How AFLC uses magnetic rubber, eddy currents, X-rays, and other unusual techniques to keep USAF's aging aircraft safe and battleworthy.

More Mileage from Older Warplanes

A STAFF REPORT

ONE need only watch routine flight operations to see the triumphs and potential troubles of a graying Air Force fleet.

Aged fighters groan under the stress of six-G turns. Vietnam-era transports rattle over primitive strips. Thirty-year-old bombers shudder and shake on treetop runs to target.

Clearly, older airplanes still are capable of stellar performance. Cracks and other old-age weaknesses, monitored by USAF's Aircraft Structural Integrity Program (ASIP), are being held at bay.

But dangers are equally obvious. With many planes beyond their planned service lives and some flying in ways never intended, concerns about structural failure are ever-present.

Moreover, ASIP workers are facing a fleet of 6,000 planes whose average age, 15.8 years, is sure to rise. This trend, made inevitable by years of slack plane production, will compel ASIP's inspectors to exercise even greater vigilance.

That reality is clearly recognized by ASIP's corps of inspection and analysis technicians, managed by Air Force Logistics Command, headquartered at Wright-Patterson AFB, Ohio.

The problem—"tired" metal—is best explained by analogy. Just as bending a paper clip back and forth creates microscopic cracks that weaken it, so too does the stress of flying weaken aircraft parts.

Early discovery of weaknesses, whether to prevent disastrous failure or to permit life-extending updates, is the essence of the thirty-year-old mission that ASIP performs with mounting sophistication.

Once, says Bernie Nasal of AFLC's Materiel Management Deputate, ASIP used a fairly primitive analytical model to predict when cracks would appear. This approach was abandoned, he explains, when ASIP found "big differences" between predicted failure times and when those failures actually occurred.

Since 1970, ASIP has been pursuing a new two-track effort—based on safety and long-term durability—that employs more extensive use of reliable, hands-on inspection as well as advanced predictive models. The change has proven to be a major success, if the record of aircraft longevity is any guide.

Still Going Strong

Hundreds of C-135 aircraft, the first of which was delivered in 1955 with a projected service life of 10,000 flying hours, are still going strong and are headed toward 36,000 hours. The fleet of T-37B primary trainers and T-38 advanced trainers, introduced three decades ago, is expected to stay in service past the year 2000.

Long-range B-52 bombers—G models dating from 1958 and H models from 1961—long ago passed their original service-life goals of 5,000 flying hours, and some will stay in action for another decade. Twenty-five-year-old C-141 transport craft continue to provide a great chunk of US long-range airlift. F-111 fighters produced between 1966 and 1976 and F/FB-111 bombers produced between 1967 and 1970 will remain in USAF's inventory well into the next decade.

The heart of the structural-integrity effort lies in ASIP's Individual Aircraft Tracking Program, a systematic recording of flight histories for all USAF aircraft, whether they be at the end of decades of service or newly arrived on the flight line.

Even those in patently good health are treated like patients in a hospital, with all vital signs monitored and scrutinized.

A multitude of specialized sensors, hooked to an aircraft like emergency-room equipment hooked to a patient, produces information on such invisible stress as deflection of metal between two points, while other devices monitor and record factors such as airspeeds and G-force experience.

So important are the data to the prediction of structural problems that ASIP has devised a wide variety of techniques to do the job:

- Counting accelerometers (used on smaller aircraft) record each instance in which an aircraft exceeds certain gravitational limits.
- Mechanical strain recorders bolted onto all F-16A/B fighters and a few T-38s and F-5s identify unusual structural movement between two points by producing etchings on foil-like tapes.
- Vgh (aircraft speed, vertical acceleration, and height) recorders, installed on ten percent of older F-4s and T-38s, record these aspects of a flight.
- Multichannel recorders, sampling aircraft performance up to 240 times per second, keep track of twenty-six individual flight parameters.
- Specialized monitors on large aircraft record fuel and cargo weights and numbers of takeoffs and landings.

Useful for all planes, tracking is critical for air machines flown in ways unforeseen by their designers. The B-52, to cite but one example, has been transformed over the years from a high-altitude to a very-low-altitude machine. The change places unplanned-for stresses on critical components throughout the bomber.

Hunting for Flaws

Careful recording of stressful operations to predict structural damage is but one facet of ASIP's work. The accuracy of these types of projections is vigorously tested—and at times disproven—by frequent, direct examinations of actual aircraft components.

