Continued Airworthiness of Aging Corporate Aircraft

Those who maintain older business aircraft may face similar inspection and life-extension challenges as those who keep the air carrier fleet flying.

—

by
Jack L. King
Aviation Journalist

The tragic inflight cabin rupture of the Aloha Boeing 737 in April 1988 resulted in extensive media attention being focused on the airworthiness of aging pressurized airline transports, and served as a catalyst to review the aging status of all aircraft.

Corporate maintenance personnel may not be greatly concerned with the aging problems of airline equipment or the programs, such as Supplemental Inspection Documents (SIDs), developed to prevent catastrophic structural failure when operated beyond design life limits. However, a review of the background leading to these programs could be enlightening, since proposals for similar SID coverage of aging corporate aircraft is being developed.

Judging the life span of an aircraft has been a problem associated with airline operations, but economics and competition have been the deciding factors in replacing equipment. The reliable and durable Douglas DC-3, the most successful transport aircraft ever built, was a primary workhorse and profit maker until faster pressurized transports made this masterpiece obsolete. During the post-war heyday years of corporate flying, the popular DC-3 converted to corporate configuration was also the flagship of the industrial fleet.

Although many aging DC-3s, which

have passed the half century mark, are still in operation throughout the world, airframe experts point out that since this model is not pressurized it should not be used as a standard for comparison to the complex machines in use today. The basis for this reasoning is the stress applied to the pressurized aircraft cabin structure by each cycle of operation. Thus, a pressurized aircraft would be more subject to cabin rupture than an unpressurized model.

One of the most difficult problems with aircraft is detecting minute cracks and corrosion in the external metal skin, especially if they develop beneath a painted surface. Inspection procedures such as observing each rivet pattern of a large transport with a magnifying glass, are not efficient. Although airlines are faced with economic justification decisions, the Boeing Commercial Airplane Group, in cooperation with the United States military, has proven the continued airworthiness of its 30-year-old KC-135 Stratotanker, the forerunner of the Boeing 707, through comprehensive inspection and costly replacement programs which progressively rebuilt the airplane.

Due to the higher utilization of scheduled airline transports, the problems associated with operating aging equipment were first experienced by airline operators, and a review of their progress made may help guide corporate maintenance personnel.

SID Program for Extending Life Limits

The U.S. Federal Aviation Administration (FAA) and the aviation industry have been addressing the aging aircraft issue for several years. This cooperative effort resulted in the development and implementation of the SID program applicable to large transport category airplanes. A SID is an addition to the basic complete maintenance program for an aircraft and is for airplanes that continue to operate beyond their design service life.

Recommendations to insure the safe extended service life of aging Boeing jetliners have also been proposed as Airworthiness Directives by FAA. The proposal recommends 74 mandatory modifications for Boeing 727 jetliners when they approach a threshold of approximately 60,000 flight hours; 56 mandatory modifications for Boeing 737s when they reach the milestone of approximately 75,000 flights and 31 modifications for Boeing 747s when they approach 20,000 flights. Boeing points out

that the 737 jetliners make many more flights per day than the 747s, hence the disparity between the number of flights by type of aircraft.

The Aloha Boeing 737 aircraft involved in the tragic midair cabin rupture in 1988 had acquired 89,680 flight cycles. A comprehensive inspection such as detailed in the SID program could have identified the aircraft's existing structural discrepancies and prevented the accident.

Survey of Corporate Aircraft Manufacturers

The North American Sabreliner, Lockheed JetStar and early model Learjets were the first business jets utilized by corporate operators. However, for this report several manufacturers of corporate aircraft were contacted to determine if they had developed any specific inspection or modification programs to insure the continued airworthiness of their aging models.

Sabreliner

The original Sabreliner model was designed and built for military use as the T-39 trainer/utility aircraft before it was offered as a corporate business aircraft. The manufacturer originally placed a 10,000-hour life on the airframe, and, since many operators were nearing this maximum flight time limit, Sabreliner Corp. developed a comprehensive inspection and modification program to extend this time to either 15,000 or 30,000 flight hours. Based upon the average use of about 330 hours per year the 15,000-hour time limit would provide another 15 years of extended operation.

