BE Radio™

January/February 1996/$5.00

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...from the Editors of BROADCAST engineering

THIS MONTH:

- Transmission

ALSO:

- Audio control systems
- Tower leasing

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This month...

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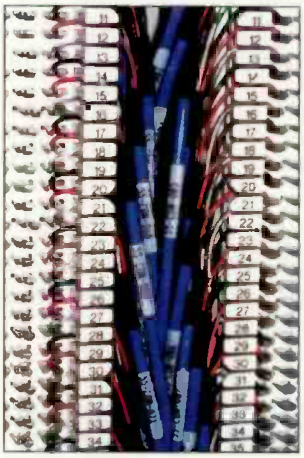
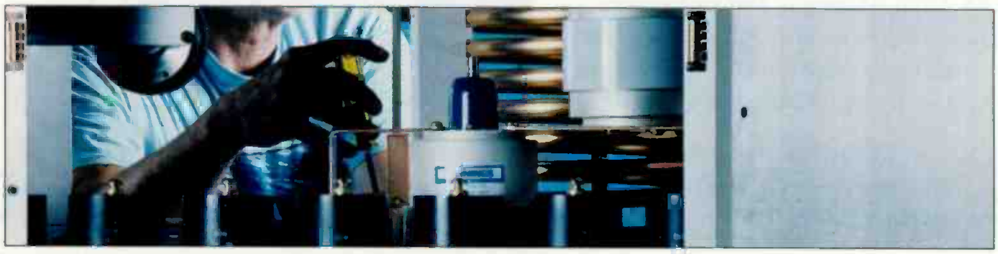
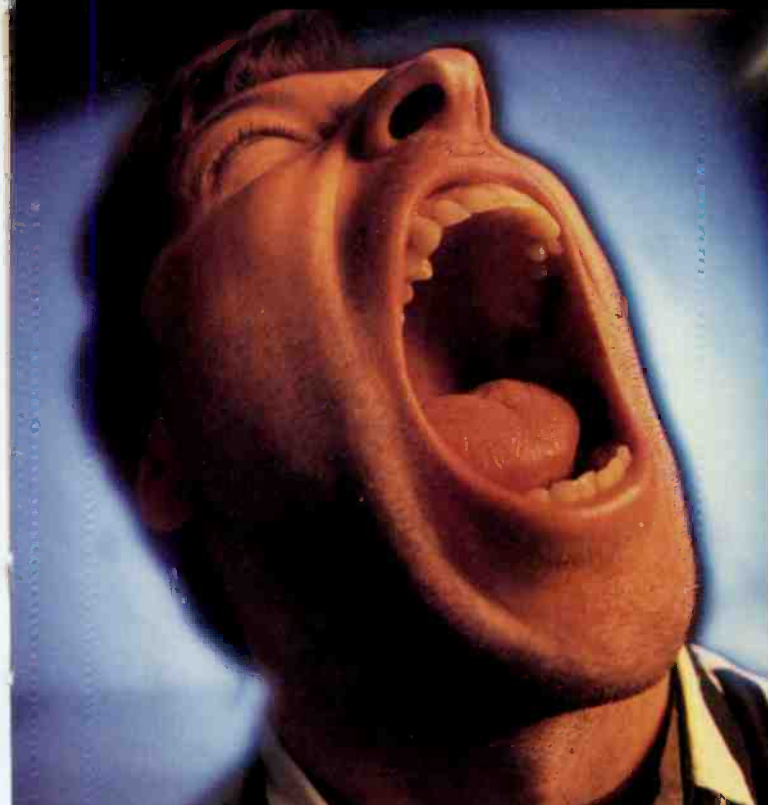


38 *Audio control systems*

ON THE COVER : *(Right)* Experienced RF designers and engineers continue to find ways of improving today's AM and FM transmission systems. (Photo courtesy of Harris Corporation.)



Two Proven Methods To Attract More Listeners.



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[OPTIMOD 9100: About $5,000]

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True, extending your reach while saving on power isn't nearly as much fun as hiring a big, loud star*. But which sounds better to *you*: a bigger mouth, or a bigger bank account?

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Circle (5) on Action Card

Editorial:

All aboard!

How cozy it must have felt to be a baron of the passenger-train industry during its glory days. The postwar boom and the growing mobility of Americans made it seem like the good times were here to stay. The passenger train was on top of the world, and it just kept getting better every year.

When do you think these industry leaders began to realize that their silver streak was about to be derailed? There were probably some who saw it coming and acted accordingly, while others thought the competition would never really amount to anything. Still others ignored the growing threat and hoped it would go away, while some may not have noticed it at all until it was too late.

We can look to our own industry for a similar story of dispatching a well-entrenched tradition – the decline of AM radio. Although it didn't happen overnight, and AM's captains did their utmost to hold off Armstrong's minions, ultimately the upstart FM competition claimed the day.

Such hindsight is always 20/20, but how well can we see the next wave of potential giant killers approaching? Certainly they're out there, but which ones – if any of the current crop qualify – will have what it takes to take over? Let's scan the horizon.

There's *cable radio*, which is reportedly about to launch a second offensive with new rates, services and hardware that solve some of its current downsides. There's *fixed DBS* (or *direct-to-home*) service, which puts cable radio where no cable has gone before. There are telcos, which may soon offer similar services – or different ones that involve on-demand capabilities. Then there's the "deathstar" – mobile DBS radio and its dozens of national DAB channels on mobile, portable or fixed receivers. It's already gotten a flashing yellow light to proceed and could get a full green soon. Finally, don't underestimate *on-line radio;* its current low-fidelity and limited access could be solved by improving software and increasing bandwidth. Coupled with future wireless Internet access via cheap, portable PCS-based terminals, it could become the killer application that turns the industry upside down, combining on-demand functionality with the flexibility of today's radio.

