RADIO GUIDE

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A Forum for Radio Engineers

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July 1989 | Volume 2 - Issue 7 | Copyright 1989 - Rochester Radio | 511 18th Street SE | Rochester, MN 55904

Three-Phase Power Circuits

The transmitter is probably the single most expensive piece of equipment at any radio station. You can usually make do when something in the studio goes up in smoke; there's usually enough redundancy somewhere (in most stations) to, at least, allow you to get some type of audio on the air.

The real problem occurs when the transmitter dies. The only reason most stations have backup transmitters is that, usually, the standby was the original on-air unit in the first place! How many stations do you know of that will go out and buy a standby transmitter for a few thousand dollars, when the main transmitter is in working condition? I can hear it now. "We're on the air, aren't we? Why do we need another one." Of course, it's like running a taxi service with one cab, but that's another story.

There are usually more important things to spend station money on -- like ratings buffoonery, silk station jackets with outrageously large call letters, and fake ten-foot-high boom-boxes. Somehow, the transmitter is out of sight, out of mind. Until, of course, at 2:00 a.m. you hear, "Honey, it's the station calling." If you don't have a reliable standby transmitter, then you must have reliable voltage surge and phase-loss protection.

It's probably easier to pick out those areas in the country that are **not** affected by thunder storms and lightning. During a thunderstorm, over or under voltages and phase losses are not uncommon. It's unbelievable what the loss of a phase can do to 3-phase blower motors. The over-current is **something**; you can literally fry eggs on the motor housing. Many motor control contactors have over-current protection built into their circuits. The problem occurs when the motor is running and loses a phase. Many times it will just keep on running, without tripping the over-load protection. A few times like this, over the years, and that motor is going to die. I don't know about you, but I've never had too many spare 3-phase motors lying around.

Of course there are other things that phase-loss and voltage surges can do to equipment, but my point is, if you have 3-phase gear, it needs protection. Now, how do you do it? Let Radio Guide and the rest of us know what you've done to protect your site against phase-loss and voltage fluctuations. Send it in; we'll print it.

1st Anniversary Reflections

The Radio Guide has been in print for a year. Anniversaries are always a time for reflection. This time I'd like to to think of the people that helped Radio Guide to become what it is. Radio Guide would not exist without the continued support of its advertisers. More importantly, where could it be without your technical contributions? It's a partnership, of sorts.

The objective is what is important -- the dissemination of technical information to all broadcast engineers. It doesn't come cheap, and someone's got to foot the bill; our advertisers are doing that. If it's going to come at all, then you've got to give of yourself and send your technical information to Radio Guide for publication.

As I've said before, Radio Guide does not rely on a staff of writers or columnists. We rely on your individual technical contributions. The need is in the field, so that's where the information should come from. So far, you've done well, and I thank you. But since the need is continuous, I'll keep addressing it.

Finally, what some consider to be a touchy subject; your reaction to our advertisers. If you've talked with me on the phone, you already know my feelings on that subject -- here it is. I will never ask you to buy a product, because it is advertised in Radio Guide. That is between you and the manufacturer or distributor. What I do, is simply provide space for that firm's message to reach you. Many times the decision to purchase is made quite a while after being exposed to product information in various publications.

If you **truly** feel that your purchase decision was influenced by Radio Guide, then let the advertiser know about it. I can only offer the promise of results, you can offer the proof -- but **only** if it's a fact!

Next month we will discover how to build an Octopus Component Tester. Also, info on the upcoming Madison Conference.

In This Issue . . .

Page 2	Corrections - Notes - Help
Page 3	Telephone System Input Power Transformer Testing
Page 4	Home Brew Plate Blocker RPU Transmitter Feed
Page 6&7	Resolving RF Interference
Page 8&9	Survival in the Mountains
Page 10-13	Collins 820D-2 AM Transmitter Tips
Page 14&15	RCA BTF-20E Troubles & Other Tidbits
Page 15	STL Dish RF Radiation

Corrections - Notes - Help

Telco RF Filter Address

Quite a few of you have called to ask where the Suttle Apparatus telephone RF filter can be obtained. The article regarding this RF filter can be found in the May, 1989 issue of Radio Guide.

Michael Mallory in Roopville, Georgia, found the address of the company:

Suttle Apparatus
P.O. Box 28
Lawrence, IL 62429
(618) 943-5721

They apparently only sell through distributors, but at least you can call them and find out where their distributors are. Michael says that the distributor in Atlanta is Power & Telephone Inc. (404) 691-6813.

Thanks Mike, for the info . . . Editor

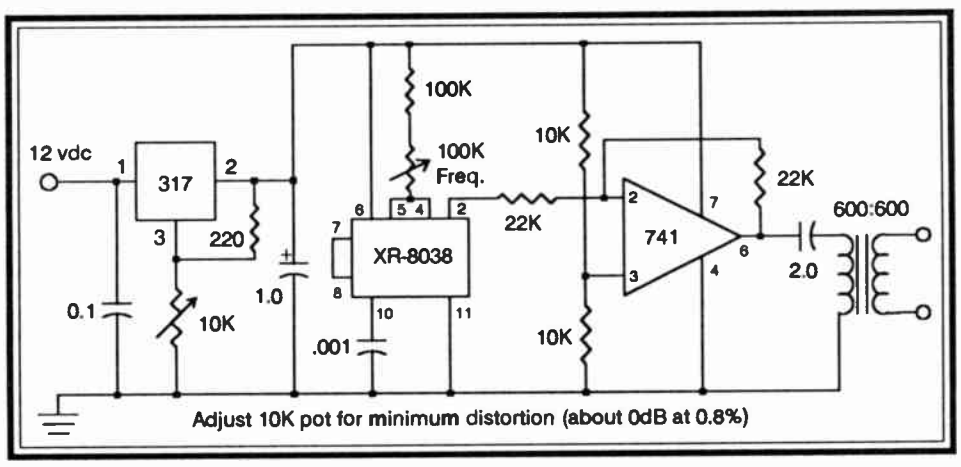
Bauer Transmitter Anyone?

Richard Jenkins, GM of K-LOVE, in Santa Rosa, California, wrote to ask if there's anyone who could help him out. They've got an old Bauer 607A, 1 kW FM transmitter. It is very unstable. They've put in a lot of parts, but when the plate-on is hit, it goes intermittent. Give him a call, if you've got the answer.

Tone Oscillator Circuit Snafu

In the last issue (June, 1989) of Radio Guide, there was an article on page 8 by Robert Hensler, regarding a tone oscillator circuit. The schematic looked real good until (of course) everything was printed and sent out. It was pointed out to me that the 741 op-amp did not have any pin numbers on it - - my fault Robert.

Here is the schematic with the proper pin numbers in place.



Please-We Need Your Help!

