently damaged by grinding from bolt-head damage caused by the adjustable wrench.

It may be more costly in time and money to use only the proper size of fixed-size wrenches, but aviation safety hinges upon such minor details as the integrity of fasteners. Aircraft technicians who treat the adjustable end wrench with the same disdain as they would a plumber's monkey wrench are helping avoid one of those links in the chain that can lead to disaster in the sky.

Twinjets Mark Five Years in Extended Range Service

One hundred thousand routine flights during five years of service have proved the capability of twin-engine Boeing 767s to fly long-range routes previously flown only by three and four-engined jetliners. Mechanical reliability of standard and special equipment can take much of the credit.

The aircraft, with added optional equipment, first received authorization for extended range service (up to 120 minutes of flying time from the nearest suitable airport with one engine inoperative) in May 1985. Until then, air carriers with fewer than three engines had been required to stay within 60 minutes of such an airport. First approved for specially equipped Boeing 767s with Pratt &

Photograph not available.

Whitney JT9D-7R4 engines, similar approval was granted three months later similarly equipped aircraft using the General Electric CF6-80A engines.

Today, there are more than 150 ETOPS (Extended Twin Operations) equipped Boeing 767s flying more than 3,000 flights per month. As of March 1990, the 767 had achieved a 99.8 percent arrival rate to the destination. That is, only two flights per thousand were required to turn back or divert.

With this experience, additional approvals have been granted allowing Air New Zealand and American Airlines to fly GE-powered Boeing 767s on routes that have points up to 180 minutes from an alternate airport. The proposed 767-X widebody twinjet, targeted for 1995 delivery, will be ETOPS equipped as a standard feature, and enhanced testing is planned to enable aircraft to be service ready for ETOPS beginning with the first delivery.

The SRM — A Book for Many Reasons

Aircraft operators use the Structural Repair Manual (SRM) in many different ways. To the aviation technician it is a valuable source of data for on-site use. Engineers may use the information to interpret or adapt it for use by the mechanic. Inspectors may also have need to refer to the manual.

The intent of the SRM is to provide data in a form that can be understood and used by any of the readers no matter what their level of technical expertise. It is intended that the data will be adapted to suit aircraft damage encountered without jeopardizing structural integrity. Where the damage exceeds the coverage in the SRM, or when repairs seem excessive for the extent of the damage, there are alternatives available to the operator. In those cases, a specifically engineered repair can be initiated by the operator for regulatory agency approval. Damaged components also can be replaced rather than repaired. Additionally, the manufacturer can supply or provide technical assistance, or carry out an Aircraft-On-The-Ground (AOG) repair. To ensure that the manufacturer's manuals provide operators with the best data to meet their needs, operators are encouraged by the manufacturers to submit any relevant service experience data and recommendations for improvement. This can be the source to maintain the currency and integrity of the manuals.

Treat that SRM with the respect that it deserves, for it can beat your path to the expert solution to many of your job requirements. ♦

MAINTENANCE ALERTS

This information is intended to provide an awareness of problem areas through which such occurrences may be prevented in the future. Maintenance alerts are based upon preliminary information from government agencies, aviation organizations, press information and other sources. The information may not be accurate.

Fuel Tank Explosion Results in Fatalities

A Boeing 737-300 suffered an explosion shortly after pushback from the ramp. Of the 119 persons on board, eight persons were fatally injured and 30 received serious injuries. The airplane was destroyed by fire.

Although the investigation is far from complete, the preliminary evidence indicates that ignition of the fuel-air mixture in the center fuel tank was the cause of the explosion and fire.

At the time of the accident, all the fuel boost pumps were in the On position; however, the center fuel tank had not been filled during the previous four weeks of operation. During the pushback, the center fuel tank low-pressure light illuminated, indicating that the center fuel tank had been emptied of all usable fuel. Laboratory tests of fuel samples from the airplane and the storage tanks from which it had been fueled indicate that the fuel vapor in the center tank would have had a flash point of between 112 and 117 degrees F. At this flash point, a heat source of between 400 and 500 degrees F or an electrical arc of .25 milli-joule would have been sufficient to initiate an explosion of the fuel-air mixture.