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By the way, for those who think the real pot of gold lies with data broadcasting, a word of caution: Although it does hold promise, remember that broadcast radio is the new kid on the data-transmission block, and there's even more well-established competition in that market than there is on the audio side (i.e., wired telco, cellular, PCS, DBS/LEOsats, microwave/paging and specialized mobile radio). Plus, most of these competitors offer intrinsic bidirectional and addressable capabilities – desirable features to most data customers that broadcasters cannot easily provide.

This impressive list of emerging competition could make life interesting for broadcasters. Another look back at the passenger train industry may be helpful, however. Its most successful survivors didn't consider themselves in the passenger-train business, but rather in the *transportation* business. Broadcasters should learn from this model, and position themselves as purveyors of *communication* rather than simply as being in the radio business. Radio may be what you do, but it does not define what your businesses are.

Skip Pizzi

P.S. *BE Radio* is committed to keeping you posted with the latest information about radio's emerging competitors. You may also notice a few changes and additions to the magazine starting with this issue. Expect even more enhancements in our next issue, including the best pre-NAB radio coverage in the business. Thanks for all of your comments about *BE Radio.* They've helped us make the magazine better, so keep them coming!

By Skip Pizzi, radio editor

Contract Engineering:

The engineering professional

By William Fawcett

You probably have read or heard numerous references to "professionalism" that emphasize the importance of personal appearance, business structures, communication skills or membership in professional organizations. Although all of these are important, they may have little to do with true professionalism.

The dictionary defines *professionalism* as "professional character, spirit or methods." This implies that professionalism actually runs much deeper than organizational skills or depth of knowledge. It concerns *character.*

Confidentiality

The broadcast engineer will often be privy to critical business information well before most other staff at a station. For example, format changes may require new studios, or changes in ownership may require facility appraisals. The contract engineer who serves multiple stations in a single market is in an even more precarious situation. Your professional reputation (i.e., "success") depends on how you handle the confidentiality issue.

When a client goes on a fishing expedition to squeeze you for such information about a competitor, a good first response is to say "Oh, I don't know" or "Hard to say," with a blank look on your face. Your body language will usually throw the client off, and hopefully, the topic will turn elsewhere. Outright lying doesn't work well for many folks, and a stern rebuke might make things uncomfortable. If the client knows better than to believe your "I don't know," and therefore persists, then a matter-of-fact, "Well, I don't tell WXYZ about your business, so you can't expect me to talk about theirs," will usually diffuse the situation without offending.

On the other hand, if the topic is a matter of public record, such as an FCC filing that has been formally processed by the commission or if it is available for public inspection, it may be acceptable to divulge information to the extent that it is indeed public. To make sure your client knows you understand what confidentiality is, preface your reply like this: "Yes, this is a matter of public record: WXYZ has filed an application for voluntary assignment of license." Having a subcontractor copy and supply that application from the FCC files for your client is another "fire wall" technique.

Generally, you shouldn't have to supply your complete client list to any new client for their review — it's probably none of their business. However, in a situation where you could be working for two fierce competitors, being up front with both of them could save a lot of trouble down the road. You might even want to avoid such problems entirely by looking elsewhere for business when you already have one of these competing stations as a client.

The worst-case scenario occurs when you are privy to confidential information from one client that might drastically impact another one of your client's plans. Ethically, you must mentally divide the two clients' projects. Nobody said this was going to be easy.

Purchasing

If you are a broadcast engineer with extensive purchasing duties, consider taking a purchasing seminar oriented toward *Certified Purchasing Manager* (CPM) certification. Not only will it make you a better buyer, but it will also open your eyes to the ethical issues at stake. Volumes have been written on purchasing ethics. The following are just a few highlights:

1. Don't buy from "friends" because they are friendly. Buy for price and service. Many contract engineers may count broadcast vendors as "friends" and speak to them frequently. But to deviate from effective purchasing techniques for the sake of such "friendship" not only affects the client's bottom line, it is also a setup for corruption and embezzlement.

2. When you solicit bids, make the vendors understand that they should give it their best shot the first time. It is counterproductive to allow them to play the game of undercutting your best bid by three dollars (and "throw in the freight"). But worse yet, you betray the trust of the other vendors who made a good-faith effort.

3. Everyone loves a good horse trade, and the used broadcast equipment market lends itself to that pursuit. The contract engineer will often become an agent in the middle of a haggling session between two clients over used equipment or perhaps a tower lease. Strive to ensure that both parties get a good deal, and then make sure they both understand that they both got a good deal.

Speak well of others (or not at all)

This may seem out of place, but I believe it is extremely important. You've probably seen this principle at work among doctors or lawyers: In most cases, no matter what your doctor/attorney thinks of another doctor's/attorney's performance, your doctor/attorney won't badmouth the other.

For example, it's often tough to swallow when your competition runs a jack-leg outfit billing at half your rate, and you spend half your time cleaning up his messes. And then, a prospective client asks you what you think of Johnny Electron, Contract Engineer. Best response: "Yeah, I know him, and he seems like a nice fellow, but let me tell you what *I* have to offer."

As a consultant, you may be called in to evaluate the installation, upkeep and maintenance of a broadcast facility. In such a case, you may have to "tell it like it is," but remember that a shoddy facility is often more of a reflection of the station's budget than the

William Fawcett is president of Mountain Valley Broadcast Service, a contract engineering firm in Harrisonburg, VA.

Contract Engineering: The engineering professional

engineer's competence. Confine your assessment to the current conditions, and avoid speculating about who's to blame for them or why.

Your resolve to speak well of others will be sorely tested when you lose a client to Johnny Electron and you see the facility going downhill. You have every right to be upset, but at that point you have nothing to gain by speaking out.

