‘Smart Fluids’ Could Revolutionize Aviation Hydraulics Technology

Most of us are familiar with the expression, “This is the greatest thing since sliced bread.” Here is another version:

The newly emerging technology of electrorheological fluids could be the greatest advancement for hydraulic systems since CH2:C(CI)CH:CH2. So implies a report from Technical Insights, Inc., an organization that tracks technological innovation around the world.

First of all, how many readers recognized the formula for the “sliced bread?” It was one of the first substitutes for natural rubber, developed in 1931 from acetylene and hydrochloric acid. Its high resistance to heat, oils and gasoline made aviation hydraulic systems practical because the mineral-based fluids used in them quickly deteriorated natural rubber seals and gaskets. The sliced bread was in the form of the O-Ring made of (got the formula figured out yet?) Neoprene.

Credit for the development of reliable, high-pressure aviation hydraulic systems must also go to improvements during the early and mid-30s in precision hydraulic activators, fittings and valves. The latter basic component in the system brings us to the next greatest thing since sliced bread.

Electrorheological (ER) fluids are expected by the prognosticators at Technical Insights to bring about the redesign of up to 50 percent of all hydraulic systems and devices. Among the areas most likely to be affected are aerospace hydraulics, a $600 million a year market.

What’s so great, or smart, about these new fluids? ER fluids are suspensions of fine particles, mostly polymers (Neoprene also is a polymer) in nonconducting oils and other fluids. These “smart fluids” are unique in that when an electric current is passed through them, they instantly turn into a gel-like solid.

When the current is removed, they revert to a liquid. No change in temperature is required for these abrupt changes in state, which occur within .0001 to .001 seconds.

Smart fluids are expected to change the basic design of hundreds of ev-

eryday hydraulic systems and devices. For instance, all moving parts could be eliminated in a hydraulic valve for ER fluids; the flow would be stopped by electric current. A similar parts reduction would apply to smart fluid drive clutches, automatic transmissions and self-adjusting suspension and steering systems that need little or no metal-to-metal contact. Besides being made with fewer parts, such devices would require less precise machining and exotic materials.

Research is well underway in the United States and other countries on ER fluids and their applications. Aircraft and ground support equipment may benefit from current ER fluids research into: hydraulic valves with no moving parts; vibration-damping, suspension and steering systems; actuators, tensioners, stepper motors; a springless electric clutch with no wearing parts; and, new types of automatic transmissions.

When will this all take place? The report notes that, although many development challenges remain to be solved before ER fluids are fully commercialized, the first ER products will be available within three to five years. That's plenty of time to make some room in the old toolbox for a multitester, isn't it?

The special report "Smart Fluids: New Route to Advanced Hydraulic Systems/Devices" is a technical explanation of ER technology and an analysis of its expected impact on the manufacture of vehicles and machinery that will utilize it. The report is available for $960 ($1,000 outside North America). More information may be obtained from Technical Insights, Inc., P.O. Box 1304, Fort Lee, NJ 07024 U.S., (201-568-4744).

NEW PRODUCTS

Cylindrical Pressure Gauges Provide 360-Degree Visibility

Hedland Flow Meters has acquired a line of three compact pressure gauges. The Vista-Gage can replace present pressure gauges and allow 360-degree readability of pressures from 200 to 5,000 psi and vacuums to 30 inches of mercury. The companion Vista-Cator has a three-color scale that reads a go/no go indication where an exact pressure readout is not desired. Both gauges have one-quarter-inch NPT pressure ports, are made of brass with lexan lens covers and are available for oil, water, gas, high and low temperatures.

The third unit, the Vista-Monitor, is a compact combination accumulator charge pressure gauge and charging valve. It is designed to be used as a permanent installation that constantly checks charge pressure. The gauge is made of black oxidized steel with O-ring seal ports, providing a

permanent charging head and integral bleed valve.

The gauges and pressure monitor can be mounted at any angle and are claimed to withstand shock, overpressurization, machine vibration, pulsation and pressure surges without damage.

More details are available from Hedland Flow Meters, 2200 South Street, Racine, WI 53404 U.S., (414-639-6770).

Return of The ACK-2 Lube Kit

Remember the ACK-2 aviation lubrication kit of greasing attachments? It was assembled by Allied Tech Tronics from components supplied by the Australian firm of Macnaught Pty. Ltd. and marketed to the civilian market by Snap-On Tools. Since Tech Tronics no longer supplies this equipment, Macnaught has assumed production and distribution of the kit. According to U.S. distributor Aviation Consumables, Inc., the manufacturer has made improvements to increase serviceability and durability of the components — plus reduced the price by nearly 30 percent.