If you have any short tech-tips, send them in or better still, call me at (507) 280-9668 and we'll talk about them. Remember, it doesn't do anyone any good if you keep that information to yourself. Don't assume that everyone knows about your special technical tip. Send them in - - they'll be printed in the next issue.

If we're doing alright, let us know. If we're not serving your needs, let us know that too - - and at the same time be sure and tell us what you think needs correction, modification or expansion.

Telephone System Input

By Jim Turner - TVM Enterprises
Kulpmont, Pennsylvania

If your station is considering the purchase of its own telephone system, you, as Chief Engineer, should become involved in the decision making process. Not only will you show your boss you care about the operation, but it may give your supervisors some technical insight without a sales pitch. In other words, you'll serve as a valuable advisor to what some may consider simply a business decision.

If your studio is located at the transmitter site, then the most important consideration for that new telephone system is RF immunity. The facts are simple - - the more electronics added to the system, the greater the chance of RF pick-up. Ask questions about the proposed system's usage at other stations and what testing has been done within a strong RF field. If you've ever tried to eliminate RFI in a telephone system, you know the headaches involved. So don't borrow trouble. Get it in writing that the new system is guaranteed free from RFI. The same is true of power surges and lightning strikes. Ask to see a complete schematic of the entire system, so that you can judge for yourself the quality of design.

If your station does talk-shows then the ease of conferencing calls becomes an important consideration. Many talk-show guests can only be obtained if they don't leave their home or office. As such, it's very important that the host can easily connect outside callers to the guest. Many systems require a formidable procedure of button pushing to accomplish it. In others you can accomplish conferencing by just holding down two buttons. In any event, check it out before the purchase, on an operating system.

One of the good features about the old Com-Key system was that you could see the line ringing from just about any angle. A light bulb inside the line button had its light diffused by the button, thus assuring visibility. That feature is non-existent with a simple LED arrangement. While you may or may not use studio muting for the ringer, many times you can see the line blinking before you are in a position to hear it. You'll appreciate it when you're trying to call after hours.

What about recorder or console attachments? Can this be easily performed or is the audio circuitry so tricky that you risk an unusual imbalance if you try it? Again, have any other radio stations ever used the system?

The same goes for muting the audio and ringer. On the old mechanical style key systems, both operations were simple. But with the totally electronic systems you can render the system inoperative or destroy components if you do it incorrectly. Check out in advance with the schematic.

In conclusion, the most important question you can ask the smiling salesperson is, "What other stations are using your system?" If they cannot provide you with any, then look elsewhere. You should get all of your requirements guaranteed in writing as well as obtain a complete service manual for the system. Make a complete list of your current requirements to give to the salespeople, rather that allowing them to sell you what they think you need. Heck, maybe they've never been in a radio station before and don't have the foggiest idea of what a beeper is or what "remote" means.

Power-Transformer Testing

By Lee Eichelberger - Contract Engineer
Kuna, Idaho
208-922-3390

I have used this procedure for testing transformers for several years and found that it works very well. The transformer that is to be tested should have all primary and secondary leads disconnected and the transformer core should be connected to a good ground.

Connect one side of the secondary to the core. Put a trouble light in series with the primary to limit high fault current and to use as a current draw indicator. Connect the primary leads, with the trouble light in series, to 120 VAC. If the transformer is good, there will be enough reverse EMF to reduce the brightness of the bulb. If the transformer is bad, the bulb will operate at full brightness.

If the transformer under test is a three-phase unit, the test will have to be repeated three times, once for each winding. I would emphasize that one side of the secondary under test needs to be connected to the core, which in turn is grounded. I used this test procedure to find a fault that even a transformer winding shop missed.

Home Brew Plate Blocker

By Alan Roycroft - Broadcast Services Inc.
Honolulu, Hawaii

Nothing is more disheartening than to find the transmitter meters all reading "tilt," nothing going out over the air, and you don't have the needed part.

A common problem is the plate blocker found on most later FM transmitters. It consists of a metal sleeve or tube swaged around the outside final PA tube mounting, with an insulating cuff made from Teflon tape about 6 inches wide. This device prevents the DC plate voltage from passing on to the Pi network, but does pass the RF signal. Usually a replacement is never on hand, and it takes between two days and two weeks to obtain one.

Stuck with this problem, I decided to "home brew" a blocker. First get a small electrical grinder fitted with a thin flat grinding wheel. Remove the blocker assembly from the transmitter, but do not attempt to pry the two metal sleeves apart. They are pressure fitted and you will distort them. Carefully cut a narrow groove down one side of the outer sleeve, ensuring that you do not mark the surface of the inner sleeve which contacts the tube's plate. Once apart, remove the insulation and clean up the cut - - especially the inside of the cut. Finish off the cut with varying grades of emery paper.

If you are really out in the sticks, call on a local draftsperson or architect and ask for some acetate drawing paper (even if it's used). I ran a 10 kW CCA for some months using paper that had a wonderful drawing of a public toilet. Next, obtain two hose clamps. The local truck and trailer supplier will have some 7-inch sizes. Wrap about 4 or 5 layers of the paper around the inner sleeve, being careful not to wrinkle the material. Then wrap the outer sleeve into place, securing it with the two hose clamps. During re-assembly of the blocker, arrange the screws or tightening nuts on the hose clamp in a position away from grounded components so there is less chance of a flash-over. If the clamping bolt extends beyond the nut on the hose clamp, grind it off, and tidy up any sharp edges. Do not over-tighten the clamps.

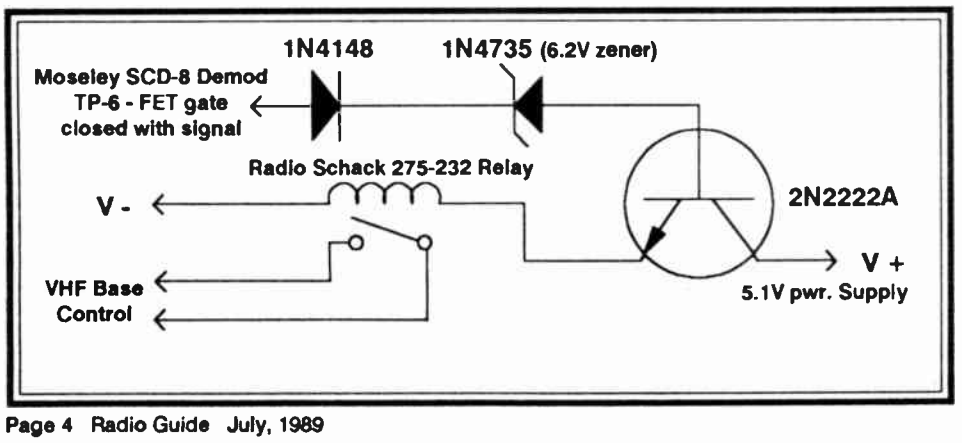
Test the repaired blocker on low power for a few hours and then up to full power, watching out for any arcing. If there is, make sure where the arc occurs; it may be just some part you have bent out of position and may have nothing to do with the modification. If you have more than 6 kV of plate voltage, you may need extra turns of paper, or you may even find some Teflon paper in some corner of town. At least the acetate paper will get you on the air while the Teflon paper arrives. It sure saves the $800 for a new blocker.