No compromise

Do you do your client a favor by letting him or her take a few shortcuts? Why buy a distribution amp when you can twist a few wires together? (I think the record for stacked spade lugs on a barrier strip is 12.) Used equipment (i.e., "someone else's problem") or really cheap new equipment may seem like a bargain, but is it always?

As a professional, you know what the long-term results of such decisions are, and you must forcefully convey those to your client. Be realistic and avoid being a prima donna, but don't let stupidity reign. For example, one engineer's client wanted him to install a transmitter in a garden shed. While the engineer wasn't crazy about having to squat on a dirt floor full of mouse droppings, in a shack that was either ice cold or oven hot, his real concern was for the rapid deterioration of the equipment in such an environment. As Kenny Rogers says, "You got to know when to walk away..."

Accountability

You probably have the keys to your clients' facilities. You certainly have access to remote sites. And undoubtedly, no one else at any of your stations knows what all that stuff is. It's easy to "borrow" a part or a spool of wire, but make sure that there is a formal accounting for all such transactions.

More important, your hours are such that perhaps no one really knows when you come and go. Make sure your billing accurately reflects the time you spend on the job. Detailed invoices are helpful. Some engineers will knock a half-hour off of their bills here and there for time spent chatting with the receptionist.

> Character counts in other professions besides politics.

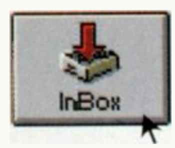
Perhaps a better solution is to avoid the chat in the first place. It makes a better impression with the GM who has no way of knowing if you are billing for that "consultation." Remember, you're a professional, and you've got work to do.

Get a life

One of broadcasting's great mentors was the late entrepreneur/engineer/attorney John Mullaney. He was best known as the "Father of the Folded Unipole," but what really stood out in his life was his devotion to coaching boys basketball. You will be a better person and a better professional if your life includes more than broadcast engineering. Furthermore, you have a better chance of being treated by your clients like a real person if you act like a real person. Maintaining a balance between work, family and community will permit you to better serve your client when you are on the job.

Short-term business gains can be made with investments in new technology or aggressive promotion. But in the long run, clients that will stick with you will do so because they trust you and they feel good about working with you. Character counts in other professions besides politics. As you begin a new year, these are some issues to consider and to emplace, if you aspire to be a true professional.

The Old Way.



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Circle (9) on Action Card

Managing multiple stations

By Chip Morgan

Here's a story from the not-too-distant future: You've just been selected to manage a new 7-station operation. All of the stations are already on the air, but you'll be in charge of moving them into a single existing facility that will house all of the studios and the offices. (If you think this sounds far-fetched, just wait. It will probably be the typical radio management job in the next few years.)

Moving in

Your first job is to move five of the stations into the space that used to handle two. The owners want to use this facility because it looks the best and has the most expansion room. Unfortunately, it has the worst wiring and the worst line-of-sight to the transmitter sites.

Nevertheless, you begin planning for the additional five studio-to-transmitter links (STLs) that will be needed and the two new air studios and two additional production rooms that need to be built. (If the math seems wrong, read on.)

The plan

One of the stations has been using digital storage for its spots, and the owners are convinced that digital is the future. So far so good. You've done that before.

But in this case, there will be four formats involved: country, oldies, Spanish and urban. The country format will run on the biggest FM. Oldies will run on the non-directional AM. Spanish will run on three AMs, two of which are directional stations located more than 50 miles away (in opposite directions). Urban will run on the other two FMs, one of which is a Class A that's 30 miles away. The stations were not particularly well-managed or well-programmed before. (That's why they sold at a good price.)

The idea is to set up a group of stations that may share some programming, but with a distinct spot inventory for each transmitter. For example, the two urban stations will simulcast all dayparts, except for spot breaks, during which different spots are sent to each transmitter. The three Spanish stations will each run separate local morning and afternoon drive shows. They will simulcast at all other times — again, except for spot breaks, which will be unique to each station. The oldies and the country stations will be full-time satellite-programmed, and therefore, won't require control rooms. Their programming computers can share a small corner of the rack room. All of the spots for all seven stations will be stored and played back from a common spot server.

Putting it all together

Working with an outside consultant, manufacturers' reps and your engineer, you design a system, then order all of the equipment. Meanwhile, you manage the remodeling of the studios and offices to accommodate the extra stations (including more sales workstations, offices for each of the four PDs, more traffic and billing space, and so on). There is just one GM (you), one sales manager and one engineer. The owners are confident that you all can handle seven stations as long as you have a good support staff. (This, of course, is your responsibility to hire — or to retain from the existing stations' staffs).

Note that although all seven stations have used contract engineers, you hire an engineer for your full-time staff. In fact, he used to be the contractor for four of your stations (along with a number of others in the area), so he knows the facilities pretty well. The amount of work that this consolidated operation will require has made it economically advantageous for the licensee to hire its own engineer again.

After a somewhat terrifying period of debugging, the computer-based programming system put together by your team works quite reliably.

On the air

You complete the installation in the studios, and all is well — at first. Some of the transmitters are fed by 950MHz STLs (including some multiple hops), while others use digital telco lines and still others require analog telco lines. Unfortunately, none of the transmitter sites has modem equipment and only one has a backup transmitter.

Your engineer starts complaining that he's up 24 hours a day putting out transmitter fires. Most of the problems occur during storms, and none of the sites has an emergency power generator. The engineer reminds you that he originally had recommended generators and UPSs at all of the sites, but you cut them out of the budget. Some things you have to learn the hard way.