The ACK-2 kit of lubrication attachments is designed to be used with the Macnaught line of manually and air operated lubricators and all hand-operated grease guns. These lubricators provide greasing pressures of up to 10,000 psi and allow single-hand operation. The kit is housed in a heavy duty, display-style carrying case that allows all attachments to be seen at once for quick selection. The accessories in the ACK-2 kit are designed specifically for greasing extremely difficult access locations such as flap tracks, ailerons and landing gear. Individual items are available separately.

More information on the ACK-2 kit and other Macnaught greasing and pumping equipment is available from Aviation Consumables, Inc., P.O. Box 27205, Cincinnati, OH 45227 U.S., (513-561-9977).

Recovery Dollies For Disabled Aircraft

Two disabled-aircraft dollies have been added to the Tronair line of aviation ground support equipment. The units are designed to secure the main or nose gear while supporting the aircraft during recovery to a maintenance area.

The dollies are available in two different sizes to accommodate a wide range of aircraft weights: an 8,000-pound and a 16,000-pound unit. The Model 4951 incorporates a self-contained hydraulic system and pivoting wheels that allow lowering and raising of the dolly frame; with the Model 4952, the aircraft may be either pulled or jacked and lowered onto the dolly.

Once the hydraulic Model 4951 is positioned around a disabled landing gear, the dolly frame is lowered to the ground and a mechanical cinching system clamps the aircraft wheel.

Photograph not available.

Then the dolly and the aircraft are hydraulically raised and the aircraft is ready to be towed. The dolly's towbar can be used for guidance when it is used on main gear or for towing the aircraft when used to support a nose gear.

With the Model 4952, once the gear has been placed onto the dolly, an adjustable cradle captures the wheel during transport. When the dolly is used for main gear, large swivel casters allow tracking with aircraft towing direction; when used with a nose gear, an integral towpin allows a universal towbar to be attached.

The dollies are produced by Tronair, S. 1740 Eber Road, Holland, OH 43528 U.S., (800-426-6301).

Plastic Pallet For Gear Components

Here's a case of "trickle-down" technology, not from the space program, but from the nation's "first" executive airplane: Air Force One.

A new pallet was originally developed by Armin Thermodynamics, Inc., for storing tire, wheel and brake assemblies in the cargo compartment of the President's airplane. The plastic PTL2-25HOLE pallet is now available for both military and commercial aircraft storage of spare tires or tire-wheel-brake assemblies.

The four-foot-square by two-inch-thick pallet weighs 25 pounds and has molded-in hand holes to facilitate handling. A center cutout fits various size assemblies. The pallet is reusable and also can serve as a separator or divider.

More information can be obtained from Armin Thermodynamics, Inc., P.O. Box 204, 1900 West Iola, Broken Arrow, OK 74013 U.S., (918-251-9656).

Photograph not available.

Fiberscope Cuts Time For Turbine Checks

In a product brochure, the Industrial Fiberoptics Division of Olympus

Corp. claims substantial savings in time for jet engine turbine blade inspections for its working channel flexible fiberscope.

Regular fiberscope inspections of the second-stage turbine blades of the Pratt and Whitney F100 engine had required 29 separate penetrations and about eight manhours in order to check all 58 second-stage vanes. Olympus added a hook to the end of the retrieval cable in its working channel scope and revised the inspection procedure to eliminate all but the initial borescope insertion.

In use, the technician maneuvers the borescope probe through the first-stage vanes and blades to the target area of the second-stage vanes. When he has these vanes in his viewing image, he extends the anodized aluminum hook at the end of the retrieval cable and attaches it to the trailing edge of a first-stage blade. An assistant then manually rotates the turbine wheel by turning the power takeoff shaft at the engine gearbox, which rotates the scope's viewing tip past the second-stage vanes.

Since the scope tip is always locked in place at a known distance from the vanes, focus remains constant and photography of the vanes is easier, according to Olympus.

The brochure on the Olympus Multipurpose Working Channel Flexible Fiberscope and other literature on the company's line of borescopes and fiberscopes are available from Olympus Corp., Industrial Fiberoptics Division, 4 Nevada Drive, Lake Success, NY 11042-1179 U.S., (516-488-5888).

New Shape for Aviation Oil Container

Phillips 66 X/C aviation oil containers will no longer roll off the shelf or around the floor of an airplane's baggage compartment. The round plastic bottle has been replaced by a more compact, rectangular shape that is designed to take up less storage space, fit more easily into limited aircraft cargo space and stack better on the mechanic's shelf. It retains the pouring neck of the previous bottle, although the new one is slightly longer for easier pouring. The new multigrade aviation oil package should be easy to find — look for the bright blue color.