RPU Transmitter Feed

By John Maples - WMYU-FM
Knoxville, Tennessee
615-693-1020

Should your SCA no longer be in use, you can use the Mux-2 of your STL to key and modulate a VHF RPU base station located at your main transmitter site, using your subcarrier generator/demod equipment.

Simply add the following transistor switching circuit to the demod unit, and a mike and amplifier to your generator. This is a good alternative to using a telephone line. Line charges for this purpose can be significant, especially if the site is in another county, where the altitude is important.



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6.PROGRAMMABLE MUTING SWITCHES ON EACH INPUT.
7. NINE INPUTS ON LAST CHANNEL.
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11. PHONES SELECT/GAIN CONTROL. Prog1/Prog2/External/Cue.
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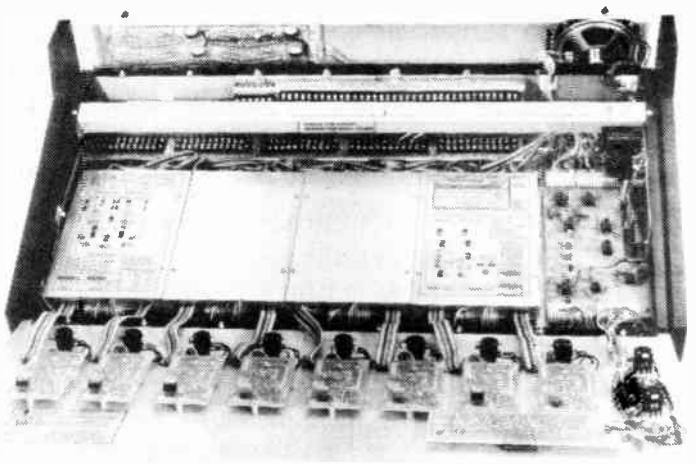

PARTIAL SPECIFICATIONS

INPUTS: Two per channel except the last channel which has nine. Balanced bridging 1k ohms in mic mode & 150k ohms high level. Input #1 of each channel programmable mic thru high level. Input #1 of each channel may be strapped for mono or stereo feed.
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Remote start/stop (xL4)
RSS6/8 ..... **$325**
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Linear faders; Available6/89
LF8 ..... **Contact factory**
Linear faders; Available 6/89
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230VAC power source

Resolving RF Interference

By Time Walker - Broadcast Consultant
Ruffin, North Carolina
919-939-2065

With population densities increasing around antenna sites and more stations increasing output power, the likelihood of stations receiving neighborhood interference complaints are increasing also. Even if the FCC didn't expect the radio station to be instrumental in resolving the interference, it's just good public relations to do so. You never know, that irate caller complaining about our station interfering with his or her TV reception may be on the rezoning committee or some other governing body next year, and broadcasters need fewer critics in high places, not more. Here is a systematic approach to resolving interference complaints that has proved successful in nearly ever instance that I've encountered.

The Systematic Solution

First, be a sympathetic listener. This step is as important as all that follow. Most complaining parties don't call until they get really mad, and they're in no frame of mind to here you respond with "Well, our station was here first!", or "Most cheap receivers have that problem.", or "It's not our fault, you need to have the telephone company fix that." I know of a physician who complained several times to a station about being unable to use his residential telephone because of interference from the station, and was told by a station employee each time, "Oh, I'm sure it's not as bad as you make it sound." That was the extent of the station's efforts until the good doctor called and asked for the FCC's address so he could complain to them.

Get as much information as possible from the complaining party. Ask questions using non-technical language. Seek out the details with leading questions like: "Does this happen all of the time or only during the day?", "Does the music get louder on rainy days?", "Have you always heard that radio station on your telephone?", etc., so that you have a clear understanding of the nature of the interference.

Attempt to identify the source of the interference using information supplied by the complaining party and you own on-site observations. Determine the frequency of the interference and if it's an integral harmonic harmonic of the station's frequency. Look for audio bars in the TV picture that fluctuate with the station's modulation. Interrupt the station's carrier briefly and determine if the interference disappears. Switch to alternate or standby transmitters, change power, change antennas or patterns, and observe the results.

Evaluate the environment around the equipment receiving interference and try to determine how the interfering signal is getting into it. Measure the field strength in the area where the interference is reported. Determine if the complaining party's equipment is grounded and constructed of RF shielding material. Check whether the interference persists briefly, after the equipment's power cord has been removed from the wall and it's power supply bleeds down. If not, perhaps the interference is entering through the power cord. Remove a receiver's antenna connection and observe the results.

Direct Interference

You may discover any of several mechanisms at work. Direct interference can result from rectification of an AM signal in the early audio stages of an amplifier. I once found that a loose speaker wire in a church PA system was detecting the 2,000 mV/m AM signal to the extent that it invaded the early amplifier stages at the most inconvenient times.

(continued on page 7)

RF Interference. . . (continued)

You'll seldom find equipment, outside the studio/transmitter environment, that is properly RF grounded. AC power circuit's safety grounds usually don't function effectively in the RF domain. I've found that a good RF ground is an excellent point to begin eliminating interference, Find a nearby water pipe ground or, if necessary, implant a dedicated ground stake near the equipment.

Determine if the transmitter is harmonically clean, if your investigations indicate that the interference is harmonically related to your station's frequency. Measure the harmonic content of the station's signal at various locations. If the harmonic content fluctuates drastically from location to location, look for some local generator of the harmonics. I located a power pole guy wire that made intermittent contact with a steel structural member of an elevated water tank. Atop the water tank was, you guessed it, the county's emergency fire transceiving antenna which operated on the exact 30th harmonic of the local radio station. The nearby AM station's transmitter was clean but the harmonics generated at this intermittent connection occasionally precluded communications by the county fire marshal, which made him very unhappy.

Indirect Interference

Direct interference manifestations may appear to be a time-consuming hunt-and-find proposition but, to me, they don't even compare to indirect interference. By indirect interference, I mean intermodulation products generated by the presence of several signals which, mixed non-linearly, produce sum and difference products, as well as the fundamental element. These can be generated inside the equipment being interfered with, or external to it. Receiver front ends that are overloaded by one or more strong signals can render a receiver almost useless for receiving anything except the strong signals. I've discovered externally generated intermodulation (IM) products originating from gutter downspouts, tin roofs, fences and such. I investigated one case that reported interference on 44 frequencies! Fortunately, the complaining party was an amateur radio operator who had carefully measured all the frequencies. I used a computer to analyze the relationships of these frequencies and discovered that they were either harmonics or IM products of the four AM stations serving that community. The culprit turned out to be in the overhead power and telephone distribution system of this neighborhood. IM products can be a real stinker to eliminate, but try to find the source and prevent the IM products from being generated. Part of the difficulty with IM products is that they often occur within the frequency band of the desired signal, so filters and traps are not always acceptable measures, particularly with strong FM signals. A field strength meter is frequently helpful in tracking down the local IM generator.