This gets you thinking about disaster plans. You always had one in mind, but now you can't do it all. You and the engineer begin working out a realistic plan. The PDs are given transmitter building keys and shown the basics. (Did the tower fall? Is the building still there? Is the power on? Call these numbers when you get there, etc.) You make arrangements with a local generator rental company to give you priority service. You even have electricians install manual transfer panels at the transmitters so you can "plug-and-play."

All of the local contract engineers and previous station chiefs (at least the ones you still are on speaking terms with) have been briefed and have keys and phone numbers. Now you can catch up on your sleep — but not until you've penciled in emergency power systems at the three most troublesome transmitter sites on next year's budget projections.

Just when you're starting to get comfortable with the job, the unthinkable happens. The *studio* building has a 4-hour power failure. All seven stations go off the air simultaneously — during morning drive, no less. The sales department is livid. The owners are outraged. Everybody wants to know why there isn't a generator. After you remind them that the item was cut by a group decision at the

Chip Morgan owns Chip Morgan Broadcast Enterprises (CMBE), a broadcast design, systems management and engineering firm based in Sacramento, CA.

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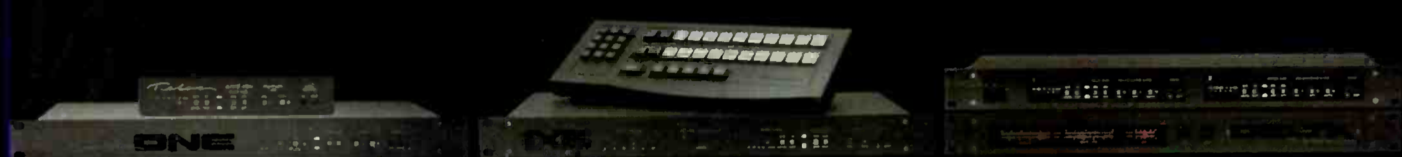

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last budget meeting, you're authorized to get a generator installed at the studios *immediately.*

New kinds of fires

With a growing cash flow and reduced expenses, the "station" starts hiring talent. The first new morning jock hates the way the mics sound. You explain that you've installed a great mic and quality processing, and that your engineer has one of the best ears in the business. (Unfortunately, he's deaf in the other one.) Seriously, the jocks sound great on the air, but this jock's show is on the distant Class A FM. The air monitor can't get the station well enough to sound good in the headphones at the studio.

Because you've moved seven studios under one roof, the studios are outside of the principal community contour (5mV/m daytime for AM and 3.16dBu contour for FM) for some of the stations. You left enough equipment at the old studios to stay legal under the main studio rules. Now the owners want to dispose of the old properties. You need to find a place that will work under the main studio rules and that can also serve as sales offices for the area(s). Then you'll have to install a studio there using the old equipment.

When all of the new stations moved in, the engineer wisely admitted that he couldn't handle the office phones anymore. Actually, he could have, but he would have needed more help. So you bring in an outside vendor to handle the new lines and phones. Now they'll also handle the phones for the new sales office/studio.

Just then, another storm breaks and knocks five of the stations off of the air. Your on-call generator people really only had four generators (they told you they had 10). All of your disaster plans work, but huge amounts of revenue go down the drain because it takes several hours to get all of the generators hooked up and running. The storm lasts two days. When it's over, the sales manager, engineer and all of the PDs are so worked up that you threaten to quit if the owners don't authorize generators at all transmitter sites *now.* They tell you to call for bids.

The second year

A year has passed and the owners ask you to put together a capital budget. Now that emergency power has been handled, the first item on your list is transmitter site remote control. It takes the engineer two days just to drive to all of the transmitter sites, and you want to minimize the travel time. Most of the sites only use four channels on their existing remote-control systems. You and the engineer are thinking about how to use the others to eliminate some trips to the sites.

Meanwhile, the production staff can't keep up with the demand for spot production because the sales are growing. New digital delivery systems have been installed, and image liners and promos are now being done in-house. You get approval for two new production rooms. They need to be on-line in 30 days. No problem. Nowadays, that's plenty of time.

Most of the initial staff training for the new equipment is being handled by the system manufacturers or consultants, with subsequently hired staff being brought up to speed by veteran operators and/or the engineer. This works pretty well because the systems' intuitive design doesn't require much formal training. Even though you pushed hard for a simple system, it turns out that this element was far more important than you thought it would be – and you're reminded of this every time a new hire comes on board. Sometimes you just get lucky.

The owners call you to their office. They're thinking about doing this all over again in another market. Would you like to be in charge?

Circle (13) on Action Card

RF Engineering:

Power tubes

By John Battison, P.E.

Despite the rapid increase in the number of fully solid-state AM and FM transmitters on the market, many tubes are still in use.

These tubes are still regarded with love and affection by many of their engineers. It's true that solid-state transmitters use less primary power and are, therefore, more efficient. They also run cooler and can allow "graceful degradation" to occur. The latter refers to the solid-state transmitter's ability to stay on the air (in most cases) if one of the final drive units fails. Operation can continue at reduced power, and the faulty unit can be removed and replaced with the transmitter remaining on-air throughout the process.

Despite its many apparent advantages, however, solid-state operation does have some drawbacks. For instance, tubes are generally more forgiving. If you accidentally draw too much plate current or allow the grid current to rise, it is usually possible to save the tube if you react quickly. Solid-state devices seem to be far less resilient when treated badly or overloaded. An accidental bridge will often ruin a semiconductor, while a tube might shake it off with just a bright flash of B+.

Psychologically speaking, there is also something relaxing and comforting to technicians in the red glow of heaters and plates. On cold nights, it is pleasant to enter a cozy tube transmitter area and be greeted with a blast of warm air. On the other hand, when entering a solid-state transmitter area, you're often greeted with a blast of cold air conditioning, which is required to keep the little beasts adequately cool. (Of course, in the summer, the opposite effects may occur.)

