RADOME REFRESHER

While they're right out there for everyone to see, radomes are often the last thing a technician thinks about when troubleshooting radar performance problems.

BY DALE SMITH

Every technician knows what a radome is, but how many of us really understand the role it plays in the overall performance of today's sophisticated airborne electronics systems? And, more importantly, the role careful radome inspection and proper repairs can play in keeping a radar in tip-top condition?

"For quite a while, radomes were viewed by technicians as nothing more than part of the aircraft's structure that happened to cover the radar antenna," explained Jon Tripp, owner, ACRES Consulting. "And unfortunately, even today, technicians often treat it like another aerodynamic fairing. If they see a crack in it they just squeegee on some filler, give it a quick coat of paint and send it on its way."

While that may have been an acceptable course of action five or 10 years ago, today it may just do more harm than good. "With today's low-power transmitters, the performance of the radome is becoming more and more a factor in how well a radar will function," added Scott Unger, vice president and COO, Bryte Technologies Inc. "Because of this, the days of slapping on a fiberglass patch over a damaged area are over. Today, technicians who are working on radomes need to be very aware of the jobs these parts are playing and take appropriate steps to ensure that their repairs do not impair the system in any way."

The low-power, high-performance radars that are found on the majority of today's business aircraft are very sensitive to spurious signals and side lobe reflections that might bounce off the inside of the radome. Repairs and damage to the radome directly impact the radar efficiency and resolution, which depend on a clear, non-distorted and reflection-free antenna view through the radome.

In fact, today's radar systems are so sensitive to changes in their radome's performance that as little as 12 to 15 mils total thickness of additional filler material or paint will reduce the signal efficiency of the system. It's so important that FAAAdvisory Circular 43-14 specifically states; "all repairs to a radome, no matter how minor, must return the radome to its original or properly altered condition, both electrically and structurally."

"The repair technician really has to know what they're doing when they repair a composite radome," Mike Hoke, principal, Abaris Training Inc. said. "It's not just a simple structural repair. They're also repairing the microwave transmissivity capabilities of the radar system. That adds an additional complication that you don't get when you're repairing a control surface or other composite part."

Likewise, avionics technicians need to fully understand what makes a good

composite structure repair so they can spot a bad one. "An avionics technician certainly doesn't need to learn how to do the repairs themselves," he added. "But it's really a good idea to learn what to look for when inspecting a repair to be able to flag a bad one. And since they are probably the first line of defense for spotting radome damage, they really ought to know what they're looking for."

The Good, the Bad and the Ugly

It doesn't take a rocket scientist, or highly trained avionics technician for that matter, to spot a poorly done composite radome repair. Dimples, limps and poorly matched or applied paint are all telltale signs that the fix under the finish isn't going to come up to spec. And even if the exterior finish of the repair looks like a million dollars, that's no guarantee that the repair underneath is as good as it needs to be so it doesn't degrade the radar's performance.

"A good paint job can hide a lot of sins," explained Don Moyer, manager of sales and marketing, Saint-Gobain Performance Plastics (formally Norton Radomes). "You need to look carefully at the inside of the radome. You don't want to see signs of excess resin buildup. Most radomes today use a honeycomb core sandwiched between the fiber layers and if resin fills those honeycomb spaces it will significantly reduce the radar's signal sensitivity. When you look inside, what you want to see is a nice clear, uniform skin with no signs of excess resins or fillers."

Often times, a poorly done composite repair is a result of circumstances rather than an unskilled technician. "Especially if the damage to the radome was squawked at a base that didn't have the proper composite repair capabilities or there wasn't time to make the proper repair before the plane had to leave," Tripp added. "Someone probably said the plane had to be fixed before it was released for flight. So the technician on site followed the information in the SRM. Chapter 51 says you can apply dent filler to composite structures—maybe it does, or maybe it doesn't apply to the radome—but either way, the material will significantly affect the performance of the radar. And the pilot is probably going to write up a radar problem on the flight back. If the technician doesn't know about the radome repair, he's going to waste a lot of time troubleshooting a perfectly good radar unit."

Radome Inspection Tips

While that may be an extremely unlikely scenario, it does do a good job of illustrating the very real benefit of making a visual inspection of the radome a routine part of your radar troubleshooting process. "If a technician is going to develop a 'logic tree' that they're going to follow to troubleshoot a radar system, maybe one of the first branches in that tree should be a thorough visual inspection of the radome," Unger suggested. "That way they check the easy stuff before they tackle the hard stuff."