Filters and Traps

I have, on occasion, used high-pass filters very successfully on CATV interference when the local TV repairman and the cable TV people couldn't seem to get the interfering signal out of the coax. In these instances, however, it was the AM station's fundamental that was causing that was causing all the headaches and not external IM products. There are times when a good RF trap in the antenna or something as simple as as power line filter will make a big difference.

I try to enlist assistance from the local telephone company to suppress RF on telephone circuits. Most local telephone companies will install an RF filter on the phone line and this generally works. One instance where it didn't work, however, was where the resident wired his house with 12-pair cable and left 11 pairs un-terminated. Simply stripping and grounding one end of these 11 pairs did the trick.

Last Resorts

If possible, I prefer to avoid the complaining party's equipment. Otherwise, you may discover that you're expected to provide lifelong free service on the equipment. In addition, most manufacture's warranties are void unless the equipment is modified by an authorized service center. If, however, this appears to be a logical course of action, there are several techniques that an be useful. RF bypassing the amplifier input (particularly microphone inputs) can sometimes eliminate the interference. As microphones are concerned, few things will beat a balanced low impedance input and matching microphone. And, an external antenna (with an in-line RF trap) shouldn't be difficult to promote when receivers suffer from interference by the station fundamental. Who knows, maybe all that's required is just a good solid RF ground.

Survival In The Mountains

By Bruce Anderson - KIQX Radio
Durango, Colorado

Most FM transmitter facilities, by the nature of the beast, are located high up. In this neck of the woods, 14,000 foot mountain peaks are abundant, and they make dandy transmitter sights - - except for the lack of accessibility, no power, harsh environment, and major shadowing problems in populated areas. So most of us here in the Rockies have opted for slightly lower environs to put our facilities. Relatively small peaks and ridges, where you can easily get to your site if you are a mountain goat, costs a fortune to have the local power company install an unreliable line, the wind blows the snow into mammoth drifts five month of the year, and the multi-path you create in town is taken for granted since you're the only game in town.

Off The Beaten Path

Most sites around here are between 8,000 and 10,000 feet above sea level; most of our audience resides between 5,500 and 9,500 feet elevation. We happen to be on a mile-long ridge we share with plenty of government and private communications services, the local VHF TV station, and another Class C FM. The road (polite term) is 5½ miles of dust in the summer, at least three times that long in the muck of the spring and the fall, and an indeterminable length when you're snow-showing up it in a winter storm.

Only fools and tourists predict the weather in the Rockies, so any of us working on Smelter Mountain any time of the year are prepared for anything. I keep a change of warm clothing and a spare pair of heavy boots in the building. Also, I have a little camp stove, some freeze-dried food, and plenty of water stashed away in the building. The water, by the way, is kept far away from the equipment, lest the containers freeze and burst during the winter.

A few other simple items kept in the transmitter building can really keep you out of trouble. Spare sunglasses, for example, can be a safeguard against snow-blindness if you're working outside or have to hike back down to civilization. I carry plenty of spare parts for the truck on board the truck, and keep a battery charger handy at the transmitter. A bumper jack, a come-along or winch, and plenty of wooden blocks have gotten me unstuck a couple of times in transit. Stores around here do a booming business in kitty litter during the winter time; it's great for traction on ice. I carry some in the truck and also spread some around the building if I'm working outside.

The winter in the Southern Rockies is cold, windy and often snowy. But the snow is very dry powder - - great for skiing, and wonderful for not sticking to things. In my five years here, I've never had an antenna icing problem. Nevertheless, I try not to make it a habit to walk around outside in the winter without a hardhat.

Don't Ask For Trouble

Since it's generally not seen by most people, a minimal amount of design consideration goes into the transmitter building. Esthetically, that's fine. You don't want to entice trouble, since most sites go unattended. We don't even have windows in our buildings, and our attempted break-in rate is very low compared with a neighboring facility whose nifty building looks more like a house or drive-through burger stand. However, the structural integrity of the building is of utmost performance since you're trying to keep a harsh environment away from some very valuable equipment. A snow-bearing roof should be designed and built commensurate with the amount of snowfall in the area. It should be checked each autumn for cracks, especially around the seams. In the winter, when constant freezing and thawing can introduce melting snow into even the tiniest cracks, the roof ought to be monitored as often as possible for leaks. A week after a big storm last year, we detected a leak right over our standby transmitter. As a result, during the summer, we replaced the entire roof with one of our own design. So far, in spite of more snow and more radical temperature changes, not a drop of moisture made its way in, this past winter.

Mountain-top broadcasters must be aware of lighting. Lightning will generally go for the easiest route to ground, often striking (but not always) the highest thing around. That's usually your tower. We go with the theory that, if lightning hits, expedite its way to ground, and be done with it. Do everything you can to get it on its way without taking anything with it. We've made the tower as much a part of the ground as possible, through copper straps, underground grids, grounding rods, and plenty of bonding. It must work; before going to all that trouble, we took some pretty serious hits. I must assume that we still get struck, but now the lightning goes harmlessly off where it's meant to go.

(continued on page 9)

Survival . . . (continued)

CB Is Useful

More safety features: I keep a battery-powered CB unit at the transmitter, in case there's an emergency and power is out. As opposed to Ham or other fixed bands, there's usually somebody monitoring CB Channel-9, including our local sheriff. At least one engineer who runs up and down the mountain, carries a telephone lineman's handset all the time. Every quarter mile along the buried cable is a box you can break into and tap the right pair on the terminal block. Illegal perhaps - - but worth it if your life is in danger.

Every autumn, around here, comes hunting season. Our site is on State Division of Wildlife property, so at least a blaze-orange vest is wise. Hunters, I've found out, will shoot at virtually anything that moves.

I have a couple of steadfast rules: I never go into the rear of the transmitter or fool around with the high voltage without (1) another person in the building and (2) checking, double-checking and triple-checking to see that the power is off. Likewise, I never go further than five feet up the tower without someone on the ground. An extra person hanging around (usually a high school or college kid who's thrilled to work at minimum wage just to learn something about the mystical world of broadcasting) often comes in handy to fetch tools or yank cable - - but it's also inexpensive insurance. If I pull something totally stupid, I'd much rather have somebody around to call the paramedics than to have them find my charred body a while later.