A number of AM transmitters are still in use with tubes, such as types 4-500 or 4-250 in their finals and modulators. These "old" tubes are still being made in the United States, and they continue to do a good job. However, there have been a number of bad reports regarding the life span of the Chinese versions of these tubes.

Heat

All tube operation is based on heat. This heat is a good friend and a bad master. It is extremely important to follow the manufacturer's instructions concerning warm up and cooling. This means don't bypass the start-up delay in your transmitter in the interest of getting on the air quickly. That little thermal time delay in the interlock circuit is there to give the filaments time to warm up, to finish expanding and to shake a few electrons up to the surface of the cathode before it is hit with hundreds of volts.

If you hit filaments "ON" and high voltage "ON" at the same time, something generally has to give — and it's often the tube.

These old thermal delays are getting expensive and/or hard to find. When one fails, it's often difficult to come up with a substitute or suitable replacement. There are certainly ways of getting around this delay, which looks like a tube, but isn't. The most risky method is "manual" delay, which relies on a sign posted by the transmitter door or remote-control panel. Many operators will not read it (or will choose to ignore it). There are many simple ways to obtain a more reliable source of time delay. If necessary, jury-rigging a kitchen timer is preferable to trusting in the operator's patience and obedience to your instructions.

There is a second advantage offered by waiting for operating temperature before applying B+ to a cold tube. When capacitors are hit by B+, their initial charge time is somewhat like a short circuit across the B+ line. Breakers have been known to trip due to charging current. A power tube that is warm with excited electrons beginning to mill around inside of it should provide a "soft" load that eases the strain on weak high-voltage components.

> Despite its many apparent advantages, solid-state operation does have some drawbacks.

Be sure that all of the tube blowers are operating properly. Some older transmitters have blowers secured to the end of the power chassis, which are designed to blow cool air over the tube seal and the joint between the glass tube and its metal base and legs. It's a sad sight to see a pretty glass tube with a sagging envelope that has melted because the cooling system failed.

Operating tips

When placing a new tube into service, its filament voltage should be adjusted carefully during the "burn-in" period. This is a time in the tube's life when the thermo-chemical structure of its filament stabilizes.

The tube is run at its nominal (rated) value for about 200 hours. During this time, a thermo-chemical reaction occurs within the filament. Metallic thorium makes its way to the surface of the filament just below the carbide layer. This is where the electron flow starts in a mono-molecular layer.

The filament voltage (temperature) is then reduced slowly while observing the tube's output. A point will be reached at which the tube's output begins to drop. The voltage should be raised slightly until the original output is regained. This voltage — the lowest at which the tube will produce its rated output — should be maintained during the tube's life.

Continued on page 41

John Battison, *BE Radio's* consultant on antennas and radiation, owns John H. Battison and Associates, a consulting engineering company in Loudonville, near Columbus, OH.

Photo courtesy of Jampro Antennas Inc.

F L E X I B I L I T Y

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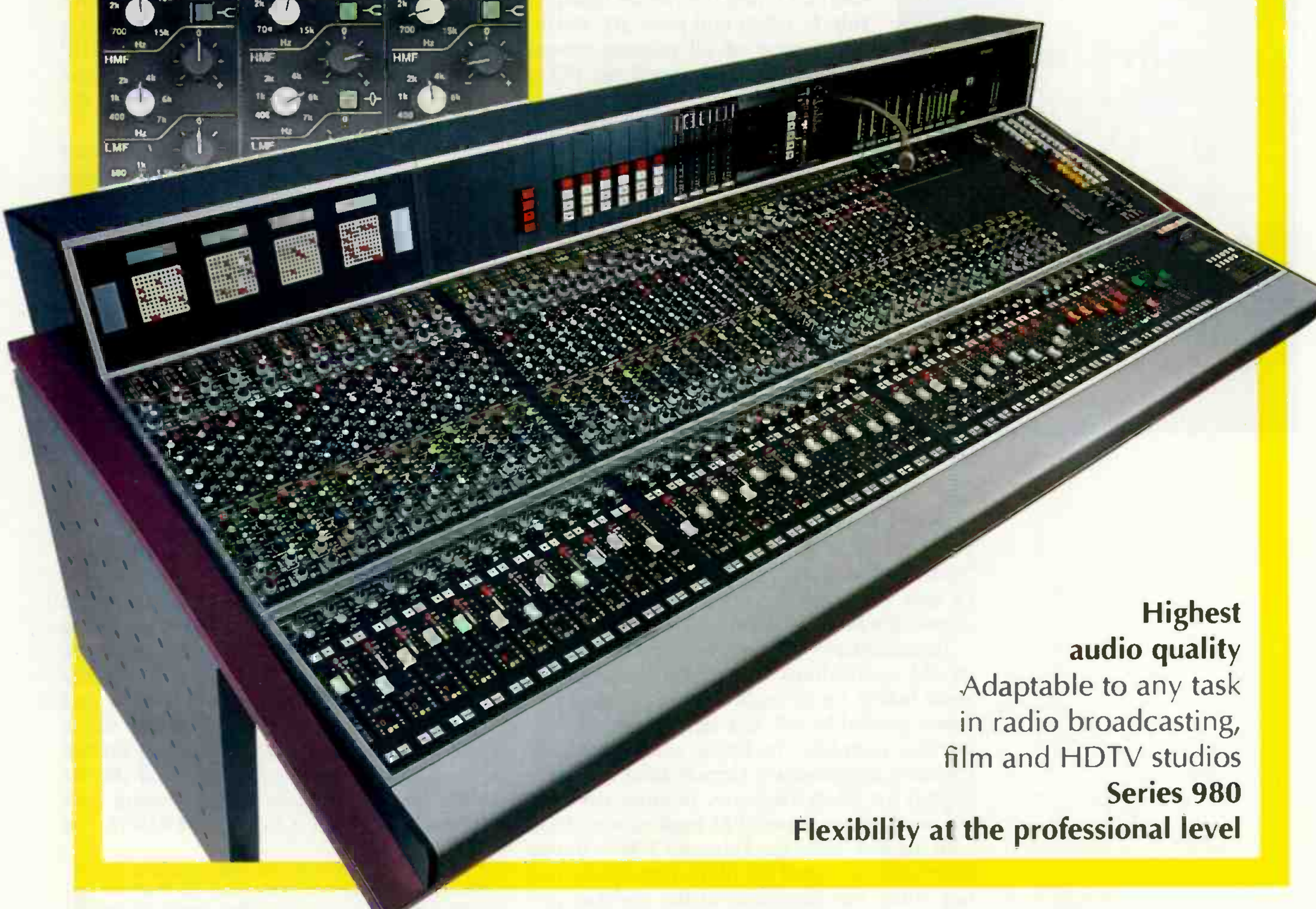

