MAGNAPLATE
COATINGS ENGINEERED FOR YOUR SUCCESS

CASE STUDY

Space-Age Enhancement Coating Solves Aluminum Longeron Failures On T-38 Jets

First flown in 1959, the Northrop T-38 Talon jet trainer is one of the true “workhouses” of the United States Air Force. Over 60,000 pilots have learned supersonic techniques, aerobatics, formation, night and instrument flying, and cross-country navigation while earning their wings in the aircraft. Whenever a pilot needs to fly from one base to another quickly and efficiently, the T-38 is nearly always the aircraft of choice.

Pilots from most NATO countries are trained in the T-38 as well. And, if you’ve ever watched astronaut crews arrive at Cape Canaveral to prepare for a shuttle launch, you’ve seen the T-38s in another role, too — as the main sub-space transportation vehicle of NASA’s astronaut corps. The space agency also uses the Talon as a trainer and as an observer and chase plane.

After decades of performing reliable, top-notch service in training squadrons, it was decided in 1992 that the Talon would continue into the next century as the Air Force’s prime advanced trainer for fighter/bomber pilots.

Our story, though, focuses on Air Force concerns with vulnerable components of the T-38 that had begun to show wear; in particular the metal fatigue problems that began to appear on the jet’s extruded, anodized aluminum longerons — the main longitudinal members of the body of the Talon jets. Intricately machined and fabricated, these twelve-foot-long structural members had been subjected to wear from two main sources.

First, when Air Force pilots in their heavy flight boots exited the T-38s, they would step on the sections of the longerons immediately adjacent to their cockpits, deforming and abrading the aluminum.

Second, the center strips of the longerons serve as left and right tracks for the jet's canopy rollers; when the canopy is slid fore and aft, the rollers run along the anodized aluminum surface. Over the years, the repeated friction of opening and closing the canopies began to abrade the aluminum surface and cause severe wear. In some cases, the rollers began digging into the surface, jamming the canopies.

Over time, both the jamming and deformation problems sometimes became severe. In several cases, portions of the longerons actually broke off during flight, potentially risking damage to the jets' sensitive flight control surfaces and injury to people or property on the ground.

An Upgrade of the Longerons and Their Coatings Was Needed

It was clear to the Air Force that something had to be done, and the answer was to upgrade the T-38 Talon's longerons — particularly the anodized tracks on which the canopy rollers were jamming.

The project was assigned to Triangle Machine and Manufacturing, the aviation and aerospace pioneer of Hurst, Texas. One of the first issues they addressed was the need to find a way of treating the aluminum surfaces of the longerons so that the retrofits would be able to withstand all the years of abuse that had necessitated the upgrade in the first place.

The design engineer heading the project for the consulting firm working with Triangle Machine knew just the company to tackle the T-38 coating challenge: another aviation and aerospace pioneer — General Magnaplate Corporation. It operates surface enhancement technology centers in New Jersey, Texas and at licensees overseas.

The design engineer had worked with Magnaplate before on surface enhancement of metals, and knew from experience that it had the capabilities to create super-hard surface enhancement coatings with lifelong lubricity, and to do it in the demanding context of aeronautical design and manufacturing.

Magnaplate has an unparalleled record of success significantly improving the performance characteristics of aviation metals while meeting the industry's most demanding specs — those involving the application of metals in space exploration.

Magnaplate coatings have been applied on NASA space craft and vehicle components for every mission since the beginning of the US space program. This included applications as unique and demanding as the protection and dry-lubrication of the drill parts and casings used to gather lunar surface samples from the moon, treatment of components for cameras, telemetry equipment, fuel valves, soil samplers, landing struts, protective shrouds, seat tracks, frames, doors and windows, latches and hinges, space suit components, and the "lunar rover" vehicle. A recent NASA project involved treatment of cargo bay guide rails utilized by space walking astronauts during the Hubble Telescope repair mission.