A slicker, or raincoat, and good waterproof hat are also handy to keep around the transmitter building. I've spent more than a couple of long wet minutes un-sticking a jammed beacon flasher unit at the base of the tower. Here in the Rockies, the sky can go from crystal blue clear to total deluge within the hour. Once I was inside the building for about that length of time and couldn't hear the storm over the noise of the blowers. When I poked my head outside the door I was shocked to see acres of adobe goop - - the kind that the truck doesn't travel well in at all. At least with a slicker, it was a long but dry walk back to the pavement.

An Eye to the Sky

I keep a pair of binoculars at the transmitter. Besides letting me observe our population of eagles and elk, they're good to gaze up the tower to see if anything's loose or out of whack. Once I spotted some arcing in the power line up the mountain and saved the utility company some time and expense.

Since the Colorado weather here is so dry, I keep a good stock of grease and oils on hand. Moving parts, especially heat-prone motor bearings, get packed faithfully once a year.

Summertime brown dust and springtime pine pollen are difficult but not impossible to keep out. We use regular furnace filters on all air intakes to the building, and hospital filters on the back of the transmitter. They're cleaned or replaced regularly, depending upon the season and the level of contaminants. Keeping a positive pressure in the building is relatively inexpensive, but makes a remarkable difference in the degree of dirt. A simple barn fan hooked to a timer or a thermostat, and housed in a homemade box with a security grill and filter, does the job.

Our building floor is (unfortunately) concrete, which breeds it's own dust. We never sweep the building, we always vacuum. And several times a year the floor gets a thorough swabbing. A non-porous tile floor is in the budget for this year.

A Word to the Wise

A final couple of words to all young broadcast engineers: All the fancy formulas in your books and wisdom imparted from your instructors cannot take the place of common sense. When faced with that first massive breakdown, with palms and forehead sweating, and you've got to get the studio back on line or the big rig back on the air, remember this: **Don't overlook logic.** Or, as our consulting engineer says, "The electrons know where they're going, even if you don't."

Two final items that should be mandatory at any transmitter site, no matter where it is or what the size: (1) A Halon fire extinguisher and (2) A first-aid kit. The fire extinguisher is probably required by code and you'd be surprised at what will burn in an all metal layout. The first aid kit needn't be big or fancy but it should have the basics. So far, in five years at this site, I've bandaged a consultant's finger, put an emergency splint on a bird's broken wing, and patched up a hunter's split toe. Hopefully, I'll never have to use the kit on myself.

Collins 820D-2 AM TX

By Ralph Hartwell II - KGLA
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504-733-9281

In my opinion, the Collins 820D-2 transmitter is one of the best AM transmitters ever built. They are quiet and relatively trouble free, requiring only clean air filters and an occasional wiping with a clean cloth to keep the finish like new. They provide a great sounding signal with little trouble. KGLA has been using an 820D-2 since 1972. However, several minor problems have surfaced over the years which caused some new grey hairs to appear before the reasons for them were discovered.

Intermittent Modulation Level Changes

This one was a real head scratcher. The symptom was an abruptly changing modulation level with no apparent reason. At first, there was just a slow change in modulation level, which I corrected by adjusting the audio input level to the transmitter. At first, it was not too noticeable, and none of the listeners noticed the problem. The problem got worse with time, until after a few weeks, there was an occasional drop off in modulation to less than 10%. That got their attention - - and mine. Something had to be done!

The problem was finally traced to the modulation control relay, K1, which is located on the audio driver assembly A1A1 in the compartment below the modulator tubes. This relay is used to switch a resistive pad in or out of the audio line in order to change the input level to the modulator when the transmitter is switched between high and low power (more about this pad later . . .). Like many daytime stations, KGLA used only the high power position.

Since K1 does not operate unless you change power levels, the contacts gradually became contaminated over the years, causing poor contact and varying modulation levels. This condition was aggravated by the intrusion of fine dust forced into the relay by the cooling blower for the modulator and PA tubes. The relay appears sealed, but actually has only a slip-on plastic cover. Vibration from the cabinet cooling fan and the main power contactor caused the contaminate film between the contacts to break down occasionally, causing abrupt changes in the level of modulation.

A careful cleaning of the relay contacts restored the modulation level to normal. If you need to clean the relay, be careful; the relay contacts are small, quite fragile and break easily. Do not file the contacts, since they are gold plated and designed for low level signals. Removing the gold coating will result in rapid deterioration of the contacts and even worse problems later on.

Low Power Modulation Adjustment

The transmitter modulation level is adjusted by first setting the proper modulation level in the high power mode, then changing resistors in the resistive pad to reduce the audio drive when the low power mode is selected. This is a rather inconvenient method. The instruction manual gives resistor values for the pad for use at various transmitter power levels. These values assume that exact power levels are used and that the impedance of the audio source is exactly 600 ohms.

After changing the resistors a few times, I decided that adjusting the modulation on low power would be much easier if I were to install a pot in place of the resistors. Here's how to do it:

1) Turn off the main power circuit breakers to the transmitter.

2) Remove the front panel which covers the RF PA and modulator tubes.

3) Make sure that the high voltage interlock has killed the high voltage.

4) Remove the three audio pad resistors and install a 1000 ohm pot connected between the audio input post E-5 and the ground post E-10. I used a single turn Trimpot style unit with wire leads and a side adjust with a large screwdriver slot.

5) Connect the pot wiper to the modulator input E-9.

6) Restore the transmitter to normal operation and adjust the modulation while in high power operation.

7) Shut down the transmitter and turn off the main AC breakers. Remove the cover over the PA and modulator tubes.

CAUTION - THE FOLLOWING ADJUSTMENTS ARE MADE WITH THE HIGH VOLTAGE ON AND EXPOSED

8) With the main power circuit breakers shut off, block up the high voltage interlock in the modulator tube compartment. This allows the high voltage to be turned on with the front safety cover removed.

WARNING - WHEN THE TRANSMITTER IS TURNED ON, THERE WILL BE NO COOLING AIR SUPPLIED TO THE TUBES BECAUSE THE COVER IS REMOVED.

(continued on page 11)

Collins 820D-2 . . . (continued)

MAKE THE MODULATION ADJUSTMENT RAPIDLY AND THEN SHUT OFF THE TRANSMITTER, INCLUDING THE FILAMENTS, TO AVOID DAMAGE TO THE TUBES.

DO NOT OPERATE THE TRANSMITTER WITH THE COVER REMOVED FOR MORE THAN 30 SECONDS AFTER FILAMENT TURN ON TO AVOID DAMAGE TO THE TUBES.

9) Turn on the main AC breakers. Press FIL ON. The filaments and fan should come on. NOTE THAT THERE IS NO COOLING AIR TO THE TUBES. WORK QUICKLY BUT CAREFULLY!

10) Adjust the low power modulation pot you just installed for the proper modulation level.

11) Shut down the transmitter, turn off the AC breakers.

12) After the plate voltage meter has fallen to zero, carefully remove whatever you used to block the inter-lock switch.