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FCC Update:

Owners must register towers

By Harry C. Martin and Andrew S. Kersting

The FCC has adopted a streamlined procedure that will require tower owners to register antennas that need FAA clearance and special painting and lighting because of aviation safety concerns. In addition, the painting and lighting requirements in Part 17 have been revised to conform to the specifications in two FAA Advisory Circulars on tower marking and lighting.

Under this scheme, each antenna will be registered by its owner rather than by each individual licensee that uses the tower. The owner will be the single point of contact for resolving antenna-related problems. The burdens previously associated with the antenna clearance process will now be reduced for the FCC and the licensees.

The new antenna clearance procedures will begin July 1. At this time, the commission will require the owners of proposed antennas requiring FAA notification or of existing structures with alterations requiring FAA notification to register them prior to the proposed construction or alteration. The FCC will also establish a phased 2-year window for registration of existing towers (i.e., all towers constructed prior to July 1, 1996) that require FAA notification. During the period between July 1, 1996 and June 30, 1998, the owners of all existing towers must register them with the FCC.

Auctions or no auctions?

The budget reconciliation bill, not the highly publicized telecommunications bill, will control the future disposition of facilities for which mutually exclusive applications are pending.

The bill includes language that provides for the auction of any facilities for which mutually exclusive applications are filed after the effective date of the bill. With respect to mutually exclusive applications pending, such proceedings also will be determined by an auction unless the application has been "accepted" prior to the bill's effective date. Little guidance is available on the definition of "accepted" as used in the bill. "Accepted" may or may not have the same meaning as "accepted for filing," a term of art by the FCC.

Broadcasters with mutually exclusive AM or FM applications that have been pending since before the February 1994 comparative freeze probably will not be affected by the auction mandate. In those cases, mutually exclusive applications already have been accepted for filing. However, because none of the mutually exclusive FM applications filed with the FCC after the February 1994 freeze have been accepted for filing, they would not fall within the exception to the auction language. (Unlike FM applications that are filed only during a designated "window," AM applications are filed in response to "cut-off" lists that include previously accepted applications. Thus, an AM application filed after the freeze may have been accepted for filing.)

A broadcaster who has a mutually exclusive application for a new facility that was filed after the comparative freeze and has not been accepted for filing, may have to bid at auction for a facility authorization or will find that the time and money already invested in the process are lost.

Government shutdown creates FCC slowdown

The government shutdowns have caused processing delays at the FCC. The effects are likely to last into February or beyond. New applications stacked up and no work could be done during the shutdown.

During the holiday season, most FCC employees took leave that they otherwise would have lost. For these reasons, it is unlikely that processing times will return to "normal" until late February or early March. Moreover, budget cuts could prevent even a return to "normal."

EEO sanctions levied

The FCC granted the renewal of a North Carolina station subject to reporting conditions. It also issued the licensee a notice of apparent liability (NAL) for $15,000 for EEO violations. The action was taken following the FCC's approval of a joint request for a settlement agreement between the NAACP and the licensee, and the subsequent dismissal of the NAACP's petition to deny the pending renewal application

The record indicated that, in an MSA that was 17.8% minority, the licensee had maintained an average of 15% minorities on its overall staff and 11% minorities in upper-level positions during the 5-year period preceding the filing of its renewal application. During the period between July 31, 1988, and July 31, 1991, the licensee had 29 full-time hires, including 19 for upper-level positions.

Although the licensee claimed to have contacted a variety of general and minority-specific recruitment sources for 29 of its full-time vacancies, it could not provide any recruitment data for 15 of its 29 full-time job openings. The licensee could not provide recruitment sources for 135 of its 216 applicants, and could substantiate the use of only five general recruitment sources for any of its remaining applicants. Moreover, the licensee could not provide data regarding any of the applicants' race or national origin.

On these facts, the FCC concluded that the licensee did not keep adequate records and failed to conduct a self-assessment of its EEO program until the end of its license term. Accordingly, the FCC granted the renewal application subject to reporting conditions, and issued a NAL of $15,000.

DATELINE: Commercial radio stations in the following states and territories must file their annual ownership reports or ownership certifications by April 1, 1996: Delaware, Indiana, Kentucky, Pennsylvania, Tennessee and Texas. Also, stations must place their first quarter listings of community issues and responsive programming in their public files on or before April 1, 1996.

Harry C. Martin and Andrew S. Kersting are attorneys with Fletcher, Heald & Hildreth, P.L.C., Rosslyn, VA.

EAS Update

Unattended operation

By Leonard Charles

The final hurdle in the quest toward unattended operation of radio stations is compliance with the Emergency Broadcast System (EBS) rules. There simply is no way to handle EBS without some degree of human intervention. The FCC will rectify this situation with the institution of the new Emergency Alert System (EAS), which has as one of its primary design elements the accommodation of unattended operations.