Another branch of the logic tree should also include asking the questions and finding out what actions proceeded the appearance of the radar problem? Did it show up right after the aircraft came out of the paint shop? Or had a new protective "boot" been attached? Was there a bird or lightning strike? It sounds too simple, but knowing what could have caused the problem can greatly shorten the troubleshooting path.

Another thing to look for when inspecting the paint job is to make sure that no metallic paint stripes extend out across the radar's field of view. Even as small as they are, the mass of tiny metallic particles in the paint will dramatically interfere with the radar's signal transmission.

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OK, so what do you look for when doing a radome inspection? "Mainly what you're looking for are things that are pretty easy to spot," Moyer explained. "On the outside of the radome, you want to look for cracked, chipped or eroded paint and any signs of delamination of the composite structure which can be caused by a bird or lightning strike. It may be hard to spot visually, but is really easy to find if you do a tap test."

To do a tap test, all you need is a small tap hammer or better yet, use a quarter or fifty-cent piece. Then you lightly tap on the composite surface and listen to the sound it makes. If it makes a sharp ring then it's solid. If you get a dull "thud" sound, then there's cause for concern. "When the layers separate, you not only lose structural integrity and strength you also have a path for moisture intrusion into the area," he added. "Moisture trapped in the composite honeycomb will absorb radar energy and diminish the system's functionality."

An even more serious problem with moisture becoming trapped in the composite structure is the ongoing damage that is caused by the repeated freezing and thawing of the water as

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the aircraft climbs and descends. When this happens, the trapped water will slowly but surely migrate into more and more cells creating a larger and larger gap in the material until it gets so wide-spread that radar performance will not only be significantly degraded, catastrophic structural failure is possible.

Another moisture-induced problem is found on aircraft equipped with radome erosion resistant caps—you know, those formed polyurethane nose "boots."

If they are applied incorrectly or have been on for a long time, water can often become trapped between the cap and the radome. This layer of water can create a strong radar reflection and in addition to an overall loss of range, may frequently result in false radar targets and ground clutter returns.

Check Under the Hood Sir?

After you're done with the outside of the radome, open it up and look at the inside. Since most radomes aren't painted on the inside, it's easy to see the fiber structure. And in some situations, you will even be able to spot areas of moisture intrusion. "It's quite possible to see moisture filling the honeycomb structure," Moyer continued. "It looks like dark areas. It's better to use a moisture meter, but a visual inspection is a good start."

Also, if the radome has static discharge or lightning diverter strips, you need to give those a good look too. These diverter strips continuously collect static-build up from the surface of the radome and conduct it to the airframe without severe sparking or arching.

"More and more high-performance jets have them impregnated into the radome itself," explained Mark Wilken, regional sales manager, Elliott Aviation. "While they won't reflect the radar energy, they do transmit static energy away from the nose and back to the airframe. If they're not making good contact with the fuselage, you can actually get an electrical 'spike'on the radar display or interference in the ADF or COMM receivers. We've seen it a few times and it's something technicians often overlook."

To verify the conductivity of the diverters, technicians need to routinely check to ensure good electrical contact at the terminal ends and inspect the continuity along the length of each strip. If you want to perform an electrical check, a typical resistivity reading across the terminals should not exceed 0.010—0.050 Ohm or lower.

"We had technicians routinely changing out the R/T's but what was really happening was the static strips weren't bonded properly," Wilken continued. "If they'd inspected the strips they would have saved a lot of time and effort by not changing perfectly good boxes."

Field-Testing a Radome's Performance

Elliott Aviation has another way of helping its technicians determine the signal transparency of customer's radome. As Wilken explained it, there is a TV transmitter antenna located exactly seven and a half miles from their facility and the technicians use it to test the performance of a radar and radome combination. "We know that all the current radars will paint that tower as level three," he said. "What we do is put the airplane on the ramp and paint that tower with the radome on and then take the radome off and do it again. If the intensity goes way up we know we have radome problems."

"It's nothing sophisticated, but it's a good test," he continued. "And it's something an avionics technician can do easily without needing an A&P."

Another benefit to performing a field test of the radar/radome combination is it will immediately identify an installation that is using the wrong radome. Although it's a rare occurrence, it does happen. Sometimes the original is damaged or gets changed for another reason or maybe it's because of a radar system upgrade.

"We had a guy come in a while back who had a Piper Aerostar," Moyer explained. "He had recently upgraded the old monochrome radar to a new color system and on the first flight proceeded to fly right into the worst weather he'd experienced. And the new color radar never gave him a clue."

"He came over to our facility and we tested his radome and found it had very poor transmission efficiency with a very low return," he said. "We replaced his old radome with one of our new models and then showed him the difference in performance. He bought it on the spot." q

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