So when it came to "toughening up" the canopy track sections of the aluminum longerons, General Magnaplate was a natural resource. Air Force and Triangle Machine and Manufacturing personnel paid a series of visits to Magnaplate's Arlington, Texas Materials Technology Center. The visits were followed up by batteries of coating tests designed to establish that the enhanced surfaces created by Magnaplate's proprietary processes would produce a treated aluminum capable of withstanding years of abuse.

Evaluation of the test results indicated that the ideal solution to the problem was Magnaplate's TUFRAM® H.O. process.

The Parts to be Coated Were Very Complex

Before Magnaplate could perform the surface enhancement, however, Triangle Machine and Manufacturing was faced with the tricky task of forming and fabricating the longerons.

Widely recognized for their execution of extremely difficult aerospace designs, Triangle just recently accomplished an expansion into new facilities, including 122,000 sq. ft. of advanced machining and manufacturing equipment incorporating CNC and conventional machining centers capable of three, four, and five axis milling operations.

As it turned out, Triangle needed to use almost all their capabilities on the longeron project. As their company president describes them, the longerons are "very, very complex parts with quite a few fixtures involved. They include a curve and because of all the complexities involved, they virtually have to be sculpted using turning, milling, contouring and assembly."

Using a Surface Enhancement Coating With a Difference

The complexity of the longerons and of the process specified made Magnaplate's work equally complex and involved, and their work on the project began well before the first longerons ever arrived at its Arlington Facility. Magnaplate had to fabricate tooling to hold the over-sized longerons during the TUFRAM H.O. surface enhancement process. They also had to fabricate masking templates to cover and protect certain surfaces of the longerons during application steps involving other surfaces. Such masking is a very critical stage in high-tech surface enhancement coating, and in this case was used both to protect paintable surfaces during application of TUFRAM as well as TUFRAM surfaces during painting. Masking is a procedure that must be done with great care and precision so that critical surfaces are adequately protected during the complex, multiple steps to come.

Following inspection processes, which were performed according to rigid military specifications, Magnaplate applied their proprietary TUFRAM H.O. process to the long, narrow sections of the longerons on which the T-38 canopies would roll as they moved fore and aft.

In this multiple-step, high-tech surface enhancement process, the aluminum longerons are first cleaned and prepared using proprietary processes. The TUFRAM process converts the aluminum surface to aluminum oxide (Al2O3H2O) and replaces the H2O of the newly formed ceramic surface with inert polymeric materials to provide a multi-functional surface. In the process, the aluminum crystals expand to form porous anchor crystals that remain hygroscopic for a short period of time.

The particles of the specific polymer selected are then introduced under controlled conditions of properly balanced suspension, time and temperature to permanently interlock with the newly formed crystals. The polymeric particles become an integral part of the harder-than-steel, continuous lubricating plastic/ceramic surface.

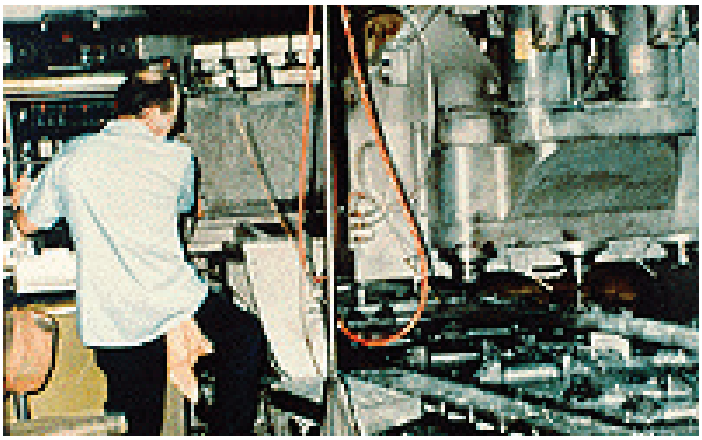
Aluminum Surfaces Tougher Than Case-Hardened Steel

The enhanced TUFRAM surface that results is gray-colored, and extremely hard (Rc 40-50). extremely smooth and dry-lubricated surface which exhibits superior abrasion resistance — greater than that of case-hardened steel or hard chrome plate — and superior corrosion resistance. Surfaces are also protected against chemical attack, and feature permanent non-stick and anti-static properties. The TUFRAM H.O. surface enhancement coating is not a "coating" in the usual sense of the word. It become an integral part of the surface of the aluminum, and will not chip, flake, peel or rub off.