The digital protocol used by the EAS contains the intelligence needed for programmable equipment to react to emergency messages. These reactions will be based on prestored header codes, which when compared to the codes on incoming alert messages will cause a preprogrammed routing of the alert's information.

How the system can be automated

The EAS rules list a table of 3-letter event codes that appear in the digital header of an EAS message. Only four of these codes carry strict requirements: EAN, EAT, RMT and RWT. A code of Emergency Action Notification (EAN) means the system has been activated for a presidential message, which must be re-transmitted immediately. This retransmission must continue until the reception of an Emergency Action Termination (EAT) code.

Even if a broadcaster opts for non-participating status, the ability to react to an EAN code by broadcasting a sign-off message before leaving the air is required. That non-participating broadcaster must also decode and recognize the EAT to determine when it is permissible to return to the air. The Required Monthly Test (RMT) is to be re-transmitted within 15 minutes of reception. The remainder of the codes carry no mandate and are to be used as determined by the state plan, the local plan and the broadcast licensee's own choice. The Required Weekly Test (RWT) is the only EAS *origination* mandated at most stations. In addition, all stations must retain documentation pertaining to each EAS activation or reception.

How then, will an unattended station adhere to these rules? Before a manufacturer's EAS equipment can be FCC certified, it must demonstrate an ability to comply to the retransmission requirements, whether set to operate in manual or automatic mode. With this equipment properly installed and programmed in an unattended station, compliance is possible only in the automatic mode. The reception of the EAN or RMT results in immediate takeover of the station's audio chain and the retransmission of the received message. Upon the reception of the EAT or end-of-message code (NNNN), the unit returns the audio chain to normal.

To comply with origination of the RWT while unattended, EAS encoder manufacturers will most likely offer the ability to preprogram this capability. A manufacturer could also provide an external interface — perhaps terminals waiting for a contact closure from an automation system — to trigger the RWT. If unattended operation is in your future, you would be wise to ask about this capability in any EAS equipment you are contemplating.

To obtain the mandated documentation while unattended, most manufacturers will offer an optional internal printer or at least the ability to attach an external printer to their equipment. With either printer option, the unattended station will receive a printout that includes time of reception, type of emergency, originator of the message, the area and length of time covered by the emergency, and the source of the last relay. These details will be automatically translated from the digital header.

Another issue in unattended operation involves the reception of the same message from different monitored sources via the EAS's web architecture. EAS equipment must store the headers of each message that it transmits until the valid time period has expired. It will use this stored information to ensure that it will not re-transmit the same message a second time. All of this can be done without human presence or intervention.

State and local elements

While unattended participation in the national-level EAS is simple, participation in a state or local EAS is not. At these levels, there are no rules mandating retransmission of EAS messages. Therefore, a state or local system must be specific in the use of each code it chooses to include in its plan.

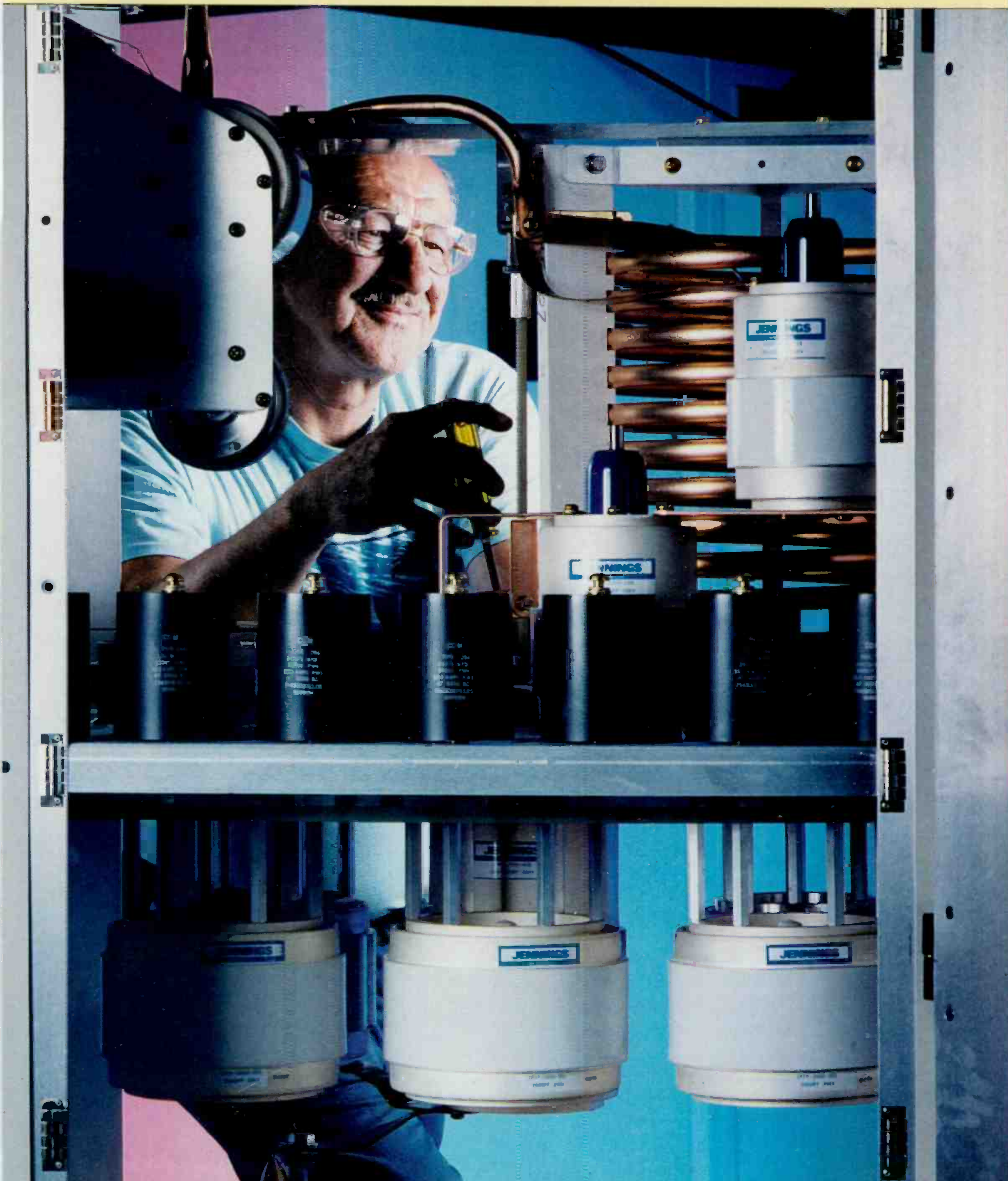
At the state and local level, the EAS can be useful for the dissemination of informational as well as emergency messages. Most stations will want the option of immediately broadcasting life-threatening-type messages, while choosing to deal with informational messages in some less-immediate fashion, perhaps by routing them to the news department. To exercise this option in an unattended mode, codes defined as life-threatening must never be used for anything else.