The 14-week modification program includes a comprehensive inspection and major dismantling of the airframe while incorporating some 40 structural modifications. Bob D. Hanks, vice president of engineering, noted that for the 30,000-hour life extension program, the airframe condition inspection is basically the same and only additional structural modification parts are required. When the modifications are accomplished and the aircraft is repainted, the name is changed to Excalibur or Sabreliner EX.

Lockheed JetStar

In reply to my inquiry regarding the Lockheed JetStar, Carlos C. Hopkins, manager of customer support, noted that damage and durability tolerance analyses (DADTA)

studies have been conducted on all JetStar primary structures. As a result of these studies and of service experience, kits have been made available to install external doublers at windshield post locations and to reinforce the wheel-well longerons.

The JetStar was the first pressurized turbine-powered business airplane, and Hopkins noted a very conservative design philosophy was utilized. "The working stress levels used for load-carrying members are very low when compared with those in a current generation airplane," he said.

The *JetStar Operators Maintenance Report* pertaining to continued airworthiness covers 100/300-hour and annual inspections, airworthiness directives and special inspections. The report notes that in some cases more frequent inspections are necessary for continued airworthiness.

Learjet Series

Learjet Corp. reports that it has aircraft operating safely with up to 25 years in service. Dick Etherington, director of configuration development, related that the company recognized the importance of monitoring the fleet as it aged, and provided for mandatory inspections that would develop insight into the health of the older aircraft and allow for repair of any damage from fatigue or corrosion that occurred with aging.

The initial inspection intervals of Learjets were set short until a data bank of information was obtained that permitted an extension of the major aging inspection periods. Etherington noted that other than replacement of the life-limited items, the 12,000-hour inspection is the most important part of the company's program to maintain the safety of its aging fleet. The inspection is a comprehensive one specifically developed for aging aircraft. This inspection is repeated at 6,000-hour intervals after the first inspection cycle.

There are some items on the Learjet series that are life-limited, established by fatigue tests. For example, the replacement and overhaul schedule for the Model 35 shows many major items with life-limits of 20,000 flight hours; and landing gear components with life-limits based upon the number of total landings, which vary from 9,000 to 20,000 when operated from hard-surface runways. Aircraft that are approved for unpaved runway operations have much lower limits of 1,800 to 5,000 landings for the same components.

Falcon Jet Series

The Falcon Jet series of aircraft produced by Dassault Corp. of France has acquired some 4,600,000 flight hours to date with 957 fleet aircraft. There is no prescribed life limit. ohn H. House, director of communications for Falcon Jet, noted that Dassault engineering had anticipated the aging of the Falcon fleet, rather than reacting to it, and before the Model 20 fleet leader reached 20,000 flights, the approval to continue operating to 40,000 flights was already in hand.

In an article titled "A Fountain of Youth for Aging Falcons" in the company publication, it was noted that fatigue tests have been completed to 100,000 cycles without any structural damage, which equates to 20,000 flights or 30,000 flight hours. Studies have taken into account the experience acquired in all areas, such as tracking and eliminating corrosion and metal fatigue—techniques that compose the new science of "airframe geriatrics."

The article also described several other interesting studies and specific tests related to extending life limits of airframes performed by the manufacturer. Some 40 stressed areas of the aircraft were considered, taking into account all known and predictable damage to those areas as well as the effects of repairs and corrosion removal. Then, using powerful computer programs, they calculated how cracks would propagate.

During the Falcon 900 fatigue tests, cracks were deliberately started at the 40,000 flight point and observed throughout the test program. During this test it was confirmed that a longitudinal crack in the pressure vessel skin along two successive webs, and passing under a ruptured frame, could be tolerated. It was noted that the resulting pressurization leak and insulating material protruding through the crack made the damage obvious.

