Cable Signal Leakage: Understanding the Cause and How to Prevent it

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Having a Best Practices Strategy is Critical to Avoid Repercussions Like Fines, Shutdowns and Customer Dissatisfaction

Introduction: Cable Signal Leakage

Cable signal leakage, sometimes called egress, occurs when RF signals "leak out" from the cable plant and spread into the environment. Cable signal leaks can be caused by loose connectors, damaged plant cables or cracked or unterminated cables. And egress or leakage is an open invitation for ingress, when outside signals get into a coaxial cable causing a disruption in online and voice services, poor picture quality, tiling, and picture freezing. These lead to customer complaints and result in long hours of troubleshooting. But signal leakage also has other repercussions for the operator, the most serious being the increased liability due to "harmful" interference with aeronautical communication.

The FCC has for decades required cable operators to monitor for signal leakage in or near the 108 MHz to 137 MHz and 225 MHz to 400 MHz very high frequency (VHF) aeronautical bands. And the FCC means business. Over the past decade stricter regulations by the FCC have resulted in some hefty fines against cable systems and in some cases, system shutdowns until leakage was repaired.

Operators have to take seriously any FCC orders to rectify violations, submit all the required reports, and respond immediately to all communications from the FCC. Failure to keep on top of it all can be expensive and sometimes disastrous.

The origins of all this FCC enforcement is not a recent phenomenon but goes back to the 1970s and the cable industry's cries of: 'cable is a closed system and will not make airplanes fall out of the sky'. The history of how the regulations came about is filled with government agencies fighting and newspapers across the country proclaiming the disaster coming with every airplane landing.

Where has it Been?

Since the early 1970s the back and forth exchanges between the cable operators and the government regulators have been fierce, with both sides determined to stand their ground. In 1971 the Federal Aviation Administration (FAA) was becoming increasingly disturbed about cable's use of the aeronautical frequencies and took their concerns to the Federal Communications Commission (FCC).

The FAA expressed their fears about interference to air traffic control during a "CATV equipment malfunction." They requested that cable television systems be forbidden to use certain frequency bands. The FAA claimed that: "If a cable is broken radiation can escape!"

Months later the FCC fired back that since there were no actual reports of interference and the probability of interference was minimal, they were not imposing any restrictions.

So with no restrictions from the FCC, the FAA had no choice but to begin using the frequency 118.25 MHz for ground and air communications. This same frequency was being used by many cable tv systems. And for the time being it seemed that the FAA had overreacted on the issue.

Then on April 1, 1976 something happened that changed everything. On that day, shortly after tuning to the 118.25 MHz frequency, pilots approaching Harrisburg, Pennsylvania, suddenly encountered strong interference on their air traffic control channel. Other pilots were also reporting that an interfering signal was causing communications receivers to "break squelch". Even more pilots reported experiencing a loud audio tone in the Harrisburg vicinity.

The FAA immediately sent another aircraft up to get verification of the problem. As the aircraft climbed to 500 feet those pilots too began to experience interference. The pilots continued to ascend thinking it could be a problem only occurring near the ground. But the intensity of the interference kept increasing as they rose higher and it continued for several thousand feet up.

The interference was immediately investigated by field staff officers of both the FAA and the FCC, with the full cooperation of the local cable operator. In addition to opening the squelch on the aircraft receivers, the interfering signals beat against each other to produce unpleasant and potentially distracting whistles whenever the ground transmitter was not activated. The investigation revealed that the local Harrisburg cable system had multiple leakage sources in their cable plant, producing large fields of radiation. An open cable TV connection at a customer's home was one of the many sources of the Harrisburg radiation.

Soon after, as expected, the FCC adopted the aeronautical cable signal leakage rules of 1977, known as the harmful interference clause. In 1978, 79 and 80, more incidents of interference occurred over airports in several states. On December 1980, faced with mounting incidents and a public outcry, the FCC decided to enact fines on cable systems with signal leakage. Since then fines have been levied for violations of signal leakage rules and also for not correcting the problems already cited.