13) Replace the front panel cover and make a final test of the transmitter.

While it might seem easier to drill a small hole to allow a screwdriver to poke in and adjust the pot, be careful that you do not short out anything in the audio driver assembly. I like to see what my screwdriver is doing, so I did it the way outlined above, even though it requires that you operate the transmitter with the front panel open.

Having the pot hidden from view also prevents unauthorized "adjusters" from twiddling with things. Of course, you can place the pot wherever it's convenient. Just remember that is is carrying audio, so route the leads carefully and twist them about three turns per inch to prevent noise and hum pickup.

Intermittent Change in RF Drive

The final grid drive was reading about half of the usual value. Re-tuning the driver would sometimes increase the drive but the next day or the next week, the drive would be low again.

After a couple of weeks of this routine, I tore the driver stage apart and discovered that the driver transistor Q3 had silicone heat-sink compound on the base and emitter pins. Since this stuff is a pretty effective insulator, it caused poor contact between the pins of the driver transistor and the socket, which resulted in low RF drive to the final PA tubes.

Careful cleaning of the socket and transistor pins restored the grid drive to normal. I was careful not to use too much heat-sink compound - - I didn't want the trouble to happen again.

I also had an intermittent loss of RF drive which I traced to a defective switch, S1, on the oscillator assembly A1A2. Cleaning the switch restored proper operation.

Transmitter Refuses to Stay on Air

There were also several occasions when the transmitter would not remain on the air. It would operate normally for several hours at a time, and then mysteriously drop off the air. All meter readings were normal. It turned out that a defective air vane switch would occasionally trip the interlock and shut the transmitter off. Installing a new switch fixed the problem. In order to find the problem, I had to run the transmitter with the rear cover off so I could watch the air vane.

One day the transmitter would not stay on the air when in the high power mode. When the **HP ON** button was pressed, the transmitter plate relay would go "klunk - klunk," on and off. I eventually located an intermittently defective remote control relay on the relay assembly board on the A3 panel. Before I discovered this, I was sure the **HP ON** switch was defective.

Filament Voltage Regulation

This is not really a "problem," but rather something you should do in order to improve the life of those tubes. At a cost of over $500 per tube, the longer the life, the better.

If you do not have a filament voltage regulation transformer installed in the transmitter, you should seriously consider installing one. According to the tube manufacturer, even a small increase in the filament voltage, above the rated value, causes a drastic reduction in the tube life - - this is detrimental to your wallet. When the tubes become weak, a small drop in the filament voltage will cause the output to decrease rapidly - - this is detrimental to your signal. A voltage regulator will increase tube life and improve your signal at he same time.

A 250 watt Sola constant voltage transformer is just the thing. It will fit on the floor of the transmitter beside the power transformer. In fact, that's what the space was designed for! These are sometimes available from various surplus outlets at reasonable prices.

(continued on page 12)

Collins 820D-2 . . . (continued)

There are two types of constant voltage transformers available: the type CVN (usually the cheaper version), and the CVS. Either on will work, but the CVS is the better choice since it has a lower harmonic content in the output waveform. If you buy a surplus transformer, be sure to get one that does not have PCBs in the capacitors used in the transformer.

If you have installed a type CVN transformer, you should use a true RMS voltmeter to make the final filament adjustment. If you have installed a type CVS, you can use any AC voltmeter.

Measure the filament voltage at the sockets of the modulator and final tubes. **Do not** measure the voltage at the terminals of the filament voltage transformers, as there is a voltage drop through the wires and RF filters in the bottom of the exciter cabinet due to the high current required by the tubes. Adjust A1R8 for the modulators, and A1R7 for the finals.

Be very careful when making the adjustments. the filament voltage rheostats are are in series with the primary of the transformers, and the the rheostats are mounted close to the screen voltage power supply. **SAFETY FIRST - DEATH IS PERMANENT.** The rheostats have no knobs on them, which makes them difficult to adjust. A trip to Radio Shack will get you a couple of plastic knobs about an inch or so in diameter. Install them and do it the safe way.

With the filament breaker on and the plate breaker off, press the **FIL ON** button and then adjust the voltage measured at the tube sockets to a value of 9.5 VAC ±0.1 volts.

NOTE: When measuring the filament voltage on the finals, be careful that the RF from the driver stage does not cause errors in the meter readings. This is likely to happen if the meter you are using has a rectifier in it. If that does happen, detune the driver tuning capacitor, or carefully pull the crystal out of the oscillator. If you do not have a second crystal installed, you may switch to the unused crystal position.

After making filament voltage adjustment, measure the voltages at the pins of **both** of the PA and modulator tubes again. The PA tubes should have filament voltages within ±0.15 volts of each other. The modulator tubes, likewise, should have filament voltages that are close to each other. A larger voltage difference may indicate a defective cathode in the tube with the higher filament voltage, but more than likely the trouble is a poor connection on one of the RF filters in the filament leads. These are screw connections, and easy to check.

Tube Life

Tube manufacturers say that the ultimate life of a properly operated tube, such as the 5-500A used in the 820D-2 transmitter, is basically limited by the number of hours of available filament life. It does not matter whether the plate supply is on or not.

Therefore, there is no reason to turn the filaments on for an extended period of time before sign-on, just to "warm up" the transmitter; nor is there any reason to leave them on after sign-off. Doing so just uses up valuable life of the tubes. The cooling in the 820D-2 is good enough so that about a minute after pressing the PLATE OFF button, the filaments may be shut down also.

Are The Tubes Still Good?

It's easy to change the tubes when they quit entirely, but how do you tell if they are getting a bit weak? After a few tries, I discovered a simple but effective way to check them.

The modulator seems to be harder on the tubes than the PA stage is; I have had to replace more tubes in the modulator than in the PA stage. It was while trying to determine if a modulator tube was bad that I figured out how to check them.

The tube to be tested must be placed in one of the modulator positions. There must be a tube in the other modulator socket to prevent the filament voltage from increasing due to the reduced load from a missing tube.

Be careful not to break the cooling chimneys for the tubes. The transmitter cannot run without them. If you don't have a spare chimney, order one. They usually get broken when cleaning the transmitter or changing the tubes.

1) Turn the modulator bias controls fully CCW This should reduce the modulator cathode current to a very low level.

NOTE: WHILE THE TEST CAN BE MADE AT EITHER THE 250, 500 OR 1000 WATT LEVEL, THE 500 WATT POSITION IS THE BEST. TESTS MADE AT THE 1000 WATT LEVEL WILL DAMAGE THE TUBES UNLESS COMPLETED RAPIDLY.

2) With the tube to be tested in position, and the transmitter on, observe the modulator cathode current.

3) Rapidly turn the modulator bias pot, for the tube to tested, fully CW. This reduces the bias to a minimum and the tube will draw a

(continued on page 13)

Collins 820D-2 . . . (continued)

lot of current and will overheat rapidly. QUICKLY read the modulator current meter and then turn the bias control fully CCW.