Cessna Aircraft

Cessna Aircraft Co., producer of the Citation series of business jets, has not developed any specific inspections or modification programs to extend the life of older pressurized models. H. Dean Humphrey, director of public relations, informed me that the existing guidelines in Cessna engineering maintenance manuals for the various models should continue to be used in inspecting airframes. He noted that Cessna, along with other members of the General Aviation Manu-

facturers Association (GAMA), is working on the proposed SID program relating to continuing airworthiness of aging aircraft.

Beech Aircraft

Beech Aircraft Corp. has not yet published advice to owners regarding continued airworthiness. Drew Steketee, director of corporate communications, noted that the company has done several surveys of older Beech models in regard to aircraft aging, and the results of these surveys are being used as the foundation for industry-wide consideration of continuing airworthiness procedures. He said that Beech expects to offer the general aviation version of the SID at a future date and, in accordance with industry practice, these documents will offer advice to aircraft operators on what to look for during inspections of their older aircraft.

Beech provided a copy of its publication *How to Buy a Used King Air* which catalogues some worthwhile advice on what to look for in an older pre-owned, turboprop King Air, and most of the advice could be applied to other makes.

Since continuing airworthiness of any aircraft is reflected by the quality and frequency of past maintenance, much of any aircraft's past history can be confirmed by reviewing the logs and paperwork. Obviously, when maintenance has complied with a factory approved maintenance program, a King Air — or any other business aircraft — could be graded with top marks for maintenance. The company also cautioned that a pre-owned aircraft could have been abused by unqualified pilots, and noted that periods of long-term non-use could be detrimental to airworthiness.

Conference Relates to Smaller Aircraft

The Aloha 737 cabin rupture, where 378 square feet of airplane structure was lost, served as a catalyst in accelerating the process of dealing with the problem of continuing airworthiness of aging aircraft, not only for large transports but for smaller aircraft used by commuter airlines and corporate operators.

The potential problems associated with aging corporate aircraft are being studied by GAMA, and proposals are being developed in a cooperative program with its member companies.

The Aging Commuter Aircraft Conference was sponsored last year by GAMA, in conjunction with the

Regional Airline Association, with participation by the FAA and various operators. The resulting 85-page summary report reflects an excellent overview of the problems associated with the aging worldwide commuter fleet that includes 1,841 airplanes of 40 different makes.

The report covers the most popular aging commuter aircraft in use, including Cessna 402/207, Beech 99, Piper PA-31, Fokker F-27, Fairchild SA-226/227, Shorts SD3-30/60, deHavilland DHC-6/7 and Embraer EMB-110. Several of these models are used by corporate operators.

It was noted that commuter aircraft accumulate hours as fast as large air carrier aircraft — 2,200 to 3,000 hours per year — and accumulate pressurization cycles even faster. The report gives a list of 23 recommendations adopted by the conference to enhance safety as well as provide continued airworthiness of aging commuter aircraft. The recommendations include actions to be taken by both the industry and the FAA in the areas of maintenance, manufacture, operation and certification of commuter aircraft.

The utilization rate of corporate aircraft is much less than that of either the major airlines or commuter operators. An airliner with 10,000 hours is chronologically young, while a corporate jet with that much time could be 20 years old. A recent survey of business jet utilization by the National Business Aircraft Association (NBAA) indicated the average annual utilization to be 475 hours with the Rockwell Sabreliner utilization being the lowest at 331 hours per year and the Falcon 50 indicated as the highest with 551 hours per year. Thus, many of the problems based upon utilization are not as critical as those facing airline operators.

The process of aging aircraft is similar to that of humans growing old gracefully — both need more frequent and more specialized inspections to insure continued health.♦

About The Author

Jack L. King was co-founder of Professional Pilot *magazine and served as part-time managing editor for 11 years. He has written articles for many aviation publications and is author of two books,* Corporate Flying *and* Wings of Man, The Legend of Captain Dick Merrill, *which was voted the top non-fiction aviation book of 1982 by the Aviation/Space Writers Association.*

King has accumulated more than 20,000 hours since 1939, served as

a corporate chief pilot for over three decades and, although semi-retired, flies a Cessna Citation on a part-time basis. He holds ATP, CFI and A&P certificates, and was a designated FAA flight examiner for several years.

