

Oral History

**WOL In-house Expertise Pays Off: How We Got Them Flying Again by Frank Koubek.*

The untold, inside story of how WOL chemists solved polyurethane problems on Viet Nam era aircraft.

If you read page 283 in the “The Legacy of the White Oak Laboratory” book, just two short paragraphs summarize problems encountered on Viet Nam era naval aircraft having electrical connector polyurethane potting compounds and polyurethane shock mounting foams and sealants. It then briefly tells how WOL polymer chemists solved these problems. If you could read between the lines of these two short paragraphs, you would be fascinated by the “the story behind the story” as old time newspaper journalists would say. As a “fly on the wall” during this period of WOL history, I will attempt to fill you in on the “story behind the story.”

It was early in 1970 and our friends in the materials group at the Naval Air Systems Command (NAVAIR) were desperately in need of help to solve problems with electrical connectors on f-4 fighter planes in Viet Nam. Hundreds of these aircraft were grounded. Like most aircraft, these planes were honey-combed with hundreds of electrical connectors, all of which were filled with an insulating potting compound. Unfortunately, this proprietary compound, selected by the aircraft manufacturer, was a poor choice. It was unable to withstand the tropical heat and humidity of Viet Nam and reverted from its solid state to a gooey, viscous, syrupy liquid state rendering hundreds of F-4 aircraft useless----grounded until someone could find a fix!! The “fix” required easy removal of the old potting compound and replacing it with a new, non-reverting stable substance. Simply replacing the metal electrical connectors themselves was impractical, since that would mean tearing out all the wiring in the planes and just about dismantling them to install all new wiring. Like the wiring in your home, aircraft wiring in these planes was installed during the early stages of manufacture with most of the plane built around the wiring.

The man of the hour to fix this problem was Dr. Joseph Augl, a polymer chemist in WOL’s Nonmetallic Materials Branch. One of the first things Joe did was to visit the Navy’s aircraft repair facilities which I believe was in Virginia or North Carolina. (Some of the crippled F-4’s were there to see what could be done to fix the problem.) When Dr. Augl arrived, he was more appalled than fascinated by the cumbersome “milking machines” being used in an attempt to remove the syrupy, gooey potting compound. Large plastic bags were filled with ineffective solvents and placed inside the planes so that the electrical connectors would be immersed for soaking in the solvents in an attempt to remove the gooey potting compound. It was a hot, sultry day in the hangar as harassed, frustrated workers sweated to clean up the connectors. The process was taking weeks to months with very little success; this process was not getting the job done!!

Dr. Augl quickly realized that if he was going to find an effective solvent mix to remove the goo and also find a replacement potting compound, he needed to learn the chemical composition of the ineffective reverting compound in use. The latter was a proprietary substance produced by a large well-known U.S. manufacturer. When contacted for help, they refused to divulge the vitally needed formulation for the polymer, saying it was a proprietary, company secret. They were of no help at all! Not to be daunted, Joe Augl went into his laboratory at WOL and proceeded to analyze samples of fresh polymer and he quickly

identified its chemical composition. It turned out to be a polyurethane having a polyester linkage in its molecular structure. This was a very bad choice made by the F-4 plane manufacturer. Polyester linkages in polyurethane polymers are readily destroyed by prolonged exposure to high heat and humidity (moisture) causing hydrolysis breakdown of the polymer and reversion to a gooey, runny, syrupy liquid; in short, a mess in the aircraft and failure of the electronic systems! Dr. Augl's selection for an effective replacement was a stable, non-reverting type polyurethane that has a polyether linkage in its molecular structure. Testing of the proposed new polymer at WOL's environmental test laboratories confirmed his selection to be a good one! The new, commercially available compound was ready to go!

While having a new, non-reverting polymer to fix all of the F-4's was a giant step forward, there remained the problem of getting "the goo" out of the connectors of the stricken aircrafts. And, the solution to this dilemma, I believe, was remarkable. Dr. Augl, now knowing the molecular structure, and using his expertise and know-how, rather quickly developed a combination of solvents that dissolved "the gook" in hours rather than the months that the old milking machines needed with less success. In addition, Joe developed a technique for injecting certain chemicals into those connectors wherein the potting compound was just beginning to soften. This "miracle injection" permanently rehardened the potting compound so that its removal was not needed!

The upshot for Dr. Augl's outstanding work produced quick results. All the connectors were quickly fixed, either rehardened or replaced with the new polyurethane; and all 900 Navy and Air Force F-4's were able to go back into combat operations! And, as one well known news commentator would say: "That's the rest of the story." (Side-note: For his outstanding efforts, Dr. Augl received the Navy's Meritorious Civilian Service Award.)

In a similar situation, NAVAIR people brought another related polyurethane problem to WOL. This time it dealt with the reversion of shock mounting polyurethane foams used as a protective cushion for the combat, black-box flight recorders on Navy fighter planes. These boxes were being damaged because, over time, the reverted foam was no longer able to cushion the black boxes when jolted on takeoffs, landings, etc.—thus damaging them. Jim Duffy, also an expert polymer chemist in the WOL Nonmetallic materials Branch, took on this problem. He quickly diagnosed the problem by identifying the offending polyurethane foam as having a polyester linkage (Just like the F-4 electrical connectors!) He tested replacement polyether linkage polyurethane foams in the WOL environmental test laboratory, and came up with the best foam that would perform well in shock absorption to protect the flight recorder boxes. This required considerable effort on Jim's part; but because of his expertise (and hard work!) in polymer chemistry, the Navy's problem was solved. Five more gold stars for WOL's scientific expertise!

The above "stories within the stories," I believe are perfect examples of the importance of maintaining in-house expertise and corporate knowledge in the Navy's laboratories. With the end of the Cold War and budgetary closing of Navy laboratories, I wonder if this expertise still exists. Who will manage the contractors and fix their mistakes in the future!

Post Note: Shortly after the F-4 connector problem was fixed, NAVAIR issued a directive to all contractors to "cease and desist" in the use of the bad reverting polyester-polyurethane potting compounds on military aircraft electrical connectors and to use the polyether type. But, just about five years later, our friends at NAVAIR told me that several contractors were still using the "bad stuff." Another good example of the need for maintaining the Navy's "watch-dog" expertise!

Another Post Note: You may also have experienced “gooey foams” in commercial products you may have bought. I have. One was polymer foam in a camera carrying case. After about five years, it reverted to a gooey mess that almost destroyed an expensive camera. I also had to discard a traveling bag that experienced a similar problem. When will manufacturers learn? Maybe, they should have taken a page out of our book.

A Post Note To Our Readers: Regarding my Oral History articles, both in past and future issues of “The LEAF,” I welcome any comments, contributions, etc. that you might send in to upgrade, or shed more light on, and yes, debunk some of my stuff. I’m 78, and my memory is not as good as I think it is! I particularly liked your inputs on “The Great White Oak Bank Robbery” (I missed the boat on that one!), and “The Goats in the 300-area. Keep them coming.