AVIONICS CORROSION 101

BY DALE SMITH

AS AVIONICS SYSTEMS GET OLDER, TECHNICIANS ARE FINDING THAT THEY HAVE TO ADD YET ANOTHER THING TO THEIR DIAGNOSTICS AND MAINTENANCE LISTS: CORROSION INSPECTION AND PREVENTION.

Corrosion: aviation's "C-word" has been a problem that A&Ps have battled ever since designers switched from wood to metal. But the concept of avionics corrosion is something that's relatively new because the avionics we're working on are getting relatively old. "It can be bad, especially on airplanes that are older than 10 years or airplanes that have spent a lot of time near the coasts," explained Jim Durbin, senior engineering manager for Rockwell Collins. "Corrosion is happening from the time the airplane leaves the factory. But it may take years (to) where it will affect systems (and be) recognized as a problem."

And unlike airframe or engine corrosions, which give technicians plenty of visual clues to its location and severity, corrosion on avionics and electrical components is extremely difficult to spot. Plugs, pins, connectors, antennal leads and seals are usually located in areas that don't encourage routine conditional inspections.

"It's just a good idea for any avionics tech working on an airplane, when you're in there getting ready to remove a box, to do a good visual inspection to see if you have any signs of corrosion on, or around, the connectors or boxes," added Barry Lindsten, director of technical services for Honeywell Aerospace. "If you spot any, that's the time to take appropriate action to control the problem."

Know thy enemy.

But before you can control it you have to know what it is. Corrosion is the destruction of metal by an electrochemical reaction with its environment. If we could view a corrosive "cell" on a microscopic level, we'd see an effective battery. You have an anode and a cathode, a connection and an electrolyte, such as water, to complete the circuit—and that circuit is what creates the electrochemical situation that causes the surrounding metal to corrode. (If you want a more in-depth look at corrosion and what caus-

TOOLBOX TIPS FOR AVIONICS CORROSION CONTROL

- Routinely inspect all plugs, pins and connectors for signs of corrosion and contaminant build ups.
- Use an approved cleaner and follow manufacturers' instructions for application and removal of materials.
- Always have clean plastic bags and/or plastic connector caps ready when removing avionics from an airplane and NEVER remove avionics on the ramp in the rain.
- When storing avionics prior to reinstallation, always keep them covered and store them in a humidity controlled room. If the boxes will be in the avionics shop or on the bench for an extended period of time, make sure to cover them nightly with plastic to keep dust out.
- Carefully inspect all rubber seals on avionics access doors that open to the exterior of the aircraft for cracks and splits that can allow water penetration. This is especially important for nose and radome mounted systems.

es it, visit the Corrosion Doctors at www.corrosion-doctors.org, or review a copy of FAA Advisory Circular AC 43-4A, Corrosion Control for Aircraft.)

The best way to stop moisture and metal from meeting is to coat the structure with a barrier. Gold and other highly conductive and non-corrosive metals have been used to plate avionics connectors for decades. This solution works very well—until the connections are subject to the vibration and movement of everyday use, which causes the metals to rub together and wear away those protective coatings. This creates an ideal setting for the formation of "fretting corrosion." And once fretting starts all bets are off.

"The majority of avionics corrosion occurs at the pin connector at the rear of the box," said Jason Smith, manager, Research & Development Lab for Zip-Chem Products. "Usually it will take the form of a change in the color of the pin or connector. It may appear tarnished or in some extreme cases you may even see rust at the base of the connector. This means the plating has degraded to a point where iron oxide appears.

"But most times it's not that easy to see," he continued. "Even though it's not heavily spotted, the smallest amounts of 'tarnish' can significantly increase the resistivity of the part and that's where you see your failures begin—especially intermittent ones. And sometimes visual inspections won't detect this tiny level of corrosion."

Making corrosion detection even harder are those extreme cases where the problem is inside the box. "You may have no visible signs of corrosion outside the box itself," Lindsten said. "But the box could have been exposed to a variety of corrosive elements over time and they could have migrated through to the internal circuitry, between the layers of the CCAs or actually gotten underneath the layers