Investigators found several conditions which could have been casual factors:

- The fuel tank float switch may have been defective, and wiring leading to the switch was found to have damaged insulation.
- The operator had installed wingtip-mounted logo lights subsequent to delivery and may have caused damage to wiring which was found to exist in various wire bundles in the wing.
- The left boost pump for the center tank fuel was found to have evidence of an interference rub between the pump impeller and the pump body, and a slight wearing of the bearings. The manufacturer has stated that such material wear is common when pumps have been run in a dry condition.

However, it is known that some operators let the pumps run with an empty tank for extended periods with no apparent problems.

The U.S. National Transportation Safety Board (NTSB) has issued safety recommendations asking that:

- An airworthiness directive (AD) be issued to require immediate inspection or testing of float switch wiring from the float switches to the refueling panel for chaffed or damaged insulation material on Boeing 737-300, -400, and -500 series airplanes. The airworthiness directive should state that special emphasis be placed on inspecting the wire bundle where it passes through the wing pylon vapor seals and under the wire bundle clamps.

- Testing techniques be developed to ensure that float switches manufactured by Revere Aerospace are free from defects that could cause an explosion or fire. After testing techniques are developed, an AD be issued to require testing and replacement of all switches found defective.

- An AD be issued directing that an inspection be made of *all* 14 CFR Part 121 aircraft at the next scheduled major maintenance inspection, of the wires in wire bundles in the wings where additional wiring has been added since the airplane was manufactured. This inspection should be directed to the determination of insulation damage where the wire bundle is under clamps and inside vapor seals and pressure seals.

- A detailed engineering design review and testing of the fuel pumps used in Boeing 737-300 series aircraft be conducted to verify that overheating and interference between the rotating components of the pump and its case will not cause a fire hazard. Testing of jet-fuel vapor should be conducted at its flash point.

Although these recommendations may adequately address the specific airplanes and components affected, technicians worldwide should take note of the fact that the potential for a similar catastrophe exists on any airplane whenever there is a source of ignition in an explosive atmosphere. Special emphasis should be placed on proper wiring installation procedures and re-inspection requirements following any rework or modification of systems in compartments and tanks containing flammable fluids or vapors.

Pass the Earplugs, Please

During a flight from Minneapolis-St. Paul to San Francisco, California, U.S., a loud, high-pitched noise was heard in the passenger cabin of the Boeing 737. The crew tried changing the cabin altitude of the aircraft and making adjustments to the air conditioning system but to no avail.

In an attempt to reduce the noise discomfort, many passengers inserted cotton balls and earplugs into their ears.

The crew found a previous entry in the logbook which reported that some sealant was missing from the wing root fairing at the left side of the fuselage and that tape had been applied over the area.

After the aircraft landed at its destination, maintenance personnel resealed all areas where sealant was missing.

Broken Rule Results In Broken Hip

Two mechanics for a major European air carrier were adjusting the body gear proximity switches on a Boeing 747 while using the gear door as their work platform. Unfortunately, at the same time another crew had been instructed to test the inflight brakes.

In order the test inflight brakes, the gear selector handle must be in the Up position. Since the gear had been properly safetied in the Down position, there seemed to be no problem. What was not considered however, was the fact that the selection of the gear handle to the Up position first leads to opening of the gear doors.

The system worked just like it was supposed to work. When the gear doors began to move, one of the mechanics was able to clamber up into the wheel well. The other was not so lucky and was caught between the folding doors. Fortunately, the technician in the cockpit had quick reactions, and upon hearing alarmed shouts dumped the gear handle to its original position. The man who had been caught jumped to the floor but was later found to have a broken hip.