Where is it Now? The Higher Frequencies

Reduce Travel Time

The FCC Rules contained leakage limits for frequencies above 400 MHz, but there were no explicit requirements for regular leakage monitoring on those higher frequencies. Leakage in the higher frequencies of the UHF spectrum was mostly unobserved. Most cable systems weren't operating in that part of the spectrum and rarely received any complaints of interference.

Today circumstances have changed. Frequencies in the 700 MHz range that had been used for over-the-air television broadcasting have been reallocated for land mobile radio communications used by first responders and others. And some of those frequencies have also been licensed to cellular phone companies.

To further complicate things, in recent years cable engineers have determined, much to their frustration, that detecting leakage in cable plants isn't the same procedure as before. Leakage characteristics can vary by frequency, and monitoring for VHF leaks does not detect UHF leaks. Some cable operators assumed that a buttoned-up plant at VHF meant a tight plant across the entire operating spectrum, but that's no longer the case.

In late 2010, the new Long Term Evolution (LTE) wireless technology, known as 4G, was introduced in the United States. LTE service operates in several higher frequency bands, including the 698 MHz to 806 MHz UHF band, and now overlaps the frequency spectrum currently used by many cable operators. This overlap has resulted in LTE field engineers discovering that leakage from cable networks is causing interference to their LTE equipment. And while not the same dangerous scenario as the 1976 airplane interference, it nonetheless is a cause of concern for the cable industry due to more FCC rules, regulations and repercussions.

Since the tried and true leakage detection equipment was only designed to operate in or near the VHF aeronautical band, cable operators had little or no visibility into any network leakage at the higher UHF frequencies. Fortunately, effective tools for monitoring for UHF signal leakage are now widely available. Test equipment manufacturers now have digital-compatible leakage detection products that operate in the UHF spectrum.

The right tools are necessary for detecting leaks in either band but the most important thing for operators to understand is that leakage indications in the VHF aeronautical band and those in the UHF LTE spectrum will not be related. A leak source can produce little or no leakage in the VHF aeronautical band, yet produce significant leakage in the LTE band. The opposite can also be true: a leak source can produce significant VHF leakage, but little or no UHF leakage. And in some cases, a leak source can produce leakage in both frequency ranges. That's why having equipment and a monitoring program for both bands is essential. Just as in the incidents of aeronautical interference, the FCC will and has already taken enforcement actions against some cable operators for UHF leakage and for harmful interference to LTE service.

Where is it Going? Prevent Future Leakage

Many leaks both VHF and UHF are caused by loose drop connectors and hardline connectors and adapters. A hardline connector that is loose by as little as a turn can result in signal leakage in the UHF band, but as we said, not necesarily in the VHF band. Corrosion damage resulting from incorrectly installed or missing weatherproofing is another culprit. These issues can be avoided with quality equipment, training programs, and follow-up checks or inspections. Post install check methods can find a potential problem at the outset when it can be more conveniently remedied.

Getting it right at new installs and service calls is critical. Operators can avoid leakage problems by training technicians to understand the causes of leakage and how to locate the sources, how to correct them, and how to prevent them going forward. Having a best practices strategy is critical to avoid repercussions like fines and shutdowns, liability and customer dissatisfaction.

Some Causes of Signal Leakage and Things to Watch for When You're in the Field:

Possible causes of leaks in the customer's house:

- A connector that has been crimped with pliers
- The use of slip-on jumpers that come with customer premises equipment
- Customer installed house amps
- Customer-installed devices that are poorly shielded such as cable-ready TVs, DVD Players, etc.