In such "Stress Spectra Surveys," carried out at air logistics centers across the US, maintenance workers use a variety of ASIP tools and techniques to hunt for unanticipated flaws.

Testing methods cover a wide spectrum. They might be as simple as tapping a coin on an aircraft's surface to detect changes of tone or using the naked eye to inspect fasteners. Most of the time, searches are more technologically advanced.

One technique, known as the

C-141s undergo depot maintenance and modification at Warner-Robins Air Logistics Center, Ga. The C-141 transport, which first entered service in 1964, still provides much of USAF's long-range airlift.

At the Sacramento Air Logistics Center, McClellan AFB, Calif., a quality assurance technician inspects a section of aircraft for structural weaknesses. AFLC "Stress Spectra Surveys" monitor strain on aircraft through a variety of tests.

"eddy current," creates an electromagnetic field within a specified part; structural imperfection shows up as a glaring deviation in the pattern of the field.

To detect damage hidden inside a component, ultrasound devices are used in order to project sound waves through material, paint a "picture" of the subsurface, and reveal voids and gaps in the part.

X rays, N rays, and other extremely-short-wavelength energy forms can be radiated through a suspect part to detect advanced corrosion in metallic fabrications, welds, and castings.

The "Magnetic Rubber" Method

Then there is the so-called "magnetic rubber" method. In this process, liquefied rubber, laced with metal filings, is applied to a magnetized part. Attraction of the metal to a particular area indicates the presence of a crack or fissure, one that might otherwise be too small to see. Application of fluorescent penetrants, specialized liquids that glow under black light, produces similar results.

Armed with detailed data yielded by the tracking and inspection programs, analysts located at AFLC's Aircraft Structural Integrity Management Information System begin the laborious task of reviewing the results and putting them into usable form.

Delmar Teet manages the system, which is based at Oklahoma City Air Logistics Center, Tinker AFB, Okla. He maintains that, after his computers and analysts digest the raw data, they can provide logistics managers with the kind of information they need both to determine the proper uses of older aircraft and to prescribe future maintenance procedures to prolong the aircraft's lives.

Report summaries tell managers how a particular aircraft is being used and, based on that record, how much damage the structure of the aircraft may have received. That information is used to advise commands when airplanes are reaching critical stress limits or when certain operations could have dangerous consequences.

For an idea of the importance of this service, one need only see the ages of some workhorse USAF aircraft. They average twenty-eight years for all 262 B-52s, 17.9 years for all sixty-two F/FB-111s, fifteen years for forty C-5As, 19.8 years for all 365 C-130s, and 17.9 years for all 949 F-4s. Even among USAF's newer aircraft, there are pockets of age. Now at least nine years old are 116 A-10s, twenty E-3 Airborne Warning and Control System aircraft, and 298 F-15 fighters.

Planning Aircraft Modifications

Equally useful is another product of AFLC's computerized analyses: detailed advice on when, where, and how to modify older air vehicles in order to maximize the number of flying hours the Air Force gets from its original investment.

Projections are made about how much longer certain structures will last under certain flight conditions. With this information, USAF officers can decide when to replace wings and other key structures on entire fleets of aircraft. Such ASIP information has been used, for example, to plan the orderly wing-reskinning and reengining of the KC-135 aerial refueler, rewinging and structural strengthening of the B-52, and wing modifications to the C-141 airlifter.

USAF is not the only beneficiary. Friendly nations flying US-built military aircraft—Turkey, Greece, Norway, and Egypt, to name a few—also receive and use ASIP data.

Today, a structural integrity master plan is prepared for each aircraft that enters the inventory. The plan undergoes continuous refinement during an aircraft's service life. The first version of the master plan is included in manufacturers' bid packages. From there, it is updated as engineers develop durability and damage-tolerance analysis procedures.

Early production models are subjected to rigorous vibration, flutter, durability, and damage-tolerance tests both on the ground and in the air. These test data are compared against projections developed during the design phase of the aircraft.

For ASIP workers, the crucial task for the last twenty years has been to make certain that the aging aircraft on hand remain safe to fly and ready to perform their mission. While the program has enjoyed remarkable success, all signs are that there will be no early letup in the challenge. ■

The foregoing article is based on reporting by Kenneth Perrotte, Chief of Media Relations at Air Force Logistics Command headquarters, Wright-Patterson AFB, Ohio, and on magazine staff reports.