

Proactive Transmitter Service and Support Strategies

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Proper maintenance and trained personnel are the number one factors in transmitter function and longevity. The objective of this paper is to demonstrate improvements that can be achieved to the broadcast signal, transmitter facility, and knowledge base of station engineers.

Each year stations lose valuable broadcasting time caused by reduced transmitter power, power failure, lightning strike, vermin infestation or engineering oversight. The cost of these disruptions is hard to recoup and offense is the best defense.

I joined Nautel Limited in 1985 as a Field Service Engineer, responsible for the troubleshooting, installation and commissioning of Nautel equipment around the world. I started with Nautel after graduating from the University of New Brunswick with a B.Sc. in Electrical Engineering and while going to school I worked in the engineering department at a local radio station, CFBC. I know the importance of proactive transmitter maintenance. Currently my position is the Director of Customer Service for Nautel; my team is responsible for helping clients in every facet of broadcast transmission systems.

Supporting transmitters that are in remote locations is also a concern. New technologies, internet access and diagnostics alleviate some of this pressure. But there is more you can do.

There are many threats to electronic devices at a transmitter site. Some of these are common to any modern electronics system, while others are unique to the mission performed by a transmitter. The following must be considered:

- lightning
- power line transients
- high radio frequency (RF) fields near an antenna

- arcing in the impedance matching/ phasing networks, RF feed cables
- cooling problems
- routine maintenance activities
- repair activities
- entrance of foreign matter (snakes, rodents, etc)

SITE INFRASTRUCTURE: OVER-ENGINEERING AND UNDER-ENGINEERING

When setting up a transmitter site, it is easy to overlook the basics because playing with the “latest and greatest” technology is much more interesting than worrying about air handling for example. I have seen sites where things were dramatically over-complicated through the addition of equipment that simply didn't need to be there, and have also seen sites where fabulous IT systems were set in place but the air filters were clogged with dust.

Paying attention to some fundamental basics will greatly extend the life of your transmitter and will help eliminate (or at least dramatically reduce) service calls at inopportune times. With the cost involved in purchasing a new transmitter, as well as the costs of lost revenue if the transmitter goes off the air, these preventive measures should be considered worthwhile investments.

CLEAN AIR & COOL AIR

These are the two biggest things your transmitter needs. Many non-technical managers don't realize this or decide to not put in air conditioning as a cost saving measure – after all, why do you need to keep a place cool when no one is going to be there? When you bring up the concept of air conditioning at the site, your manager may look at the specs on the transmitter and point to the upper end of the operating temperature specification as justification for not installing an air conditioner. Yes, the transmitter will operate at this

high temperature but its life will be considerably shorter.



Typical transmitter site

As a rule of thumb; Mean Time Between Failures (MTBF) on average will double if the operating temperature is lowered by ten degrees.

Life and Ambient Temperature

Life of certain electronic devices is temperature dependant and it is doubled when ambient temperature is 10°C lower, based on Arrhenius's Law. Thus, the relation of life and ambient temperature is given per equation.

$$L = L_0 \times 2^{\frac{T_{\max} - T_a}{10}}$$

L : Estimated life (Hr)

L₀ : Life at rated temperature (Hr)

T_{max} : Rated Temperature (°C)

T_a : Ambient Temperature (°C)

In a June 2010 article published by Erica Ho titled, [How to Prevent Your Computer from Overheating \(and Why It's Important\)](#), she explains: "Simply put, if your computer becomes too hot, it is possible to destroy and

shorten the lifespan of the hardware inside your computer, leading to irreparable damage and potential data loss. Besides losing your data, heat pecks away at your computer's internal organs—the motherboard, CPU, and more—significantly shortening its lifespan."

Even more critical, most modern transmitters have on-board computers that are typically more sensitive to extreme heat than the transmitter itself. The ideal operating range for a broadcast transmitter is below 75F. If you can keep the transmitter in that range, it will last longer than if it is forced to operate in high heat.

To minimize contamination problems and guarantee the optimum operating temperature, closed loop cooling systems are highly recommended. These systems circulate the air through the transmitter and an air-to-liquid heat exchanger. The liquid cooling loop is circulated to cooling units located outdoors. The objective is to maintain a constant air temperature in the transmitter's closed air loop which is slightly below room temperature, but not cold enough to cause condensation problems.

Likewise, the air going into a transmitter must be clean. Dust and dirt can spell rapid death for electronic components. Make sure the air entering the building is filtered, and make sure the filters are in a location where they can be easily changed.