Causes of Leakage Found within the Drop System:

- Aging and environmental stress on the cable, electronics, and connectors
- Physical damage to cables or connectors from weather
- Improperly terminated tap ports
- Staples piercing the shield
- Cuts
- Animals chewing the line
- Loose or missing connectors
- Vandalism or bullet holes
- Loose face plates
- Inferior quality cable, actives, and passives
- Cable suck-outs

Due to the Networks Shielding Breaking Down, Leakage Can Occur From:

- Coaxial cable Connectors
- Network devices
- Customer's premises

Causes of Leakage in Hardline Cable:

- Radial cracks formed from expansion and contraction due to temperature changes
- Physical damage caused because the minimum bending radius was exceeded when it was installed
- Damage caused by lightning, corrosion, or vandalism

Network Devices that Leakage May Come From:

- Amp housing
- Taps
- Splitters

What You Need to Know Now

"Uh-oh! An LTE Engineer is calling..." Don't delay responding to them. Schedule technicians right away too. And remember, don't rely on the fact that there's no VHF leakage detected — there could be substantial UHF leakage without any affect to the VHF band. Be sure and document everything, including the dates and times of all communication with the LTE representative(s). Keep complete records of everything you do in the field relating to the issue, including repair details and before-and-after repair leakage measurements.

A Few Things to Keep in Mind

The FCC requires cable operators to have a periodic, on-going program to inspect, locate and repair leaks on their systems. The cable operator is responsible for ensuring that any devices attached to the cable system meet the requirements of the FCC rules and that no "harmful" interference is caused by the cable system. And it's not just the equipment in your outside plant; this also applies to the equipment in customer homes, including those devices not provided by you, the operator. A cable operator must take immediate measures to correct a leakage problem on their system, no matter where the leak is coming from. Sometimes this involves shutting off the offending devices (and your customer) until repairs are made and no leakage exists.

Regular Required Monitoring

Current requirements comprise two major areas: Quarterly monitoring, and an annual flyover or ground-based measurement.

Once per quarter - Cable operators are required to monitor 100% of the network for leakage once per quarter. All leaks found that are greater than 20 microvolts per meter (at a 10 ft measurement distance), must be logged and repaired in a timely manner. The log must show the date and location of each leakage source, the date on which the leakage was repaired, and the probable cause of the leakage. The Signal Leakage Log must be kept on file for a minimum of two years. Regular drive outs in daily routines can usually cover 100% of the plant over three months.

Once per year - The operator must conduct either a flyover or ground-based measurement to come up with a "snapshot" of leakage performance.

This snapshot is reported in the CLI (Cumulative Leakage Index) Report 320 and can be calculated on the FCC site here. The information returned in the calculator is used to complete FCC Form 320 and can be filed online here. A flyover involves an aircraft-based measurement of the network's leakage from an average altitude of 450 meters (approximately 1476 feet which is a little over a quarter mile) above the community, and the network must be in the 90th percentile with regard to a 10- microvolt per meter field strength at the measurement altitude.

Final Thoughts

For the future the FCC is looking into eliminating or modifying the cable signal leakage rules for those companies that have deployed fiber in a service area. Many operators today are replacing coaxial cable with fiber, but the rules remain the same as the ones for coaxial cable systems. With fiber there are no radio frequencies being used, and therefore no RF interference. Specifically, the thin strands of glass composing fiber effectively replace RF transmissions with pulses of light and color, meaning the technology produces no signal leakage at all.

FCC Commissioner, Michael O'Rielly has stated, "It would seem to make sense that cable systems that are predominantly fiber should not be forced to comply with Commission rules that were adopted for a previous technology. Doing so would reduce the cost of compliance for cable systems willing to make the huge investment in fiber-rich networks. Removing rules that make no sense in a fiber-based world is a seemingly minor step that can be made without much controversy."

The cable industry has done a commendable job controlling leakage, as it can be a tedious and frustrating challenge. It is critical to understand the causes of leakage, how to deal with it when it occurs, and how to prevent it. Implementing leakage management and education programs that emphasize proper training, good craftsmanship and quality control will help ensure that future leakage problems are avoided for both VHF and UHF bands. Having the right equipment and adopting best practices strategies are key vital elements for today and the future.

Resources

Whitepaper: Using the CMTS to Find Return Path Ingress in DOCSIS Cable Plants

Whitepaper: Correlation Groups and vTDR Using DOCSIS Proactive Network Maintenance (PNM)

Webinar: Remote Return Path Analysis

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