Photograph not available.

No-Sweat Seats For Helicopter Pilots

The problem was that perspiration from hard-working Bell UH-1 helicopter pilots had badly deteriorated the seat cushions. Affected were three layers of specially treated polyurethane foam over a cellulose foam base used for shoulder and thigh support.

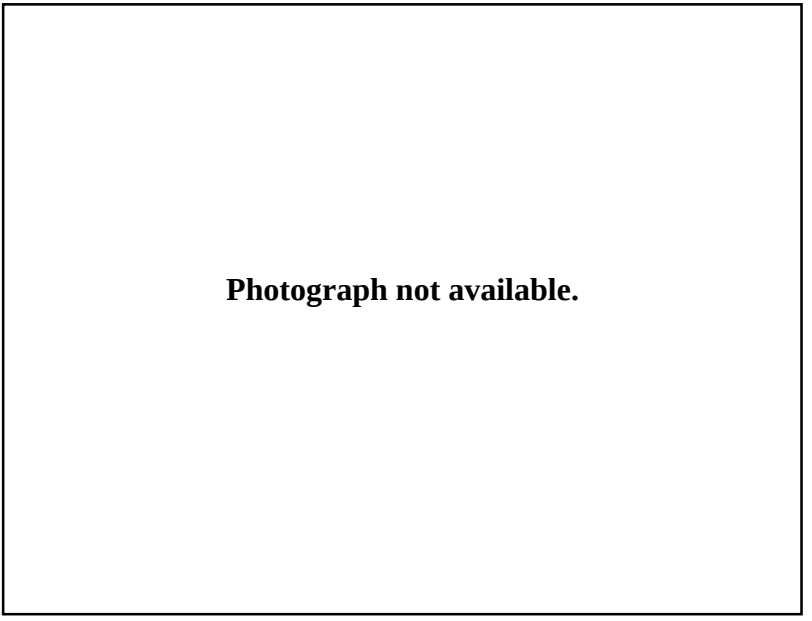
The manufacturer of various seat models for Bell helicopters, Triple H Industries, needed a film material that would both protect the pilots' seats from perspiration and pass the FAA vertical burn test.

The solution, after a three-month search, was ACLAR (R) 22A fluoropolymer film produced by Allied-Signal, Inc. The material passed the required flame test and exhibited excellent properties as a moisture barrier, as well as broad resistance to most chemicals. It also offered the toughness and wear resistance Triple H required for the application.

More information can be obtained from Triple H Industries, 404 Commerce, Azle, TX 76020 or Allied-Signal Engineered Plastics, P.O. Box 2332R, Morristown, NJ 07960 U.S., (201-455-5010).

Flow Boosted for Hydraulic Power Unit

To allow servicing of larger airline and military aircraft, Tronair has in-



creased the flow on its large capacity hydraulic power unit to 50 gpm.

The ground servicing unit has adjustable flow and pressure with a maximum capacity of 3,500 psi/50 gpm. Available for use with any standard hydraulic fluid, the Tronair units incorporate simplified maintenance through a modular approach to assembly of the hydraulic components. Acoustic soundproofing is built into the heavy duty enclosure for quiet operation.

Photograph not available.

More information is available from Tronair, S. 1740 Eber Road, Holland, OH 43528 U.S., (800-426-6301).

Aerospace Fittings Claimed Efficient, Strong

A new line of aerospace liquid fittings is being distributed by Aeroquip Corp. as a means of connecting all pressure classes of tubing up to 8,000 psi. The Rynglok fitting system is said to be quickly and efficiently joined together and that joints exceed the burst strength of the tubing material.

Designed for use on demanding fluid distribution applications such as on airframes, jet engines, missiles or space vehicles, the new product's fitting design allows it to accept any combination of tubing material and wall thickness up to an 8,000 psi pressure rating. The manufacturer claims this all-inclusive capability eliminates excess inventory and reduces the logistics involved with production and repair of the many pressure classes of fluid systems utilized in the aerospace industry. The same compact tool can be used to join tubing of any wall thickness.

Photograph not available.

Further information is available by calling the Linair Division marketing department (213-532-5980) or by requesting a free copy of Rynglok Fitting System Bulletin 1674 F-A from Aeroquip Corp., Advertising Dept., 300 S. East Ave., Jackson, MI 49203-1972 U.S.

Single Antenna Does Many Jobs

A V-Dipole navigation antenna for low- to medium-speed general aviation aircraft is said to eliminate the need for multiple antennas and transmission lines through a patented electronic system. The Model CI 161 from Comant Industries is designed to receive the traditional VOR/LOC/Glideslope bands, including the 88-108 MHz FM broadcast band.