4) The tube should show at least 0.5 Amperes of current when the bias control is fully CW. If it does not show that much current, it will not be capable of full output. The tubes will begin to show increased distortion and the modulation will begin to lose clarity.

There's Got To Be An Easier Way To Adjust the Modulator

Well, there is. You can set the modulator bias adjustments in about 30 seconds. Start by turning both modulator bias pots fully CCW for minimum modulator current. Then adjust modulator bias #1 for a reading of 0.175 Amps (3.5 scale divisions). Now, adjust modulator bias #2 for a reading of 0.300 Amps (6 scale divisions).

If both tubes show the same orange-red color on the plates, you're done. If they don't, then one of the tubes is probably weaker than the other.

NOTE: It is normal for the tubes to show uneven heating on the plates, as they age.

Since the emission of the cathode does not decrease evenly with time, you should test all your tubes (including spares and used tubes) as outlined above and put the best two in the modulator stage. This transmitter will work with weaker tubes in the RF final than it will in the modulator.

In an attempt to extend the life of the modulator tubes, some engineers set the bias at a lower level than specified in the instruction manual. Tests with a distortion analyzer will quickly show that this results in increased distortion. It also results in increased listener fatigue. Use the values shown in the instruction manual and keep your listeners happy.

The modulator drive adjustment may be set up rapidly with the use of a function generator and an oscilloscope. Feed a 1 kHz triangle waveform into the transmitter at a level sufficient for 90% modulation. The oscilloscope should be connected to monitor the RF envelope of the transmitter.

Adjust the modulator drive controls for the straightest sides on the modulation envelope. One control will adjust the slope of the negative modulation, and the other control will adjust the slop of the positive modulation.

If there is visible distortion in the waveform after attempting this adjustment, then there is probably a defective modulator tube in the transmitter. However, before changing tubes, try adjusting the bias controls slightly and see if that improves the situation. The waveform should remain uniform for any level of modulation from 0% to 125%, if the tubes are OK.

Cleanliness

The transmitter is cooled by a cabinet fan which pulls outside air through a filter in the rear of the cabinet. The filter is out of sight, and therefore often forgotten until it is so dirty it becomes completely clogged. This can be fatal to the modulator and PA tubes, since the blower for the tubes draws its air from inside the cabinet.

When the filter becomes clogged, the blower sucks dust and dirt from under the transmitter and deposits in all over the inside. Some of the dirt will get stuck on the squirrel-cage in the blower and reduce the airflow to the tubes over a long period of time. Dust and dirt will also accumulate in the exciter and modulator driver cabinets.

If the filter is clogged, then hot air exhausted from the top of the transmitter will be drawn back down through the output tuning network and recirculated thorough the tube cooling blower. This overheats the tubes and reduces their life.

The filter should be changed at regular intervals. If you can see dust on the back (outlet) side of the filter, that means that the dust has penetrated all the way through the filter. The filter is "used up," and will allow dust to pass through it, and into the transmitter. Replace it with a good quality filter, and keep a box of spare filters available. If you have them on hand, it's much easier to remember to replace them often.

If you can talk the GM into it, buy one of the Newtron brand electrostatic air filters and install it on the transmitter. While you're at it, order one for the studio air conditioner too. It will remove all that cigarette smoke from the air.

The Newtron Brand filters are the same size as the regular throw-away filters, and are a simple drop-in replacement. These filters do not use any electricity to power them, but use the friction of the air passing through the filter to generate the static electricity required to energize the filter and trap dust particles. They work quite well and, although they are expensive, they are washable and will last for many years, if treated correctly.

If you cannot locate one of the Newtron filters locally, call the factory at (800) 543-9149, or you can write to them at Newtron Products Inc., 3874 Virginia Ave., Cincinnati, Ohio, 45227.

About once a year you should open up the transmitter and clean it out thoroughly. **MAKE SURE YOU KILL THE AC POWER AT THE FUSEBOX BEFORE GOING INTO THE TRANSMITTER CABINET.** Remove any deceased vermin and insect bodies. Vacuum out dust and lint which seems to collect in the corners. Clean the cabinet fan blades and check the squirrel-cage of the tube cooling blower for dirt. Clean it if necessary. Use a damp rag and wipe off the film of dust adhering to components inside the transmitter.

The inside of the output network enclosure does not get too dirty unless stuff has fallen into it from the top of the transmitter. Check inside and if everything looks OK leave it alone. If you clean inside, be sure not to disturb any connection on the coils. Replace all the rear panel screws when you replace the panel. This is necessary to ensure that the shielding is correct between the sections of the output network for harmonic suppression.

If necessary, remove the front control panel to remove the plate current meter and clean the face of the meter. It collects quite a bit of dust since the high voltage goes directly to this meter. This is usually needed about once a year or so, in most environments.

BTF-20E Troubles and Other Tidbits

By Alan Roycroft - Broadcast Services Inc. Honolulu, Hawaii

These transmitters came on the market when there was very little else available and they did carry the magic nameplate. However, they contain some extremely poor ideas for any year and can be compared with the AM styles of that time such as the BTA-10U, for example (a bird of a different tale).

First let's consider the least of the BTF-20E's problems. PA tuning is achieved by two sets of plates, tuning and loading. The fixed plates are light gauge pressed steel about 20 inches long, fastened to the inside of a flimsy cabinet. Minor and major troubles usually start after a transmitter has been moved without using the original crate, has been standing on an uneven floor surface, has had sloppy maintenance, or even if there is a "R" in the month.

The result is either binding by too much tuning finger-stock tension on the moving plate or burning of the finger-stock by insufficient tension. The finger-stock on the moving plates should ride easily over the length of the fixed plates with a firm and even tension. If you see either of the two conditions, slacken the screws securing the fixed plates to the cabinet and then slacken the screws holding the cabinet panels in place. Rock the cabinet gently so it assumes a shape that forms to he floor and re-tighten the cabinet panels firmly. Carefully examine the the fixed tuning plates with a straight edge. If worn places are evident, remove them and have the plates milled and re-plated, or buy new panels. Do not leave worn or twisted tuning panels in place.

Carefully re-mount the tuning panels, using shimming washers if necessary. Examine the slides carrying the moving plates, for similar out of line condition, and reassemble using new finger-stock if there is any sign of wear or burning.

Lubricate the crack drive mechanism and insure that there is no stiffness and that the finger-stock is precisely at the same tension over the full range. If there is too much tension, you will (apart from damaging the stock) experience stripping of the square acme thread on the fiber rods. The first RCA threaded rods were brown and involved camels is some way or other. Next came a black material that I definitely do know to be yak droppings from Outer Mongolia. Finally came a white material that I heard did involve polar bears near Hudson Bay. Whatever - - the result was always the same. There are now a number of high-temp lube sprays on the market that can be used on the fixed plates. All of this is child's play compared with what follows.