Since the resulting surfaces are superior in performance both to the aluminum substrate and to the individual components of the coating, these proprietary processes are identified as "synergistic."

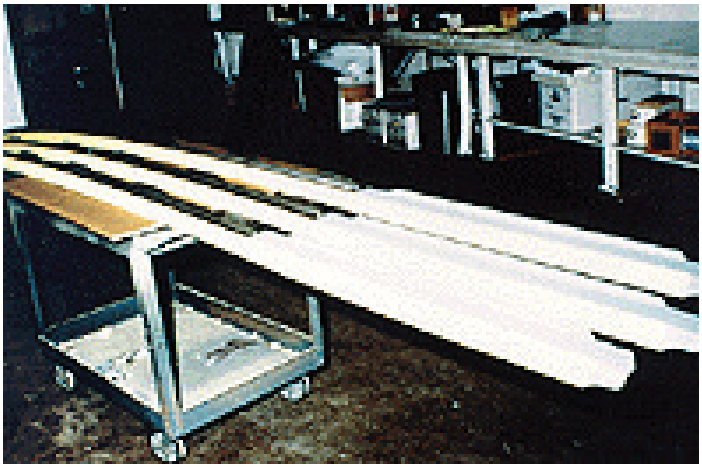
Magnaplate Finishes the Longerons Using HVLP Painting

Following the TUFRAM process, Magnaplate applied primer and finish coats of paint to the non-track surfaces of the aluminum using the latest High Volume, Low Pressure (HVLP) spray painting techniques. HVLP spraying is one of the newer developments in metal finishing — a technique that permits excellent coverage and application efficiency while avoiding overspray contamination of the workplace.



Retrofit Kits Destined for Years of Tough but Safe Service

The surface enhanced and painted longerons are part of a total canopy upgrade kit which Triangle ships to Texas' Randolph Air Force Base, where the T-38 retrofit program is administered. At Randolph, the Talons will be pulled off-line just long enough for the retrofit to be installed and then returned to service at new levels of safety and confidence. Altogether, over seven hundred longeron upgrades have already been completed for the Air Force, with over a hundred more anticipated in the near future.



Of the 1,100 T-38s delivered to the Air Force between 1961 and 1972, over 500 remain in service today - a proud record of enduring performance. And the jet's tenure of service is far from over. Trustworthy Talons are expected to continue in active service with the US Air Force until at least the year 2020. This record is due in part to the fabricating, machining, manufacturing, finishing and surface enhancement expertise of Triangle Machine and of General Magnaplate.

The T-38 longerons are complex parts with multiple fixtures and a curve. Because of the geometric complexities, Triangle Machine and Manufacturing virtually had to sculpt the 12-foot parts using turning, milling, contouring and assembly.

The TUFRAM® enhanced surface at the center of this longeron - applied at General Magnaplate's Texas Materials Technology Center — is gray-colored, and extremely hard (Rc 40-50), extremely smooth and dry-lubricated. It exhibits superior abrasion resistance — greater than that of case-hardened steel or hard chrome plate — and superior corrosion resistance. The TUFRAM surface is also protected against chemical attack, and features permanent non-stick and anti-static properties. Magnaplate also applied primer and finish coats of paint to the non-track surfaces of the aluminum using the latest High Volume, Low Pressure (HVLP) spray painting techniques.