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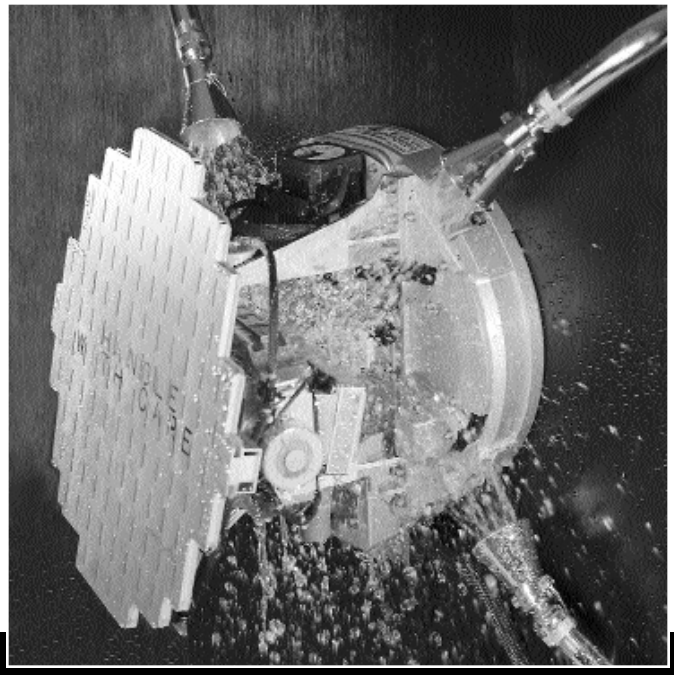

A Honeywell weather radar unit tested under shower heads.

- When dealing with avionics that use forced-air cooling, inspect the vents and inside of the boxes for dust and contaminant build up. Follow the manufacturer's practices to clean any material from the boards.
- Frequently inspect all antenna mounts and connectors at the airframe. These areas are highly prone to corrosion and require extra attention.
- If you decide to apply an appropriate corrosion prevention compound (CPC) follow the manufacturers'instructions. A little goes a long way and over application will only lead to additional clean up.
- Make proactive corrosion inspection a part of your company's avionics service procedures.
- If you ever have a question about how to handle any unusual corrosion situations contact the part's OEM immediately.

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of the boards themselves. That can be very difficult to diagnose and often leads to 'no-fault-found'situations."

Keeping metal and moisture from meeting.

The only way to effectively defeat corrosion is to keep moisture—any kind of moisture—from meeting exposed metal. Unfortunately, the very environment most avionics live in is a very humid one.

"Airplane designers used to put avionics in all kinds of left over spaces," added Mark Pearson, general manager of Lear Chemical. "Panel mount avionics and remote boxes located in the nose of an aircraft are especially prone to problems. These areas tend to create their own humid environment. The boxes get hot and then hold that heat for a long time. Then they have rather long cool-down rates and these conditions promote condensation to form on and around the boxes."

"Moisture intrusion into connector plugs is a big problem especially when you talk about avionics mounted in the nose and radome areas," Lindsten added. "You have a double-whammy because you not only have water flying up in the area, in winter you also have runways treated with salts and those get up in there too. That stuff really likes to wick up wires and get into the connectors which is always bad."

Another environment that can be particularly unfriendly to avionics is right inside your hangar. Dirt, dust and moisture are all around and ready to invade unprotected connectors and plugs. So before you remove a box from an airframe have a clean plastic bag or plastic plug covers handy.

But luckily, plastic bags and plug covers aren't the only weapons in your corrosion control arsenal. There are two steps you can take that are both easy and inexpensive. The first is cleaning and the second is the application of an appropriate corrosion prevention compound.

Clean parts are corrosion-free parts.

The proper cleaning of plugs, pins and connectors can go a long way towards minimizing the occurrence of corrosion problems. "Through our quality practices we train all our technicians to routinely inspect for dirt and corrosion," Lindsten added. "We look at all contact areas. We also make sure to clean all connectors so that if there is any trace contaminant on the piece, we remove as much of it as possible before putting it back in service."

Another situation that will frequently create corrosion related problems occurs inside the "box" with avionics systems that rely on forced-air cooling. "The problem with forced-air is, when you go into a humid environment, the system will force the moisture through the product," he explained. "That moisture will combine with any solid contaminants—dirt, dust, human skin particles, you name it—and actually create an electronic bridge between the circuitry which will start to conduct and lead to failures on the airplane.

"It can also lead to a situation that when the box comes into the avionics shop, it tests just fine," Lindsten continued, "because it's not in a humid environment. The catalyst that caused the fault isn't there any more. That's why our technicians routinely clean the dust and other stuff out of the boxes whenever they come in. It's a simple step that can greatly reduce the instances of 'no-fault-found' boxes returning to service."

Actually, cleaning the various component pins, plugs and connectors is as simple as a quick squirt from an approved "avionics cleaner." You probably have a few cans in the shop already. "The Mil Spec that we've patterned our cleaners after is MIL TRF-29608," Smith added. "It won't harm any plastics and is very effective in cleaning dirt and contaminants away and it's very fast drying so you won't have to swab up any residue. But you really just want to use enough to remove the dirt not flood the area."