NEWS & TIPS

Industry Updated On Aging Aircraft

The U.S. Federal Aviation Administration's 2nd Annual International Conference on Aging Aircraft provided an industry-wide update on actions taken since the last conference in June 1988. The session also provided participants with an opportunity to comment on the FAA's research and development efforts. Flight Safety Foundation prepared the conference on behalf of the FAA (September/October 1989 *Aviation Mechanics Bulletin*, page 10).

The growing international concern with the aging aircraft fleet and its long-term maintenance was reflected by the fact that attendance exceeded initial estimates by 30 percent. The international community was well represented at the Baltimore, Maryland meeting; of 350 attendees from 25 nations, more than one-third represented organizations and companies based outside the United States.

Conference attendees heard status reports in the areas of transport and commuter aircraft certification, maintenance, and research and development. The efforts of the Air Transport Association (ATA)/Aerospace Industries Association (AIA) task force and the U.S. National Aeronautics and Space Administration (NASA) also were reviewed.

Research and development received special attention in a series of panel discussions in the areas of fatigue, airframe loads, corrosion, non-destructive testing and inspection, and human factors. The panel discussions were formatted in order to solicit input from participants on the direction and focus of FAA and industry efforts.

Conference proceedings are now available. Registered participants will be shipped one volume at no charge. Additional requests for copies of the publication will be filled as long as the limited supply is available. Cost for the proceedings is $50 U.S. Contact Allen K. Mears, FSF.

Technical Scholarships Offered by EAA

The Experimental Aircraft Association (EAA) Aviation Foundation will again administer an extensive scholarship program to encourage aviation studies and careers, among U.S. youth. More than $100,000 in scholarships was awarded in 1989 to young people interested in aviation-related academic and technical studies.

According to the EAA Aviation Foundation, the scholarship program has helped more than 100 students begin or continue their aviation studies. Scholarships have generated grants for aspiring powerplant technicians, mechanics, pilots and those interested in other aviation-related vocations. Chuck Larsen, education director, stated that applicants should be well-rounded individuals who have been "involved in school and community activities as well as aviation, and should have established an academic record that will show an ability to successfully complete the activity for which they are requesting the scholarship."

Applications for the scholarship program and information on specific scholarship opportunities is available from the Education Department of the EAA Aviation Foundation, EAA Aviation Center, Oshkosh, WI 54903-3065. Telephone (414) 426-4800.

Are Wooden Propellers On the Way Out?

Not according to the new management of Sensenich Propeller Co. The 60-year-old division of the Sensenich Corp., the only remaining manufacturer of type-certificated wooden propellers, was recently acquired by The Philadelphia Bourse Inc. The Sensenich brothers started in the 1920s by making wooden propellers for powered ice sleds and later branched out into aircraft propellers.

Warren A. Wilbur III, president of the new company, is a 6,000-hour pilot. He previously served as an officer, and later president, of Bellanca Aircraft Inc. (another longtime user of wood in aviation). In announcing the acquisition and the decision to continue making wooden propellers, Wilbur stated, "Sensenich has a long tradition of quality in the aircraft industry, and we plan to continue that tradition for many years to come. To do so, we made sure that all the employees who helped build that tradition would continue working with us." (All of the employees who worked in the propeller division remained

after the acquisition occurred.)

Sensenich produces about 2,500 wooden and 2,450 aluminum propellers a year. The company also services and repairs two- to six-blade, variable-pitch aluminum and composite propellers used in a variety of aircraft, from lightplanes to commuter aircraft. The company will continue to operate in its present facility on East Airport Road, adjacent to the Lancaster Airport in Pennsylvania, U.S. Perhaps the new management will retain another historic aspect of the facility — the beautiful butcher-block floors in sections of the original factory.

