

DIVIDE AND CONQUER

The Smoking Power Divider:



AN ARTICLE

BY

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Things that are smoked are often highly desirable. Smoked meat, smoked fish, there are many things that are fondly thought of when saying the word smoked. Smoked is one of those multi-use words that can be both a Noun and a Verb. In the Electronic language, the same inference of Noun or Verb is still applicable but none of them are typically fondly thought of though when used as a Verb, the act of Smoking something can carry a dramatic WOW factor with wide eyes, a sort of smile and a head bob up and down. This assumes that the thing that smoked did not belong to you.

Burnt, charred, toasted, cooked, baked, roasted, SMOKED.... There are so many synonyms for such a fabulous word that the Radio and Electronic industry is rife with their uses and connotations. Often the use of these words is accompanied by other objects de' arte like charcoal, soot, and molten metal. As I have mentioned in previous articles courtesy of Mr. Richard Pryor, "Fire IS Inspirational" and when it happens to someone close to home, doom and gloom often lurk about.

THE FAILURE:

Like many failures the smoking parts went un-noticed until things got quiet and the coverage tanked. Picture if you will,,, 8 levels of panels in circular polarity. 2 faces of panels in a wide peanut pattern covering a skinny piece of geography. A simple design with dual 4" feeders stuffing dozens of kilowatts in to a left half of the antenna and dozens of kilowatts in to a right half of the antenna. Simple right? Left brain covers one half of the license and right brain covers the other half of the license. It was a bright sunny day with a surface solar load temperature of only 148 degrees Fahrenheit, a stiff breeze and power levels well within norms, and then the right half of the island suddenly got very quiet. The left half was pretty much normal, well, except for the minor V.S.W.R. issues that made it back through to the transmitter considering half the load just disappeared from the hybrid.

If it were not for the lone V.S.W.R. sensor in the transmitter looking at the composite load of the hybrid and dual antenna feeders, the failure of fully half of the antenna might have gone completely un-noticed. Even with this massive malfunction, the transmitter thought it was just having a tough day and folded back but did not shut off.



DON'T KNOW WHEN TO QUIT:

Since the one of what should have been three Reflectometers didn't correctly assess the situation and let the transmitter keep pumping gigawatts in to the damaged system, things continued to heat up.

Being the responsive type, the local Engineer received a call from some of the inhabitants of the area asking her if the station was ok. She replied that she thought so but once she called the transmitter and found that there was indeed a high V.S.W.R. alarm and the output power was low, the tune changed quickly.

Some quick testing with some simple on hand equipment revealed that left Twix was running with a forward to reflected ratio of about 23dB, and right Twix was not so good with a ratio of only 3dB. With similar looking forward signal levels, the Engineer assumed that the splitting hybrid downstairs was still in ok shape but the 3dB Return Loss ratio when divided by 2 for Insertion Loss looked frighteningly like the insertion loss of the 440 feet of transmission line in the system which indicated that something large up top had departed the aircraft in flight.

SPEED DIAL KICKS IN:

All together now,,, who do we call? First we call our Line Sweeper, next we call our Tower Crew. We put them both on a conference call and get everyone on a common date, and we all show up together for the party. Line Sweeping 101 says that you don't bring just one to the party, especially when the party is far away, had to get to, or has other unpleasant extenuating circumstances.

TOO OBVIOUS, OR WAS IT?

Assuming that the directional coupler ratio testing was correct, before we even got there, the fire was clearly going to be upstairs. Once climbing up to the Power Divider, the fire was definitely located between the end of the 4" feeder elbow and the input to the Power Divider Tee. The big question was why? As much fun as it is to write articles under the heading of "Don't Do That", and as much fun as it is to try to tell people "Not To Do That", there are people who no matter how many times you tell them the truth, or show them the facts they will continue banging their head on their desk, long after it hurts.

This failure was brought on by a fabrication error. The fire started in a short cut section of pipe that jumped from the main vertical trunk feeder sideways, across the tower face to the Power Divider input between an elbow and a Tee section. The outer portion of this cut section was divine looking. It was beautifully polished and cleaned with a pristinely soldered pair of flanges crowning both ends.