The lesson is clear: follow the book; clear the area; and be sure no conflicting work is in process before actuating a system.

Insulation Interference

An operator of a Boeing 737-300/400 experienced nose landing gear

steering forces were excessive in both directions. It was found that an insulation blanket had sagged and interfered with steering cable travel. Trimming back the blanket and repairing the cut edges fixed the problem and resulted in a production change.

Murphy's Law Strikes Again

We know the law, "If anything *can be* installed incorrectly, it *will be* installed incorrectly."

Some Piper PA-31 operators have learned the hard way that the aileron primary control and balance cables can be connected backwards where they attach to a bellcrank. This occurred once on a factory test flight with fatal results several years ago, and again earlier this year following a major repair in the western United States. Fortunately, the two persons on board survived the latter occurrence.

Murphy struck twice in this case, because even after the initial misconnection, the pilots were also "Murphied" because they failed to perform a thorough preflight control check which would have disclosed the fault.

The U.S. National Transportation Safety Board (NTSB) has issued a safety recommendation calling for the FAA to issue airworthiness directives (ADs) to require:

- Advising owners and operators of the discrepancies in PA-31 service manuals and reissuing corrected information.
- That subject cables be color-coded and matched to their respective attachment point(s).
- That the manufacturer conduct a design review to determine how the assemblies can be modified to preclude misconnecting the cables.
- That modifications be fitted, or if this is determined impractical that placards be installed on or near the bellcrank assembly, clearly indicating the proper connections.

Water Leak + High Altitude = Ice

During normal cruise conditions, a Boeing 747 suddenly went into a five-degree right turn. Switching from autopilot A channel to manual and autopilot B were no help. The aircraft continued the uncommanded five-degree right bank, even with all autopilot channels selected to the off

position. The aileron controls were frozen in the five-degree bank position.

Fortunately, the crew was able to forcefully break the aileron control free and bring the wings back to level. During landing, the speed brakes could not be deployed in either auto or manual modes.

Investigation revealed ice in the spoiler mixer assembly in the right-hand main gear body wheel well. A leak in the potable water water supply was confirmed as the culprit. ♦

NEW PRODUCTS

Metal Fires Meet Their Match

MSA Research Corp. has produced a fire-extinguishing substance that it claims will effectively smother a metal fire and reduce the immediate danger. Metal fires are stubborn and fierce, as well as dangerous. All types of gases, liquids, gels and other substances have been used against them in the past, but many are not immediately effective. Metals burn by direct oxidation. This type fire needs to be smothered by an agent that forms an impervious coating over the metal. The new product, called Firecoat, can be applied in a liquid stream from a safe distance, as much as 30 to 40 feet away. Other metal fire extinguishing agents require that the fire be completely covered with a mound of powder, which requires that the firefighter work closer to the blaze.

Hot burning metals are magnesium, aluminum, titanium, zirconium, and their alloys. When they burn, these metals gradually grow in intensity rather than flare up. The new product, a combination of trimethoxyboroxine (TMB) and Halon 1211, initially decomposes thermally to produce boric oxide which combines with the oxides produced by the burning metal to form a black oxide. This process ultimately results in a white coating which signals that the fire is extinguished.

Another type of metal fire consists of low-melting metals such as sodium, potassium and others that are categorized as "special cases." These metals burn as liquids, which impede the formation of an oxide layer. At the first application of Firecoat, the result appears to worsen the situation; however, if properly applied in short, intermittent applications, the fire will be extinguished.

Steel filings or lathe turnings produce a calm or "sullen" fire, which glows rather than flames. Boric ox-

ide does not alloy with ferric oxide, so the resulting coat shows very little black while it works, although it does extinguish this type fire, according to the manufacturer.

Lithium is the hottest burning metal of all. On a small fire, the new extinguishing agent will form a coating if carefully applied; however, it is best to be aware that this agent can do little more than control a larger lithium fire.