Surprise Safety Hazard

As a ramp serviceman was loading baggage in the belly compartment of an aircraft, he became unconscious and fell out of the compartment onto a cargo pallet. He was revived by other personnel who gave him oxygen from a portable aircraft unit.

The investigation revealed that caterers had loaded some stores cooled with dry ice into the compartment prior to baggage loading. They then closed the hatch. By the time the unsuspecting ramp serviceman arrived to load the baggage, the carbon dioxide emitted by the dry ice had replaced much of the oxygen in the compartment.♦

MAINTENANCE ALERTS

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

Loose Joint Causes Anxious Moments

The Boeing 757 was cruising at FL 370 when a "fuel configuration" warning light illuminated and the right hand fuel level indicator indicated 2,200 pounds low. The aircraft had experienced a fuel leak from the right engine before departure. It had been repaired by a seal change at a leaking joint on the fuel line to the low pressure pump.

Aware of the earlier leak, the co-pilot went to the passenger cabin

to observe the right engine. He reported a fuel leak and fuel-fed flame from the engine. The crew shut the engine down and notified ATC. A single-engine landing was subsequently accomplished at the destination airport with no further incident.

Maintenance personnel found a fuel leak at the high-pressure fuel pump joint, which was loose. (The previous fuel leak had occurred at the low-pressure fuel pump.) They replaced the seals and the engine was run to check for leaks which no longer occurred.

Easily Fixed Wire Gives False Fire Warning

The Boeing 747 had flown across the Atlantic Ocean from Boston to England without incident. However, at a height of about 1,500 feet during the approach to London's Heathrow Airport, a fire warning occurred for the number two engine. The appropriate procedures were accomplished and the affected engine was shut down. The aircraft continued the approach on the remaining three engines and landed without further incident.

The initial investigation by maintenance found no evidence of actual fire. However, it was found that the leads on the lower fire warning loop had chaffed through at a position about one and a-half inches forward of the forward connectors. Chafing had been observed by a ground technician prior to departure from Boston, but he had not considered the chaffing deep enough to warrant splicing. He made temporary repairs and wrote a defect report calling for a permanent repair after the aircraft arrived at Heathrow.

The system was reported to have suffered intermittent wiring faults caused by vibration, and technicians are advised to be aware of the weakness until a preventive fix can be designed.

For Want of a Bolt A Nose Gear was Lost

The Boeing 737 was in the beginning of the pushback prior to departure. The captain heard abnormal mechanical noises from the area of the nose gear bay. The ground technician reported to the captain that the towbar had failed. Pushback was discontinued and the engines were shut down.

Initial maintenance checks revealed that the towbar had become

detached and damaged the aircraft's nose landing gear assembly enough that the leg assembly had to be replaced. No incorrect procedures were found on the part of personnel and the incident was attributed to mechanical failure of a bolt securing the towbar head locking mechanism. Two of the eight Boeing 737 towbars at the airport were found to have elongated shear pin locating holes and were removed from service until they could be repaired. Weekly maintenance checks of shear pins and towbar head fittings were introduced.

Helicopter Dances To Strange Beat

During a landing, the pilot of the McDonnell Douglas 369E heard a faint thumping sound that followed the main rotor rpm frequency. No problems surfaced after an inspection of the swash plate and associated equipment. An aircraft runup and 30-minute hover likewise revealed no strange sounds; the noise could not be duplicated except by flying the rotorcraft.

Maintenance personnel removed the main rotor transmission and top cover. An inspection of the ring gear revealed one tooth cracked and loose to the touch — it was ready to drop off into the transmission. The pilot noted that this was the second such occurrence within a two-month period; the part had fewer than 350 total hours on it.

Unlocked Drag Links Can Cause Trouble

The pilot of the twin-engine Piper PA-34 Seneca had observed three green lights after lowering the gear prior to landing. He had double-checked the gear down on final.

