Wet Cable: Replace It or Fix It?

By Roger Tokarz, President, TAD Consulting

Until recently, this question would have been a no-brainer, particularly among those who have been around the industry since the late 1960s. In those days, a number of attempts were made to recover wet cable sections using a variety of so-called reclamation compounds. Some of these compounds were so thick that they could be pumped only under great pressure, which often caused further damage to the cable. Others were petroleum-based, resulting in deterioration of the plastic insulation. And, to add to the problem, many left pockets of water in the cable, which caused additional deterioration.

Still, the idea of reclaiming cable is attractive due to the increasing expense of replacing cable—especially in an urban environment. And, as every engineer knows, the cost of physically replacing the cable is only part of the expense. With today's cables populated by T Carriers, ISDN, and DSL, the cost of cut-over may well exceed cost of physically placing the cable.

Fortunately, a new solution exists that offers the cost savings of cable reclamation without the drawbacks of early reclamation compounds. But before we get into the details of this solution, let's take a closer look at why water in the cable causes problems.

What's the Matter with a Little Water?

In an ideal world, where the water in the cable was perfectly pure, it wouldn't be that much of a problem. Pure water is an excellent insulator—so if the water that found its way into a cable were pure (as distilled water is, for example), there would be no symptoms, apart from an increase in mutual capacitance to around 160 nf per mile (compared with the typical 83 nf for dry aircore cable). This change in capacitance would be barely noticeable in terms of its effect on transmission.

The problem is that water is never pure. Even rain water, which is a product of evaporation and condensation, is not pure by the time it reaches the ground. Because the water droplets pick up dust and other air pollution as they fall, they are somewhat conductive by the time they reach the cable. Water that finds its way into buried cable is even more conductive, since it picks up salts and other minerals as it percolates through the soil.

It's also true that if the wires' insulation were perfect, even conductive water would cause nothing more that a capacitive increase. However, insulation is never perfect. First, during the manufacturing process, tiny "pinholes" appear in the plastic, allowing water to reach the copper conductors. Second, tiny air bubbles are also present in the insulation. Although these bubbles cause no problems as long as the cable is dry, they do represent areas of potential weakness that can deteriorate over time. In fact, sooner or later (the exact timeframe depending both on how much time has passed and on the chemical makeup of the water), any insulation would start to deteriorate, even if there were no manufacturing defects. The defects simply accelerate the process. And the higher carrier voltages used in special circuits can further accelerate this deterioration.

Once conductive water contacts the wire of a pair and the grounded sheath, electrolysis begins creating high-resistance paths to ground. These *soft faults*, where the conductive water provides the path either to ground or to other pairs, seriously degrade the balance of the pair, creating noise where even moderate power influence is present. That's why the first signs of water in the cable are often reports of noise on POTS lines—or cross-talk or bit errors in special circuits.

As electrolysis continues, the aluminum sheath begins to corrode. Later, the copper pairs themselves begin to deteriorate, adding more conductive material to the water. Eventually, pairs begin to go open. This is particularly true of carrier pairs, which supply high voltage to repeaters and far-end equipment.

Most of these troubles can be cleared simply by eliminating the water. In fact, in the case of aerial cable, one of the schemes in the early days was to "vent" the cable, drilling a hole in the bottom of the cable at the lowest point in each span so the water could drain out. Whatever water remained eventually evaporated. The problem, however, was that as the water evaporated, the conductive material in the water remained, leaving some high-resistance paths still active.

That's why the only long-term solution is to eliminate both the water and its conductive components—and then reinsulate the conductors.

New Silicone-Based Compound Offers a Solution

These days we tend to think of technological advances in terms of electronics, but other industries are also making technological advances. In this case, the magic bullet is provided by the chemical industry—specifically, by a silicone-based compound that not only has none of the problems of early reclamation compounds, but also will *permanently* prevent water re-entry. When applied to wet cable using a proprietary pressure and vacuum process, this compound will drive all water out of the cable. Within a few days, it will cure to a re-enterable gel that will prevent future water entry, yet can be easily peeled away without any sticky mess if you need to work on the cable.

Because the mention of reclamation compounds in this industry generally causes a collective shudder—especially among those of us who have been around awhile—a section of filled cable was submitted to Bell Labs for testing. Bell Labs reported there was *no adverse chemical reaction* between the new compound and any of the materials used in the manufacture of telephone cables. Furthermore, the new compound has a low viscosity—just 10 cSt, compared to 220 cSt for early reclamation compounds—so it eliminates the need for the high-pressure pumping that can damage the cable. The chemically inert nature of the new compound, together with its low viscosity, means that cables treated with it will have none of the problems experienced with earlier reclamation compounds.

The Filling Process

You can either hire out the cable-filling work or send your crew to the factory for training and perform the work yourself. The process involves placing plugs with access ports on each end of the cable section. On the far end of the section, the access port is connected to a vacuum pump and a receptacle to collect the water that will be pumped out of the cable. At the near end, the silicone compound is mixed and the tank pressurized to 25 to 30 PSI. The process is monitored with a time-domain reflectometer (TDR), with the TDR waveform showing exactly how far the compound has traveled. In about 72 hours, the compound cures to a semi-solid, flexible, re-enterable gel with excellent insulation and dielectric properties.

Experiencing the process for the first time is a bit awe-inspiring. Failing T Carriers suddenly spring to life, slow DSL circuits speed back up, and noisy POTS lines suddenly go quiet.

Is There a Down Side?

The only difference between new aircore cable and cable treated with the new compound is an increase in mutual capacitance, making the pairs look electrically longer than they really are. This is a minor difference that does not affect cable performance.

Mutual capacitance increases whenever an aircore cable is filled with anything other than air. Water in a cable, for instance, typically increases the normal mutual capacitance of 83 nf per mile to about 160 nf per mile, making a 1000-foot section look electrically like a 2,000 -foot section. When the water is driven out and the new compound added, the mutual capacitance is reduced to about 120 nf per mile, so a 1000-foot filled section looks electrically like a 1445-foot section—less than when water is present, but still more than its actual length. This apparent increase in electrical length is of no consequence: it does not affect either the performance of POTS lines or the “insertion loss” calculations used to qualify DSL and carrier lines.

Cable Restored to Like-New Performance—at a

Fraction of the Cost of Replacement

In a typical filling operation, the vast majority of all soft faults disappear, never to return. The cost of replacing the cable is eliminated, along with the cut-over costs and customer complaints, since the cable remains in service during the filling process.

Bottom line: when compared with the high costs of cable replacement—including cutover costs, downtime, and disruption to the environment, landscape, or surrounding pavement—treatment with the new compound offers high value at a significant cost savings. In fact, the total cost can be as little as 20 percent of the cost of cable replacement.

The new compound , known as CableCURE®/CB, is available exclusively from Seattle-based Wire DynamiX Corporation (http://www.wiredynamix.com, 1-800-252-0556).

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PHOTO CAPTIONS:

1. Technician performs pre-injection electrical tests on an aerial cable.
2. Technician prepares pressurization tank for injecting CableCURE/CB fluid into water-damaged cable.
3. Technician applies plug to a hand-hold splice prior to injecting the fluid.
4. Technician checks TDR to verify that the fluid has filled the entire length of cable.