VLA Electronics Memo 231

Problems with Waveguide Corrosion at CN7

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Summary:

The Grounds Crew discovered serious waveguide corrosion damage at CN7 in 1996. This is a report of what happened and what was done.

Corrosion at CN7:

Because of water leaks, stacked burial vaults that form the waveguide access holes for pads CN6, CN7, CN8, and CN9 were excavated in the late 70's and reinforced with a concrete envelope. The vaults were leaking water again in 1996, so the Waveguide Crew started re-digging out these 4 vaults to seal the leaks and pack finely granulated material similar to decomposed granite around the outside of the vault walls. The 10' metal conduit "cans" used to replace other vaults are not being used to replace the reinforced vaults because of the difficulty in removing all the extra concrete around reinforced vaults. No waveguide damage of significance was noted on the first vault done, CN6, but an inspection of the waveguide leading into the vault at CN7 exhibited severe corrosion. One of the corrosion holes went through the waveguide steel casing to expose about a 1 cm diameter area of the internal epoxy-based jacket for the helical copper wires.

The yellow polyethlene waveguide jacket in the damaged area had been cut in several places by tools, probably from when the vault was dug out the last time in the 70's. In the corroded areas, the cuts were open, the jacket lifted slightly at the cut edges, and powdery rust apparent at the entrance to the cut. No white corrosion was noticed.

To repair, the damaged jacket area was cut away, the steel cleaned, and the holes filled with quick set epoxy by the Cryo Group. The repaired area was then wrapped with a non-conductive water resistant rubber butyl tape. The technique is intended to insulate and waterproof the waveguide without leaving voids. Incidentally, the leaking holes in the vault through which the waveguide passes were grouted on CN6, but are being stuffed with mastic heated with a heat gun on CN7 because of concern expressed about excessive mechanical coupling between vault walls and the waveguide when using grout.

While inspecting the damaged waveguide, it was discovered that the waveguide leading north from CN7 to CN8 is encased in concrete. Pat Lewis recalls that the concrete was an experiment during waveguide installation in attempt to keep the waveguide straight and therefore less lossy, though he was not involved in waveguide care at that time.

Only rust stains mark where the zinc ribbon passive protection system used to be in the area of CN7. The zinc was installed during initial installation as a sacrificial anode, but an impressed current cathodic protection system was installed later in 1982. A recent potential measurement between waveguide and ground at CN7 was -1.4 v where the threshold for adequate cathodic protection is a potential more negative than -0.85 volts, indicating that the passive zinc protective system is unnecessary and that the impressed current protective system is doing all it can do. Furthermore, a consultant from Pacific Corrosion Research reported after an inspection in 1994

that the cathodic protection in the area of CN7 was satisfactory.

All the information above was reported to Roy Arnold of Pacific Corrosion on December 5, 1996. His assessment was that the existing cathodic protection system is most likely doing all it can since the potentials are correct and because of the absence of any white corrosion products. Arnold contended that the polyethlene jacket will tend to block currents from the cathodic protection once the jacket is penetrated and water allowed to invade the mastic coating that bonds the jacket to the steel. The result is that the steel will not be protected and will rust. Since the potential measurements taken by the Grounds Crew are within limits, the only corrective action is to find holes caused by corrosion damage and patch them.

Additional damage to the waveguide at CN7 was discovered at the coupling between the short piece of waveguide that leads into the vault and the length of waveguide that leads to CN8. The edges of the outer coupling are rusted or broken off up to 3 cm back from the original edge. The surface of the waveguide leading into the coupling is lightly rusted but exhibits no pits. To correct this, the short section of waveguide must be replaced, but doing so would risk having to break concrete away from the longer section of waveguide. The longer section of waveguide enters two large steel flanges. Presumably, the polyethlene jacket resumes at some point after the waveguide enters the concrete, but the exposed waveguide that enters the coupling has no jacket covering. Instead, it was wrapped with duct tape during initial installation. Duct tape is still visible wrapped around the waveguide where it disappears into the flange. The purpose of the flange is not known, and removing the flange risks damage to the waveguide. For now, the exposed surfaces were cleaned and taped.

Holiday Detection:

Holidays (holes or voids) in the waveguide jacket can be found by 1) digging out suspect areas, 2) by allowing the holes to become severe enough to cause a noticeable nitrogen leak, or 3) by an above-ground survey that will cost thousands of dollars. Digging is time-consuming, a crap shoot, and likely to cause further damage. Waiting for a nitrogen leak risks invasion of water into the waveguide which could incapacitate the waveguide system for weeks. The survey imposes an audio-frequency signal on the waveguide so that "hot-spots" caused by holidays in the jacket can be found by walking along the waveguide with detection equipment. NRAO holiday detection equipment is on hand, but an experiment on an unused section of waveguide near the AAB showed that interpreting the results is difficult. The equipment detected holidays that did not exist and did not detect holidays that were deliberately created.

Conclusions:

The Grounds Crew inspected the waveguide where it enters the manholes during installation of replacement manholes in 1997. No further corrosion damage was found. The assessment is that the damage at CN7 is an isolated incident, a result of damage done to the waveguide during maintenance in the 70's coupled with a localized compromise of the cathodic protection system introduced by the concrete casing around the waveguide in this area. As a result, no further holiday detection is planned unless waveguide damage shows up during future manhole replacement.