Transmitters require air flow along with the cooling options that are available. Clearly identify the inlet areas and outlet areas. The situation at the actual site will dictate the kind of filtering needed. Some areas may be plagued with fine sand while others have insect problems. Even with all this I have seen sites with 2 cm of flies on the transmitter floor after only 6 months and other sites with the air inlets and outlets reversed.

INTERNET ACCESS

Broadcast transmitters, STLs, EAS equipment, test equipment, even the power plant feeding your transmitter may be internet-enabled now. When setting up a new transmission facility, make provisions for

Internet access. You'll not only benefit from remote diagnostics, you can get instant reporting of problems to your smart phone and even notification of things that aren't problems yet but need your attention.

High speed internet is now available almost everywhere and Internet usage has grown exponentially. In North America, 77% of the population has Internet access. In Asia, Internet usage has increased 621% in the last 10 years. More than ¾ of all Internet users have a broadband connection.

With these kind of usage statistics, it makes perfect sense for equipment manufacturers to roll Internet access into their products, and even more reason why Internet access at your transmitter site is a valuable investment. Transmitter manufacturers aren't the only ones using remote access and diagnostics via IP. The audio path through a radio station can be almost completely digital now, from the console to the transmitter. AoIP links from the studio to the transmitter are now in use.

With an Internet-enabled transmitter, you simply pull up a web browser and log in to your transmitter.

The Internet-enabled transmitter presents you with a very sophisticated tool available via the PC in the office, a laptop computer, or even a Smart Phone. You can get alarms via email and can diagnose specific issues remotely. What you cannot reset over your Internet connection, you can at least determine what module, what power supply, what fan, what fuse, what part of the transmitter is having the issue. This places you in the position to actually go to the site prepared to actually deal with the problem – on that first visit.

The instrumentation in the AUI is an example of technology that permits engineers to know that their transmitter is always in compliance with regulatory rules. With HD Radio technology, a built-in spectrum analyzer instantly monitors and demonstrates mask compliance and HD Radio injection level.



AUI showing built in Spectrum Analyzer

This concept can be extrapolated further. With the appropriate sort of user interface, your transmitter can send out email notifications to different people or multiple people for different types of events. The user has full control over what is sent to whom, and when. For instance, if it is not a critical fault, you do not need to wake someone up in the middle of the night, and can program what time the notification will be transmitted. You may elect to notify both a corporate engineer and a local technician for a severe fault, again, this is up to the user to set up as they wish. Not only do they receive an email notification of the event, but then they can use any computer with Internet access, and look deeply into the systems of the transmitter and see how it is operating.

For a small cluster of stations, or a large group, a central monitoring system can be enabled. The transmitter maintains a detailed log which also can be viewed via the IP connection. Perhaps stations may wish to contract with an outside service to do this monitoring. In fact, Nautel has been exploring the idea of offering this as a customer service. Nautel's customer service department could be notified of a problem via email and then interrogate the transmitter via the AUI to either fix the problem or recommend parts to be shipped. With proper monitoring and diagnosis, considerably less airtime would be lost, and, at a significant reduction in engineering time.

KEEPING VERMIN OUT

If you have ever had pack rats move in to a barn or shed, you know how destructive they can be – they will chew through cables, tear insulation out of walls and bring in all kinds of weeds and other fire hazards for their nests. Likewise, field mice can slip in through tiny cracks and set up shop in a transmitter cabinet. Insects, left unchecked, can short out circuit boards. All of this adds up to big problems, not to mention health hazards for you. With new construction, make sure the contractor seals all openings to the building with weather stripping, silicone, wire mesh in vents and steel wool around plumbing pipes. If you're retrofitting an old site for a new transmitter, take the time to seal cracks and close up openings that vermin could use.

Larger vermin – the two-legged kind – have been making news with thefts of copper from unattended transmitter sites. The best way to keep this vermin out is with strong fences, security lights and cameras.

TOOLS KEPT ON-SITE

At a minimum, you need a few things at the site for your routine visits as well as repair trips. Don't count on being able to grab a tool box if you're summoned to the transmitter at the last second. Keep some basic tools with the transmitter: screwdrivers, voltmeter, soldering iron and solder, a set of wrenches, and a vacuum cleaner.

Always measure before touching. Stored energy or turning off the wrong disconnect can be detected harmlessly if you measure first. Ordinary multimeters are not recommended for measuring AC line voltages. Accidents, such as having the meter set to ohms or amps, can put a short on the AC line and result in serious burns from the ensuing arc. There are non-contacting test probes available from several sources (Fluke, Ideal) as well as meters intended for measuring line voltages safely (Teagam).