Let's turn to some basic principles of vacuum tubes. Triodes are constant voltage generators; tetrodes and pentodes are constant current generators. Using a steady grid drive, a steady output voltage will develop which is almost constant when the load, be it a speaker or antenna, is disconnected. In fact, you are provided automatically with a modulation transformer and modulation reactor tester IF TRIODE MODULATORS ARE USED. Simply disconnect the modulation reactor connection feeding the final RF tube (yes, we are discussing AM for a moment). Lower the modulation level control to zero and turn on the plate supply. There will be no PA plate current, a slightly higher grid current in the final and slightly higher modulator idle current. We are going to gradually raise the modulation control on the limiter while observing the modulator plate current. If you do have shorted turns on the mod transformer or reactor, the modulator plate current will swing wildly. Run the modulation control up to, but not beyond, its regular position and then turn the plate off. This full drive test should not take more than a couple of seconds. If you have good components, the modulator plate current will swing around the idle current value, dipping up and down by about 10%.

New tetrodes and pentodes with a steady grid drive will endeavor to maintain a constant signal current in the output, irrespective of the value of the load. In the 20E final, which is properly tuned and loaded, there will be a signal current of about 2.5 Amps, in an impedance of about 3,000 ohms. You can now use ohms law table to guess the approximate voltage which changes drastically with plate tuning. A little high, but RCA took care of this with careful component layout, along with an anti-corona shield covering the bottom of the cavity, using the best acrylic that Woolworth can sell.

(continued on page 15)

RCA BTF-20E . . . (continued)

Now please imagine that a set of finger-stock riding on the tuning or loading plate does not make full contact. We have recently "retuned" the final, placing the fingers on a corroded part of the fixed plate. Those fingers that do make contact cannot carry all the tank current and simply heat up or melt away. Or, a bullet between antenna bays has been burning for some weeks and you could always correct the slightly changed plate conditions by gimmying the loading control - - or, when the rigger replaced the Heliax connector last week, he did not fully engage the male bullet in to the bottom of the transformer - - or, there had always been a poor VSWR condition in he antenna since you first arrived. Any one of these could cause major trouble, evidenced by a loud CRACK . . . and flames licking around the PA cavity door followed by chocking black smoke.

All you can do is stand outside and wait for the flames to die away (about 8 minutes) and for the cabinet to cool off (about 20 minutes), so that you can view what's left. No amount of switching off, buckets of water, or fancy extinguishers, will help. The acrylic panel will take over. There is only one thing more spectacular than a 20E fire, and that is a 40E fire with both cabinets going at the same time.

Loss of antenna load has allowed the plate impedance to rise at least four-fold and with all that I^2R jazz, you had a plate signal voltage that hit the well thought out anti-corona panel where it lived.

You've been to a 20E roast, so what now? My personal recommendations are, first, offer what parts you have left to someone down the band and look in the "transmitter for sale" for a good grounded-grid triode unit. If management insists on a re-build, buy parts - - thousands of dollars worth, and go to a glass shop and fabricate a replacement cover than will anti-corona a later arc-over.

This brings us to the condition of the coax and the antenna. I would spread it all over the yard and check each little item. To make matters more vulnerable, RCA did their best jobs on the SWR meter and safety switch (a combination of the regular SWR meter and the "shadow tuning" device that was featured on some radio of the thirties). When an SWR problem comes up, a vane moves over the face of an exciter lamp, allowing a photo-cell to see the lamp, opening or closing contacts, shutting off the plate supply. Unfortunately, RCA got the horse in the wrong cart. When the inaccessible exciter bulb burns out, all conditions of "normal" appear. I doubt that more than 50% of these SWR units are working, on all the 20Es in use. I also know of one that was bypassed because it would shut down the rig for no good reason.

The model number may be incorrect - - it should be BTF-18E. Anyone that has managed to get 19.9 kw out of these beasts, needs a new wattmeter or sampling condition.

STL Dish RF Radiation

By Keith Ericson - KOSI-FM
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In these days of non-ionizing RF radiation hazard sensitivities by all concerned, I thought it might be prudent to investigate just how dangerous the field in and around our STL dishes might be. There is some reason to be concerned.

While it is quite safe to remain behind the STL dish, being out in front of the dish is quite a different story. For many of you that may not be a reality if it is tower mounted, but if you have the dish mounted on a roof and can walk in front of it - - beware!

The density of the field in front of the dish is dependent on the amount of power fed to the dish. 10 Watts can generate a hazardous power density depending upon the size of the dish. There is an area in front of the dish in the near field of the antenna where the maximum power density occurs. This is approximately halfway from the dish surface to the point where the far field is fully formed. It is obviously a broad area, not just a definite point.

The far field is also known as the Fraunhofer zone and is the area where field intensity starts to drop at the normal inverse square law vs distance rate. Let's look at the fields we can expect in front of those dishes.

10 Watts @ 950 mHz - Applied to Dish Feed

Dish Diameter	Distance to Max. Pwr. Density	Max. Field in mW/cm^2
4 feet	3.5 feet	3.2
6 feet	7 feet	1.6
8 feet	14 feet	0.8
10 feet	21 feet	0.5

Keep in mind that numerous RF hazard studies have been done in the vicinity of 960 mHz, in the ISM band. The fields at the sides of the dish are approximately 10dB down from the point of maximum density while those behind are down 20dB. Anytime there are fields above $1 mw/cm^2$, there is cause for concern.

(Material derived from Sept. 1985, Communications News, pages 29-33, by Charles McMurrow of Booz, Allen & Hamilton)

Radio Guide

July, 1989 Volume 2 - Issue 7
Mail to: Radio Guide 511 18th Street SE
Rochester, MN 55904

Fill out the information below, and then circle the number of any manufacturer from which you would like additional information.

1 - Television Technology
2 - Henry Engineering
3 - Bradley Broadcast
4 - Inovonics
5 - Ramko Research
6 - Dataworld
7 - Hallikainen & Friends
8 - Econco
9 - Kahn Communications
10 - 3M - ITC
11 - Broadcast Audio
12 - CRL Systems
13 - RAM Broadcast Systems
14 - Broadcast Devices
15 - J-Squared
16 - Northeast Broadcast Lab
17 - Barrette Associates
18 - Tom Jones Recording
20 - Sine Systems
21 - Hnat Hindes
22 - Delta Electronics
23 - Modulation Sciences
24 - Stanley Broadcast Engineering
25 - Communication Data Inc.
26 - Northern Magnetics
27 - Ron Radio
28 - Owl Engineering
29 - Commercial Radio Co.
30 - Doug Vernier Broadcast
31 - Freeland Products
32 - Brentlinger Broadcast

Name _____

Company _____

Address _____

City _____

State _____ Zip _____ Phone _____