One note of caution here is, as of the first of January, aerosol cleaners can no longer contain HCFC-141b because of its Ozone depleting potential. Because of this some less-expensive alternatives can possibly contain flammable compounds. So check with your supplier and read all information thoroughly before using any new aerosol cleaners on electrical connections.

Better living through chemistry.

A&Ps have been using any of a number of corrosion prevention compounds (CPCs) to protect airframes for years. And it's proven to be pretty effective at keeping moisture and metal from forming a destructive relationship.

OK, so now we've arrived at possibly the most important and certainly the most debatable question: Should you or should you not use CPCs on avionics? Well clearly the answer depends squarely on whom you ask. Because it is still very early in the game, there are strong opinions in both directions.

In fact, the only extensive operational analysis that *Avionics News* has been able to find is a report that summarizes a study conducted by the U.S. Air Force titled: "Lubricant Effectiveness Study for Corrosion Protection and Improved Reliability of Avionics." The study, performed on 150 F-16 aircraft over two years found, "Ground based exposures on lubricant test connectors exposed directly in all base environments con-

firmed two conclusions from earlier work. One was that gold-plated connectors without any protection can corrode rapidly. The second was that the best lubricants can totally inhibit corrosion."

One thing I have to point out though, is that the Air Force's report only dealt with the connectors on selected LRU's on the aircraft. The test did not cover use of CPCs inside of the boxes themselves.

But that's not to say the leading CPC manufacturers haven't been doing their homework. "We have done testing on all types of avionics systems," Lear Chemical's Pearson explained. "For example, we did Ohms testing for Learjet to determine the affect our ACF-50 would have on the electrical bond in the aircraft and in the avionics stacks. And what was determined was that a 'dry'connector and a connector treated with our product had exactly the same Ohm resistance. That's an important finding because you do not want to increase the resistance. That would defeat the purpose of using the product in the first place."

"But it also points to the fact that a technician has to be careful selecting which CPCs to use," he added. "Not everything is appropriate for this type of application." Currently CPC manufacturers offer two types of fluid thin film products for avionics protection: the "oily" coatings and the "waxy" coatings—either of which, according to the Air Force's report, are suitable for use on avionics connectors.

The goal of either type of material is to form a protective barrier between the metal it surrounds and any moisture that may be present. Many of the fluid thin film products actually act as moisture displacers, effectively forcing water and corrosives out and away from the metals. Another benefit is that the CPCs can act as a lubricant that keeps metals from rubbing together and promoting fretting corrosion.

So where do you go to find which compounds are right for which application? Again, it's back to the Mil Spec. "The first and best way to make sure a product is OK to use in an avionics application is to go online on the DOD's site (www.dodssp.daps.mil/assist.htm) and look up which products are on the Qualified Products List (QPL)," Smith explained. "If they're there, these products have been completely scrutinized to ensure that they meet all performance requirements." In case you want to do the research, the "oily" products are Mil Spec-C-87177 and the "waxy" CPCs are Mil Spec-C-81309.

"Basically the makers of these products have had to supply material to an independent testing facility to confirm that it meets the military's guidelines," he added. "It's a situation where you don't have to rely on the claims of the manufacturer."

Mil Spec or not, not every avionics manufacturer recommends the use of any CPCs at all. In particular, Lindsten said that Honeywell does not recommend the use of any such compound. "It has been our experience that long term reliability of electrical circuits and connectors is not improved through the use of such lubricants, and can in fact, lead to increased incidence of intermittent failure due to trapped contamination and wicking into the equipment circuitry," he said.

While the CPC manufacturers certainly can't fault the OEMs, it's no surprise that they don't agree with them. "We've been on the market for over 17 years and we've been tested on all applications quite extensively by avionics technicians around the world," Lear Chemical's Pearson said. "We have had no reports of any negative effects. That combined with our testing leaves us totally confident that ACF-50 is non-conductive and can safely be used on any avionics connector."

What do you do now?

If you've gotten this far and are feeling rather confused, you're not alone. Like everything in aviation maintenance you have to approach each situation as a totally individual and isolated case. If you suspect corrosion is a cause of a problem, and the box is under warranty, then by all means contact the OEM and follow their instructions to the letter.

If, on the other hand, the box has long past its coverage—which will be the case in the vast majority of situations, then it's up to you to use your experience and skill to determine the severity of the problem and create an effective solution.

No matter whether you decide to use a CPC or not, no one can argue the benefits of a careful inspection of all pins plugs and connectors followed by an appropriate cleaning. And don't forget about those antennas. "If you are replacing Comms or Navs, remove, check and rebond as part of the installation," explained Durbin, "It's always bad when a customer has paid good money for a new radio and it doesn't appear to work any better than the old one because the antenna has gotten corroded." q

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