The antenna mounts on the aircraft's vertical stabilizer and is electrically enhanced to allow use of the new Radar Weatherwatch (TM) system or commercial FM broadcast equipment. The unit is supplied with a center feed module and a 50-ohm BNC connector. It is constructed of space-age plastics and high-conductivity, corrosion-resistant, non-ferrous metals to provide low weight, low drag and all-weather endurance.

With the proper 50-ohm coax cable and Comant coupler/diplexers, the single antenna is said to accommodate most combinations of navcom transceivers and glideslope receivers, as well as the Weatherwatch or other FM broadcast receivers.

Photograph not available.

More details are available from Comant Industries, 12920 Park Street, Santa Fe Springs, CA 90670 U.S., (213-946-6694).

Fueling Monitor Cartridge Guards against Water, Solids

Monitor cartridges designed for aviation fuel handling are said to provide maximum water removal, solids holding capacity and shutdown protection.

The Fuel-Gard two-inch and six-inch cartridges by Quantek, Inc. absorb free and emulsified water, remove ultra-fine solids even when surfactants and fuel additives are present and shut down system flow when hit with a localized slug of water. Design of the filters allows flow from the outside to the inside at the rate of a gallon per lineal inch for the two-inch size and four gallons for the six-inch size with a one micron nominal filtration.

The presence of water or solids in the incoming fuel is indicated by an increase in pressure differential or a decrease in the rate of fuel flow as the monitor reaches its maximum capacity of contaminants. The cartridges are said to meet the latest edition of Institute of Petroleum Specifications and Qualification Pro-

cedure for Aviation Fuel Filter Monitors with Absorbent Type Elements.

For more information, contact Quantek, Inc., A Facet Subsidiary, P.O. Box 50096, Tulsa, OK 74150 U.S., (918-834-2929).

Debris Monitor Gives Early Failure Warning

The Quantitative Debris Monitor (QDM) from Aeroquip is designed to provide early warning of aircraft engine or transmission failure.

The system collects and analyzes magnetic debris produced by mechanical components. The QDM sensor produces voltage pulses proportional to the mass of the captured particles. The pulses are then amplified and a signal conditioner classifies the incoming signals as indicating particles heavier than 12.5 micrograms and those greater than 800 micrograms. The data is processed further to determine the rate of occurrence and the total count of debris particles in each of the two size categories. Limit settings are provided for both a rate and a total of debris accumulation which trigger an alarm.

The QDM system provides a two-level alert. A maintenance alert is indicated by most gradually occurring fatigue and spalling failures, and allows time for analysis and corrective action. A mission alert signals the pilot of a rapid-onset, or catastrophic, failure that requires immediate action to avoid further damage or total function loss.

Complete technical information on the QDM system is available in Aeroquip Bulletin 3507, free from Aeroquip Corp., Advertising Dept., 300 S. East Ave., Jackson, MI 49203-1972 U.S.

Activated Reducers Make Alumagrip More User-Friendly

The application of Alumagrip aircraft paints is claimed to made easier by A.R. activated reducers from U.S. Paint. The latest line of thinners is designed to help make Alumagrip more user friendly by com-

Photograph not available.

bining thinner and time-saving additives in one package.

The new reducers with pre-measured accelerators are said to reduce the risk of improperly measuring and adding separately packaged dry time accelerators. The reducers are claimed to reduce dry-to-tape times for Alumagrip topcoats by as much as 50 percent, and a moisture scavenger helps avoid topcoat blushing that could occur during unfavorable weather conditions.

A.R. Reducer technical product and material safety data bulletins are available from U.S. Paint, a Division of Grow Group, Inc., 831 South 21st Street, St. Louis, MO 63103 U.S., (314-621-0525).

Photograph not available.

MAINTENANCE ALERTS

Unequal Power On Takeoff

The Number Two engine of the Lockheed 188 Electra was found to be unserviceable during startup for a scheduled flight from Lafo Agrio, Ecuador. The captain decided to leave the passengers behind and ferry the airplane to Quito on the three remaining serviceable engines.

Shortly after liftoff, while it was still over the runway, the airplane veered to the left and crashed into a fuel storage installation. The aircraft was a total loss and all six crew members aboard received fatal injuries.

Smoky Approach

The pilot of the Airbus A300 arriving at Madras from Singapore reported a problem and made an emergency landing with smoke pouring from one engine. CFR crews quickly extinguished the cause of the smoke.