Touchdown on the main gear was normal and the pilot lowered the nose wheel to the runway. Within six seconds, the nose gear collapsed. No one was injured in the incident and there was no fire, but both propellers and the nose cone were damaged.

Examination revealed that the nose gear had collapsed following the failure of a bracket that secures the retraction actuator and downlock link to the forward fuselage bulkhead. The bracket is normally unstressed during landing because the drag link assembly is over-centered in the downlock configuration and supports any drag load on the landing gear leg. However, if the drag link does not go fully over-center, the drag loads would be transmitted through the retraction actuator, which could lead to failure of the

bracket. A service bulletin from the aircraft manufacturer (*Piper Service Bulletin No 413*) called for a one-time check of a particular dimension within the drag link assembly to prevent inadvertent nose gear retraction after landing. The dimension in the drag link assembly of the accident aircraft was within limits, but was less than the optimum specified.

A few months later the pilot of another PA-34 belonging to the same company reported a similar occurrence. During the ground run after landing, the nose gear down light went out, the warning horn sounded and the nose gear collapsed. Examination revealed that the nose gear drag link may not have been overcenter and was not locked down, even though the pilot received a green light indication for all three gear.

Hard Landings Find Weakness

A student pilot in a Bell 47G was practicing autorotations to a taxiway under the tutelage of an instructor. The instructor reported that several hard landings were made during the maneuvers. Following one of the autorotations, the helicopter was being hovered when it rolled to the right. The cyclic control did not affect the direction or rate of the roll and the rotorcraft impacted the ground and rolled on its right side.

The two occupants were able to evacuate the aircraft successfully, the student pilot suffering minor injuries. The helicopter did not fare so well; it caught fire and was destroyed. An FAA airworthiness inspector found a corroded lower engine mount bracket that had been fractured.

Broken Brakes Bring Bother

The DC-10 had landed in the touchdown zone and the pilot experienced excellent braking action on the fog-moistened runway surface. Approximately half way through the right turnoff to the taxiway, however, a strong shudder was felt throughout the aircraft, and the pilot had difficulty continuing the turn. The vibration ceased when the brakes were released.

The pilot had to stop twice during the taxi to the terminal. After the aircraft arrived at the gate and the pilot reported the incident, a mechanic inspected the brakes. The rubber cup cover and brake assembly appeared to be too hot, and maintenance personnel replaced the

number 2F brake assembly.♦

NEW PRODUCTS

How to Encourage Employee Safety

A "Safety Unit Meeting Kit" from Du Pont Safety and Environmental Resources teaches supervisors how to lead more effective safety meetings by promoting employee involvement.

The kit provides direction for a series of seven meetings with a leader and groups of as many as 12 employees. Materials emphasize the use of a teamwork approach that encourages workers to identify and analyze safety problems during the meetings and define actions to solve them. Topics focus on the correction and prevention of unsafe conditions, and the recognition and elimination of unsafe acts.

The kit contains a leader's introduction, an audio cassette that helps the leader get started, a step-by-step leader's session guide, a videotape for use in three of the meetings and 12 workbooks, one for each employee.

Direct inquiries to Meeting Kit, Du Pont Safety and Environmental Resources, P.O. Box 80800, Wilmington, DE 19880-0800 U.S. Telephone (800) 532-7233.

Lifting Table Lightens Loads

A line of mechanical elevating tables comes in a range of capacities that can lift and position parts that weigh up to 2,000 pounds. The units are available from Lee Engineering Co. Inc.

The Presto line of mechanical elevation tables utilize four self-locking screw thread posts for raising and lowering, to assure positive holding under full loads at any level.

Photograph not available.