The inner conductor was another story. I refer to another article about using a pipe cutter on inner conductors. <http://www.radioworksrfconsulting.com/pipecuttr.doc>

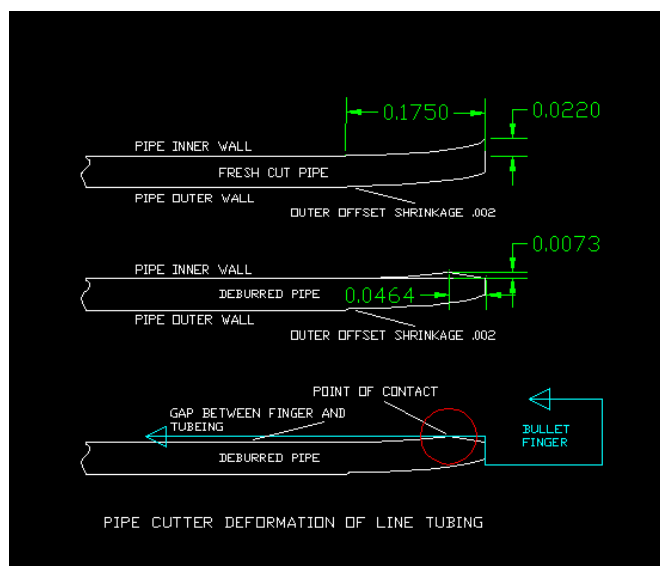


FIGURE 1:

Figure 1 shows three actual measurements of different types of cut-off wheels and techniques of cutting. The inner conductor was cut on both ends with a pipe cutter, and the poor connection on the one end was worse than the other end and it simply burned the bullet fingers off from the extremely concentrated points of contact from the rolled tubing edge, current, and lack of sufficient heat dissipation. Figure 2 shows an actual Optical Comparator shadow image of a wheel cut inner end highlighting the deformation of the end of the tubing. Pipe cutters is an extremely



FIGURE 2:

controversial subject, but time and time again with inadequate filing or de-burring, the use of a pipe cutter on inner conductors has proven to be the source of line, bullet, and component failures. One end of the horizontal cut piece survived to be a witness and the pipe cutter roll pinch was so severe it was clearly visible to the naked eye.

THE TOTAL DAMAGE:

The questions with a repair like this comes some simple thoughts. Is improper, or incorrect technique permissible?

The questions of what compromises something improper or incorrect abound? Who needs to make this decision? Who is on site during the construction who knows the difference, can be aware of these issues, and stop them in process to correct them before they turn in to a failure down the road after the warranty runs out by 24 hours? Who on

site has the horsepower to effect these changes and to make sure that the corrective measures are adhered to, document the issue and insure that this is not a problem going forward? All of these things and more, are problematic. In this case because of the way that this Power Divider was constructed, and due to the location of the failure, the fire not only sooted the entire divider in both the ascending and descending splits, the center feeder transforming match was totally destroyed.

When the transmitter failed to shut down because there was no monitoring on either of the individual feeders or the hybrid reject load, the diminished level of R.F. was still sufficient to promote the on-going fire in the matching Tee, and the meltdown continued through the soot and carbon until the power was removed. Fresh oxygen was continuously pumped in from the dehydrator while soot and smoke was expelled through the multiple outer wall breaches from the arcing and molten metal pooling.

A LESSON LEARNED:

This system was doomed from the start. There was no one on site to watch the construction techniques of the crew and consultants. The assembly techniques and greasy finger prints on the inner caused any number of issues with the system that resulted in this and other lesser burn problems in the branch feeder system. Once the fire started, there was no one and nothing there to watch it burn.

There were no active reflectometers on either of the main transmission lines, or the reject load. The feeling was that all of the components were installed so oversized that they were too big to fail. Where have we heard that before? The reject load on the hybrid splitter exploded from the excess power forced backward in to it from the line failure. This reject load failure had never been an issue from other branch feeder failures that resulted in pattern and coverage issues along with extra tower lights of the wrong colors. The reflected power from branch feeder failures was well within the capability of the reject load but a 1kW load on a 30kW transmitter is a bad pairing. With the hybrid reject destroyed and the reflectometer of the transmitter in question, and no metering on the two main trunk lines, this system was set up for failure and it did just that.

There are places to save dollars when designing a system and there are places not to skimp on dollars. Play out the failure scenarios when designing a system. Bounce the design off of a couple of people that you trust, and pay the money for a third party inspector to be on hand during your construction phase so that errors like pipe cutter technique and greasy fingered bullets won't come back to haunt you. Seemingly simple things can look so harmless but when you really dig, there is merit to many things that will promote safety and long life of your equipment and personnel.