There was no damage to the aircraft other than to the affected engine, and no injuries were sustained by the 209 occupants.

Lickety Split and No Thrust Reversers

The Boeing 737-200 had made a normal approach and touchdown at

Tegucigalpa, Honduras. However, when the pilot went to activate the thrust reversers, they failed to operate.

In order to avoid overrunning the runway down a steep slope, the pilot elected to make a sharp turn to the right. The airplane ran off the runway and became bogged down in soft ground. There was damage to the airplane's undercarriage, but no injuries were sustained by the 52 passengers and seven crew members aboard.

Spring Snaps, Gear Collapses

The Beech Baron B55 was on a training flight with only two persons aboard. During a landing approach, the left main landing gear would not extend, and attempts to lower it using the emergency system proved unsuccessful. Fuel was burned off by flying locally for 2.5 hours and the airplane was landed after emergency crews were alerted.

The Baron touched down on the right main gear and then on the nose gear and the left wing held up aerodynamically as long as possible. Near the end of the rollout, the left wing dropped to the runway and the airplane veered to the left. It stopped on the runway. The CFR crews arrived immediately and applied foam, but there was no fire. The airplane sustained damage to the left wing but there were no injuries.

Investigation later revealed that the uplock retraction spring in the left main gear operating mechanism had detached from its operating lever because of corrosion around the attachment hole. The result was that the left main gear remained restrained by its uplock. When the gear actuator attempted to lower the stuck gear, an overload failure of the retraction linkage occurred. Investigators also found similar corrosion around the spring attachment hole for the right main gear.

Detached Downlock Prompts Belly Landing

The first part of a one-two scenario occurred when the landing gear failed to lower during an airworthiness flight test after major maintenance had been accomplished to the Cessna 310G. When the landing gear selector was placed in the down position, the mechanism failed to operate, although it had retracted normally after takeoff. The emergency hand crank was successfully used and the single down-and-locked green indicator light went on. The landing was normal, and the airplane was returned to the shop.

After two days the gear problem was reported fixed and the airplane was again pronounced ready for the flight test. During this second flight the gear was successfully cycled twice using the normal procedure. The flight then had to be curtailed because of poor weather, and the airplane returned to the airport. The

gear again appeared to work properly and the green light illuminated. However, as soon as the main wheels touched down, the pilot felt a vibration from the left side and experienced extreme difficulty keeping the airplane straight. He re-applied power and took off again.

After reaching pattern altitude, the pilot selected the gear up position and did not get the proper indication, a single red light. When he tried to lower the gear he could not obtain a green down-and-locked light through either the normal or the emergency procedure. During subsequent flybys, tower personnel reported that the left gear strut appeared to be in the approximately normal down position but when the pilot selected the up position, the strut was at a 45-degree position.

The pilot made a successful emergency landing with the gear in the up position. The airplane sustained extensive scraping damage to the underside of the fuselage but there were no injuries to the two crew members aboard.

Later investigation of the left gear mechanism revealed that the downlock bellcrank had become detached at its pivot point on the main strut at its connection to the lower link of the overcentering downlock assembly. The bolt at the bellcrank pivot had been sheared at two points by transverse loads between the bellcrank and its attachment lugs on the main strut.

One failure had resulted purely from a shear force but the other combined that with bending and some secondary surface damage on the face of the fracture. Neither of the fractures showed evidence of a preexisting defect.

According to investigators, this is typical of overload shear failure with the bolt failing from pure shear at the first location and, once the bolt has been partially broken off, failing at the second location from a combined shear and bending force.

The bolt from the lower end of the bellcrank was not found, but damage marks in the bellcrank hole led inspectors to believe that the bolt had been there when it had been subjected to violent twisting and offcentered loads. Here again, there was secondary damage to the lugs on the lower link but no hint of preexisting defects. It was believed that the failure at the lower end of the bellcrank was secondary to that of the bolt at the bellcrank pivot above.

Another area of damage was at the actuating rod attached to the top end of the bellcrank; it had been bent in a manner suggestive of compressive collapse. The combined mechanism damage was indicative of what would have happened if the system had sustained landing loads without the main side brace being locked in the over-centered position while the downlock itself was in a locked position.

A Snap in the Night

The pilot, with his instructor aboard the fixed-gear Piper PA-38 Tomahawk, was practicing night landings. During the landing roll after the fourth pattern, a snapping noise was heard and the airplane dropped onto its left side. The instructor secured the engine and electrical systems and informed the tower. He was unable to prevent the airplane from veering to the left and it departed the runway and came to rest in the grass nearby, aimed approximately crosswise to the runway. Neither occupant was injured, but there was damage to the left wing of the airplane.