An awareness of how to deal with metal fires is important for the aviation technician on the line, in the hangar or in the shop where metal residues are generally found. The attention of the machine operator is also directed to fire awareness, because his cutting tool on a "turnings" machine is a specific area where metal fires can occur.

More information on Firecoat may be obtained from MSA Research Corp., P.O. Box 429, Pittsburgh, PA 15230, U.S. Telephone 412-538-3510.

Lights, Air, Power, Action

For working in confined and poorly lit areas, a proper light source can aid the safety of the working environment and the quality of work performed. The KH 600 Series work station light provides almost everything but the tools and elbow grease to get the job done. The 37-pound aluminum unit with carrying handle provides:

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- Four detachable flourescent U-lamps with polycarbonate mounting clips.
- Four ground fault protected power receptacles.
- Three 3/8-inch brass socket air outlets and matching inlet.

The total light output of the four units is 11,600 lumens, equivalent to approximately 720 incandescent watts. Lamps are rated at 12,000 hours useful life.

Direct inquires to KH Industries, P.O. Box 312, Angola, N.Y. 14006, U.S. Telephone (716) 549-0135. Fax (716) 549-2725.

Continuous-Length Cable Ties

Have you ever had the problem with a cable tie being just a little too short, or never having the right length on hand? Strap Lock, recently introduced by Advanced Cable Electronics, is designed to reduce the need for stocking many different lengths of cable ties.

To use, the cable is cut to length and inserted into a lock fastener that can double as a spacer. With the material available in continuous lengths, there is no unusable waste or scrap, no limit to size or diameter of the bundle to be wrapped, and no special tools required for installation. A single wrap is rated at 120 pounds minimum loop tension and the product can be multiple-wrapped with corresponding increases in added strength.

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Available in 1,000-foot spools, the product can also be provided in 25- or 500-foot packages.

For more information, call or write Advanced Cable Electronics Corp., P.O. Box 1291, Wesboro, MA 01581, U.S. Telephone (508) 366-0669.

Borescope by the Book

Olympus Corp., one of the major manufacturers of fiberoptic and rigid borescopes and associated equipment, has published a textbook entitled, "The Science of Remote Visual Inspection," written by Peter G. Lorenz, director of sales and marketing for Olympus.

The textbook is aimed at the entry level non-destructive testing inspector, yet there is plenty of useful information and reference data for the advanced worker in the field. Subjects include:

- Basic optical and fiberoptical science.
- Types of remote visual inspection (RVI) equipment and light sources.

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- Techniques for measurement of defects and gray scale analysis.

- Advanced RVI including video and computer technology, ultraviolet (UV) inspection, ultrasonics, eddy current, and laser energy.

- RVI applications.

Olympus has recently offered to conduct seminars at no cost for interested companies and for instructors at technical schools in the aerospace field. The company makes the textbook available at a special price to technical schools.

To obtain more information on the textbook and the seminar, contact Olympus Corp., IFD, 4 Nevada Drive, Lake Success, N.Y. 11042, U.S. Telephone (800) 446-5260. Fax (516) 488-3973.

Flame-Resistant Fiber Developed for Aircraft Interiors

Stringent new regulations from the U.S. Federal Aviation Administration (FAA) call for a lower peak and total heat release for aircraft interior vertical surfaces, including textiles. A new fiber from Du Pont is claimed to meet these higher standers and to posess an inherent flame-resistant capability.

The fiber, called Nomex CGF, will not degrade over time and its fire resistance cannot be washed out during cleaning because there are no topical treatments used. Once certified, textiles made of this fiber will comply with the new FAA requirements, according to Du Pont. Tests have shown that the heat release of these fibers is lower than the requirements established by air carrier aircraft manufacturers. The material also has low smoke and toxicity ratings.

Further details on Nomex CGF can be obtained from: Du Pont Co., External Affairs Dept., Wilmington, DE 19898, U.S. Telephone 302-999-4576. ♦