LIGHTNING PROTECTION

We all know that a broadcast tower is a lightning strike

waiting to happen. However, the electrician who wires your transmitter building may not realize that the 10 gauge ground wire that he would normally install for a job isn't going to keep that lightning strike out of your transmission equipment. Remember what you are trying to accomplish with lightning protection: give the lightning a low impedance path to ground, well away from your transmitter. Insist on a minimum 3" wide copper strap and a number of well buried ground rods.

Also make sure your lightning protection is installed properly. Our company (as well as other transmitter manufacturers) supplies a surge box to go with the transmitter. That box **MUST** be in the proper location, between the AC power entering the building and the RF output to the antenna. With new building construction there is a higher probability this box will be installed in the proper location, but when the site gets reconfigured for a new transmitter things can get moved around and your surge box can end up in a location that simply won't protect your equipment.

One of the first things I look at when I visit a site is where the surge box is located in relation to the AC and antenna feed line.



Surge Box Protection

When a new transmitter is involved it is frequently shoehorned into a space that is barely large enough, and in this situation I usually find the surge box has been moved next to the AC disconnect on the wall, with the antenna feed line nowhere near the surge box. At the very least you need to run the antenna feed line over to

the surge box where it can be grounded and allow this crucial piece of equipment to do its job.

MAINTENANCE

New transmitters will call for help if anything slips out of tolerance. Older transmitters may not have this capability and are more likely to need TLC. Regularly scheduled visits to the transmitter site are a must, regardless of the age of your transmitter. Make sure your engineering budget (or expense allowance, if you're a contractor) covers routine transmitter and site maintenance. It's important for the GM or station owner to understand that the transmitter site can't be handled as a "break+fix" situation. If the transmitter breaks while you're thousands of miles away or when you're on a service call for another station, the owner could be looking at some very inconvenient off-air time and associated lost revenue.

The first thing you should do when arriving at the transmitter site is do a visual inspection. Is the site cluttered or dirty? Are any rodent nests visible? Has the program director been using the transmitter building as a storage facility for old equipment and station paperwork? If it's the latter, make some noise with the GM or owner. Clutter, especially when it involves lots of boxes, interrupts air flow around the equipment and can create fire and safety hazards.

The next step, unless you are one of the fortunate few who actually has a cleaning crew for the transmitter site, is to do some cleaning. **DO NOT USE COMPRESSED AIR TO BLOW OUT YOUR TRANSMITTERS!** All you're doing is moving the dirt from one place to another, and it will just settle somewhere else where it doesn't belong. Use a vacuum cleaner with an extension hose and a brush tip to gently knock the dirt off your equipment and into the vacuum canister. Look inside the transmitter cabinet to make sure it doesn't need vacuuming. Clear away any cobwebs.

Next, make some routine measurements. For older transmitters without on-board diagnostics, this is especially important. Get a baseline for normal operation.

- Make sure all of the power modules are operating at spec.
- Check all of the fuses.
- Many transmitters have main and standby exciters – the standby exciter is no good if it's broken. Cycle it. (In fact, I prefer not to use the term "standby" because it encourages people to let this gear sit unused forever. Call it Exciter A and Exciter B, and cycle between the two to make sure they both keep working!)
- Check your protection circuitry: simulate an SWR fault and see what happens. (This can be done by turning the transmitter on slowly into an open circuit.)

A word about safety: we tend to get complacent when we are working around things we know. *Don't get complacent...the voltages in your transmitter building can kill you.* Remove rings, watches, dog tags or any trinkets that could make contact with anything carrying high voltage. Tuck in your shirt to avoid having your clothing caught by things that could get damaged (or that could damage you). Always pay careful attention to where you're putting that wrench or screwdriver.



Maintain outside your building as well.

IN CONCLUSION

Transmitters are an expensive purchase for any station; one that you can't repeat every couple of years.

Keeping your transmitter site running at optimum levels is key as is preparing for the 'what if's'. With the remote diagnostics built into the modern transmitter of today, there is little excuse for not being aware of signs of trouble well before a failure occurs. These tools allow us to know what is actually occurring inside our transmitter, in real time. Knowing when things are degrading and getting them fixed early can prevent more severe failures later. Alarm thresholds can be monitored and emails sent to the appropriate people

describing the event. Knowing what is wrong before the station engineer heads to the transmitter site allows for a better probability the failure will be repaired in one visit.

Having said that, the best defense is always a good offense. Keep your site well maintained, keep it clean, keep it cool and make sure your lightning protection is adequate. With these simple steps, you will be much less likely to need to cut short that vacation or get called away from the family on Christmas Eve.