When the aircraft was examined, it was found there had been a failure of the single bolt that secured the inboard end of the left landing gear spring strut. When this happened, the gear pivoted to the rear, producing an overload on the saddle mounting which caused it to fail and the gear leg to fold.

This chain of events began with the inboard mounting bolt, which had failed from a fatigue fracture that extended across about 80 percent of the cross section of the bolt, at a position nearly in line with the lower surface of the wing. Where it passed through the spring strut, the bolt shank exhibited corrosion and fretting debris. One of the saddle clamp bolts also showed fatigue cracking from multiple locations near the head of the bolt; however, this affected only a small portion of the cross-sectional area. The saddle bolt had failed because of a wrenching overload subsequent to the failure of the inner bolt.

An earlier Piper service bulletin enforced by an airworthiness directive (AD) had mandated landing gear bolt replacement. This had been complied with on the accident airplane at 1,100 flight hours. However, a later, non-mandatory service bulletin with similar requirements had not been done on the airplane, which had flown another 2,000 hours since the first bolt replacement.

A Piper inspection report form on the Tomahawk specifies inspection of the gear assembly, including bolt condition, torque and security, at intervals of 100, 500 and 1,000 hours.

Danger: Jet Intake

What are more familiar aviation-oriented stencils than "No Step" and "Danger: Jet Intake?"

The first had its origins back in the wood-and-fabric days when a misstep could put a shoe through doped cloth skin, but continues to have application. This one seems to have been imprinted indelibly upon the consciousness of all who scramble around on airplanes. The second caution slogan came in when the jet age spawned turbine engines powerful enough to ingest objects the

size of a person. With the continuing growth in turbine engine power, the latter caution becomes an imperative "imprint" for anyone who even approaches the intake areas.

Just as pilots continue to hand-prop light airplanes without having a qualified person on board, ground personnel occasionally drop their guard around the jet engines with which they have become so familiar. Case in point:

An engine trim was being accomplished on a Boeing 737-200 with JT8D-15 engines. The main landing gear was chocked with the parking brake set, Number One engine was not operating and Number Two engine was running at takeoff power.

The mechanic was standing outboard of the operating engine outside of the danger boundaries. He was not wearing the prescribed safety lanyard. He was wearing a standard communications headset.

The cord from the headset entered the airstream of the engine intake and was sucked into the engine. This pulled the mechanic off balance — and he followed the cord into the engine intake, becoming wedged against the inlet guide vanes. Parts of his clothing and a number of personal objects were ingested into the engine but, fortunately, the mechanic only received minor injuries.

The mechanic was treated at a hospital for minor cuts and bruises and shock and was released. The engine had to be changed because of internal damage caused by the objects it ingested.

Metallic Debris Prompts Takeoff Abort

When the throttles of the Lockheed L-1011 Tristar were advanced to takeoff power, Number Two engine would not accelerate beyond 50 percent N1. The pilot rejected the takeoff by the time the airplane had reached 30 knots. After the flight crew was unable to clear up the problem, the aircraft was returned to the ramp.

The fuel pump for the affected engine was changed, and the engine ran satisfactorily. When the removed pump was checked, it was found that the fuel flow was restricted by seizure of the pump trim valve actuator because of unidentified metallic debris. Disassembly of the pump and removal of the debris restored the unit to proper operation.

For Want of Oil A Bearing Was Lost ...

The pilot of the Fletcher FU-24 agricultural aircraft was beginning his 12th top dressing run during the third job of the day when the engine rpm began to increase. He pulled the propeller rpm control slowly back but this had no effect, even at the full low rpm position. Within a

few seconds the reverse occurred and the engine rpm dropped rapidly, following which the pilot heard metallic noises and felt vibrations that increased in intensity. The engine stopped abruptly. The airplane was then at an altitude of about 100 feet agl.

As soon as the engine quit, the pilot jettisoned what was left of the material he was applying and turned into the wind for an immediate forced landing. The pilot was not injured in the ensuing landing that caused substantial damage to the left landing gear when the FU-24 ran through a fence.

When investigators disassembled the engine to look into the cause of the engine failure, they found that the Number Seven connecting rod had failed at the big end bearing. This had caused substantial damage to the crankcase and surrounding parts. Also, the Numbers Four, Five and Six big end bearing cages were found to be unserviceable. It was observed that bearing material had run out of the sides of the bearing cases, an indication of excessive heat buildup due to lack of lubrication. Additionally, all four of the engine's connecting rods and crankshaft journals showed evidence of overheating.