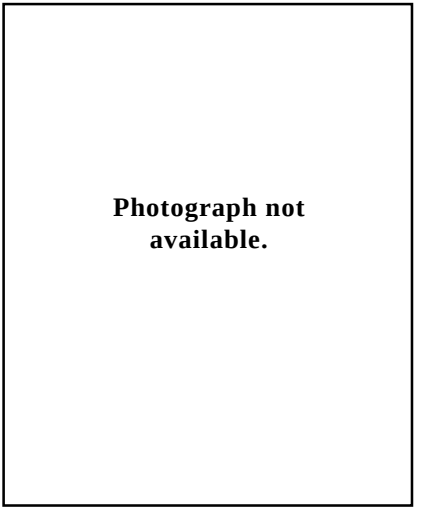
Equipped with hand crank studs at both ends of the table for light (3/8 inch per turn) and heavy loads (1/8 inch per turn), the tables come in eight standard sizes from 24 inches by 36 inches up to 30 inches by 60 inches.

Maximum lift heights range from 24 inches to 42 inches with 18 inches of vertical travel. A bottom base plate offers stability and doubles as a storage area. When the table is elevated, a center storage shelf becomes available. The unit rolls on five-inch phenolic wheels, and a foot-operated wheel lock is standard. Table dimensions can be modified, and a push handle is also available.

A catalog and price list are available on request from Lee Engineering Inc., John Letourneau, Marketing Manager, 500 Narragansett Park Dr., Pawtucket, RI 02862 U.S. Telephone (800) 343-9322 or (401) 725-6100.

Socket System Claims Better Grip

A new high-strength socket system incorporates a unique design that is said to grip fasteners more efficiently than conventional sockets. Introduced by the Wright Tool Co., the patented Wright Drive® socket is designed to spread contact stress more effectively by providing a larger contact area. As a result, says Wright, torque load is transferred away from the corners of fasteners, preventing the rounding, indentations and distortion that can occur when working on soft steel, and on brass fasteners and fittings.



Wright Drive AS954 sockets are available in standard and deep, 1/4-inch, 3/8-inch and 1/2-inch drive, SAE sizes through 1-1/4 inches and metric sizes through 32mm. They are suitable for use in a wide variety of automotive and industrial applications and for 12-point aerospace fasteners.

The Wright Drive AS954 design is claimed to offer a socket-to-fastener contact area 10 times larger than a conventional socket and

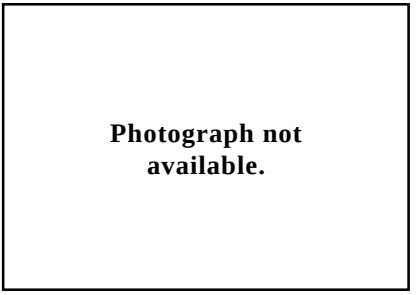
almost twice the contact area of a first generation AS954 socket. This is said to improve leverage, eliminate fastener rounding and increase tool strength significantly.

The socket is hot forged of special 4140 alloy steel and then heat treated. It incorporates drilled lock holes for positive holding as well as chamfered drive and fastener openings.

More information is available from the Wright Tool Co., One Wright Place, Barberton, OH 44203 U.S. Telephone (800) 321-2902; in Ohio and Canada call collect (216) 848-3702.

Infrared Heaters Described in Brochure

A new brochure describes the Vantage II line of low-intensity infrared unitary heaters manufactured by Roberts-Gordon Inc. Units are design certified by the American Gas Association and backed by a three-year limited warranty. The gas-fired radiant heaters are designed to provide fuel cost savings while improving worker comfort. They can be installed in aircraft hangars, warehouses, fire



stations, machine shops, vehicle maintenance buildings and other buildings. Models are available in straight, U-shape and L-shape configurations with tube lengths from 10 feet through 60 feet, and inputs of 40,000 BTU/hour through 150,000 BTU/hour.

The brochure provides features, dimensions, specifications, minimum clearances to combustibles and architectural/engineering short-form specifications. Benefits claimed for infrared heat include clean, quiet, draft-free warmth and rapid heat recovery when large doors are used, such as in hangars. Installation photos are included.

For a free copy of the four-page brochure, contact Roberts-Gordon Inc., P.O. Box 44, Buffalo, NY 14240-0044 U.S. Telephone (800) 828-7450 (nationwide) or (800) 221-0955 (New York).♦