Technicians removed the two oil gallery end plugs on the crankcase. They found a piece of material blocking the oilway to the Number Four main bearing which, in turn, supplied the Numbers Six and Seven connecting rods. Another piece of material was found at the front of the same oil gallery, suggesting that this had caused a blockage of the oilway to the Number Three main bearing which then supplied the Numbers Four and Five connecting rods. The left oil gallery proved entirely clear.

Examination of the material that had blocked the oilways indicated that it probably came from the oil filter adapter gasket, although this could not be definitely determined.

The engine had run 1,390 hours since a complete overhaul. Since then, the only disassembly work on the engine had been what was necessary to install the oil filter adapter gasket. That had been accomplished 661 hours after the overhaul, and there was no entry in the engine's logbook that showed subsequent maintenance work that would have disturbed the gasket.

Dirty Blades Lose Lift

The Hughes 269 helicopter was being used for aerial application work. The pilot had sprayed about 30 drums of plant plasma in the early part of the day and switched operations to another job that involved a mixture of plant plasma and 2-4-D fertilizer. The weather was warm with a calm wind.

There was a slope adjacent to the new loading site. The pilot planned

to utilize this to fly downhill as a means of accelerating the loaded helicopter to translational airspeed before climbing out of ground effect on the way to the application area.

The pilot carried a slightly reduced load for the first takeoff, but the helicopter still felt heavy when he picked it up into a hover. However, the engine power and the rotorcraft's response seemed normal as he accelerated downwards along the slope.

When the aircraft approached the bottom of the slope, where there was a fence and a pile of logs, the pilot was caught by surprise as the Hughes suddenly sank. Before he was able to jettison the load, the tail rotor hit a fence post. The Hughes continued to sink and ended up on the log pile. The aircraft was destroyed, but the pilot evacuated without injury.

Investigation later revealed that the main rotor blades were coated with a thick layer of fish fertilizer material to which dirt particles had adhered. The rough surface on the airfoil acted similarly to heavy frost on the wing of an airplane and impaired the lift. Investigators of the helicopter accident concluded that the surface roughness of the rotor blade probably led to early separation of boundary level air, causing the rotor blades to stall at high angles of attack such as would have occurred when the pilot increased collective pitch to climb out near the bottom of the hill.

This accident compared similarly to that of another occurrence that involved the same model of helicopter. In the earlier instance, an agricultural chemical had coated the main rotor blades and dried into a rough, powdery surface. That pilot, too, had used a downslope to accelerate and also had been unable to climb out of ground effect.

Engine Refuses Air Start And APU Decides to Quit

During a flight test of the Boeing 757, the left engine was shut down to check its ability to restart at FL260 and a speed of 260 knots IAS.

During the first relight attempt, there was no indicated fuel flow and the engine restart was not successful. The pilot decreased the altitude to FL250 at an indicated airspeed of 286 knots. Again, the engine failed to relight, and another attempt was made at FL200 and 160 knots airspeed, this time with crossbleed help from the right-hand engine. That attempt failed, too, so a fourth try was made at 15,000 feet and 240 knots, using the crossbleed. This time the engine started. However, by this time the APU had failed, so the airplane was returned to the airport.

Technicians later found that the left engine HP fuel pump suffered from

a low output flow and changed it. It had not been modified to a new standard that had been established to improve common occurrences of low output fuel flow in pre-modification pumps.

Loose Bolts Sink (Air)Ships

The Hughes 369 had flown a number of short flights that day carrying sightseers at a charity event. After flying to the airport to refuel, the pilot returned to the site of the event and took on four new passengers.

When he applied full power prior to liftoff, there was an uncontained engine failure and the rotorcraft settled onto its skids. Debris from the engine punctured the main fuel tank and fire developed. The passengers and the pilot escaped without injury, but the helicopter was destroyed by the ensuing fire.

The final report by investigators concluded that the helicopter accident was caused by a loosening of the tie-bolt nut clamping the first- and second-stage gas generator turbine wheels together. This led to the uncontained failure of the first-stage wheel. The debris that flew out of the engine punctured the fuel tank which led to the fire. The conclusion was that the loose nut which had caused it all had not been locked during assembly.

Hidden Glitch Slips Clutch

The pilot of a Hughes 269 helicopter was re-positioning a hunter from one forest clearing to another. The hunter's equipment was slung beneath the rotorcraft on the cargo hook.

The helicopter was at a height of about 200 feet from the ground and flying over a wooded ravine when the engine abruptly went into overspeed. The rotor rpm did the opposite and began to decay. The pilot quickly lowered the collective pitch control and went into autorotation. The main rotor blades contacted the canopy of the trees as the helicopter descended into a stream, landing right side up but substantially damaged. The pilot and his passenger suffered minor back injuries. Signals from the emergency locater transmitter guided a rescue helicopter to the accident site.

Upon investigation it was found that the cable to the clutch had broken adjacent to an end ferrule. The fracture was located in an area that was not normally accessible for regular inspection.

Older Airliner Has Hot Flash

The BAC 1-11 was passing through FL300 during a descent when the TGT indicator showed a temperature increase to 750 degrees C.

The pilot shut down the engine and diverted to a nearby airport. The landing was normal, and there was no damage to the airplane and no injuries to the occupants. Upon investigation, it was found that the high-temperature indication was not a false alarm. It had been caused by a defective airflow control regulator that was out of adjustment and was operating quite sluggishly. The unit had flown for nearly 650 hours since last certified as airworthy.

The Bugaboo of Stress Corrosion

The DC-8 had just lifted off and the gear was raised. The flight crew immediately heard a loud bang and felt a vibration. The vibration quickly stopped and all engine and system instrument readings were checked and found to be normal.

The pilots elected to continue the flight which was without incident. When the gear was lowered prior to landing, the crew again experienced a noise followed by a vibration. Although the gear indicators showed a down-and-locked condition, the pilots made a flyby for a visual check. The tower controller reported that the gear appeared to be down and locked, and the subsequent landing was routine.

After landing, the aircraft was inspected. Maintenance personnel found that the nose landing gear retract cylinder rod fitting had failed at the pressure bulkhead because of corrosion and stress. When the gear had been retracted after takeoff, the retract cylinder had punctured the bulkhead, but the close fit effectively sealed the hole and the aircraft pressurized normally. When the gear was lowered at the destination, the retract cylinder pulled away from the bulkhead and produced the noise and vibration noticed by the crew.

Left Out in the Cold

The Shorts SD-330 had been suffering from a long history of hydraulic problems and was about to be ferried to a maintenance base for repairs. The pilot was advised that the emergency braking system was inoperative.

Engine start was normal but both pilots commented on an unusual noise they thought emanated from the engine-driven hydraulic pumps. However, pressure of the main hydraulic system indicated its normal 3,000-psi; and, both crew members found their brakes operated properly when they tested them on initial taxiing.

As the departing airplane turned from the parking ramp to the taxiway, the nosewheel steering failed. When the pilots applied the brakes, they found that these, too, had failed. The airplane began an uncontrolled left turn and ran into a parked Vickers Viscount. There was substantial aircraft damage, but there were no injuries to the pilots.

Examination of the Shorts hydraulic and braking systems showed that there was corrosion within the emergency brake accumulator that had allowed nitrogen to enter the main hydraulic system. It was noted that the airplane had been stored outside for a lengthy period without servicing.

Assymetric Reverse Thrust

The Boeing 727 had made a night landing and the pilot selected reverse thrust. The airplane then veered to the left and struck a runway edge light. There was only minor damage to the airliner and no injuries among the seven crew members and 75 passengers.

The directional control problem was traced to a failed actuator on one side of the cascade thrust reverser of the Number Two engine.

Flap Track Flap

The Boeing 747 was making an early morning approach to London Heathrow after a flight from Abu Dhabi. Shortly after he selected 30 degrees of flaps on the ILS approach, the pilot heard a thump, following which the Boeing heavy yawed and rolled to the right. He took corrective action and landed the airplane without incident.

Inspection of the aircraft revealed that the Number Six flap track had failed.♦

Mechanic's Creed

Upon my honor I swear that I shall hold in sacred trust the rights and privileges conferred upon me as a certified mechanic. Knowing full well that the safety and lives of others are dependent upon my skill and judgment, I shall never knowingly subject others to risks which I would not be willing to assume for myself, or for those dear to me.

In discharging this trust, I pledge myself never to undertake work or approve work which I feel to be beyond the limits of my knowledge, nor shall I allow any non-certificated superior to persuade me to approve aircraft or equipment as airworthy against my better judgment, nor shall I permit my judgment to be influenced by money or other personal gain, nor shall I pass as airworthy aircraft or equipment about which I am in doubt, either as a result of direct inspection or uncertainty regarding the ability of others who have worked on it to accomplish their work satisfactorily.

I realize the grave responsibility which is mine as a certified airman, to exercise my judgment on the airworthiness of aircraft and equipment. I therefore, pledge unyielding adherence to these precepts for the advancement of aviation and for the dignity of my vocation.

Flight Safety Foundation
Written by Jerome Lederer
Director, Safety Bureau
U.S. Civil Aeronautics Board, 1941