These codes would then be programmed to activate immediate and automatic retransmission. Without this level of code confidence, stations may choose to ignore all local EAS messages. On the other hand, with a high level of code confidence, even attended stations may choose to operate in automatic mode for life-threatening codes to shorten their reaction time. Informational messages could still be handled manually.

The FCC has decided to allow unattended operation before the final broadcast EAS implementation date of Jan. 1, 1997. Stations choosing unattended operation prior to that date must ensure that they are compliant with the current EBS rules. Exactly how to attain that compliance is up to the licensee. The FCC cautions that unattended EBS compliance does not preclude a station from EAS compliance by Jan. 1, 1997.

Leonard Charles is an SBE board member and an engineer at WISC in Madison, WI. He also chairs the SBE National EAS Committee.

The SBE has published a primer detailing the EAS and its operations. To obtain a copy, contact the SBE National Office at 317-253-1640.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New developments in transmission

By Kirk Harnack

Small improvements add up in the RF chain.

Throughout most of North America, the radio broadcasting transmission marketplace is now relatively mature. This has encouraged manufacturers to concentrate on incremental upgrades and replacement systems to stimulate continuing business. As a result, a significant number of options have emerged that enable broadcasters to extend the limits of their existing transmission systems' performance.

While the casual observer might assume that all recent research and development in broadcast transmission has been focused on future systems like DAB, this is not the case. Significant incremental improvements have been made recently in analog transmission equipment for AM and FM broadcasting.

These efforts include an increasing use of solid-state components, the emergence of digital systems and various improvements in transmission line and tower design.

Solid-state systems

For years, AM oscillators, FM exciters and AM low-level audio stages have used semiconductor circuitry. Now, completely tubeless AM transmitters are available from 20W to more than 1MW. FM transmitters are available on a practical basis up to about 10kW in solid-state versions.

Transistorized broadcast transmitters offer genuine improvements in their design and layout. Some of these changes have come about in just the past year or two, but they are fast becoming standard equipment with several transmitter manufacturers.

As with any new implementation of a technology, there are substantial benefits along with a few limitations. Some benefits of solid-state broadcast transmitters are as follows: Solid-state transmitters use much lower power-supply voltages than tube transmitters. A typical 50kW AM tube transmitter will have a 12kV to 30kV power supply, while one popular solid-state 50kW AM transmitter has a 72V power-amplifier (PA) power supply. The absence of high-supply voltages can reduce the amount of dust that is attracted to high-voltage points and surfaces. The need for long ceramic stand-off insulators is also reduced or eliminated. In addition, high-voltage problems, such as arcing, carbon tracking, AC power-spike amplification and the like, are greatly minimized or gone altogether.

Solid-state transmitter designs typically include increased redundancy, and therefore, increased reliability. Most tube-type transmitters are completely geared toward the supplying of the final tube(s) with power, signal and cooling. If any system fails, the entire transmitter shuts down. A typical solid-state AM or FM transmitter will use many amplifier modules, power supplies, cooling fans and redundant support electronics. Transmitter designers and manufacturers use this redundancy in their designs to allow a transmitter to remain on-the-air during failure of components or modules. Many designs even permit service work to be performed with the transmitter still on the air. Imagine changing air filters, cleaning cooling fans and even troubleshooting and replacing failed components, all without turning the transmitter off — and doing it safely, too.

Tubes have a definite and fairly predictable life span. Solid-state devices can almost last forever. Although there are unpredictable failures in solid-state components (as with tubes), the redundancy inherent in solid-state transmitter design usually provides ample backup for the system.


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New developments in transmission

Solid-state AM transmitters are usually much more efficient than their vacuum-tubed counterparts. Some stations even pay for their new solid-state transmitter purely with savings from reduced electrical power consumption.

Transistorized transmitters need fewer different supply voltages. A typical FM transmitter with a tetrode tube final amplifier will have four power supplies just for the tube (filament, bias, screen and B+). A solid-state amplifier typically needs only one supply (for the B+). Lower-level stages in a solid-state transmitter often use a small bipolar power supply.

The RF and audio performance in solid-state designs are frequently better and certainly more predictable than the RF and audio performance in tube transmitters. A certain amount of "slop," "fudge" or "play" is expected from tubes in AM and FM transmitters. Performance and efficiency can vary from year to year and even from day to day. On the other hand, a properly working solid-state transmitter is extremely stable and its performance is assured.

There have been some drawbacks to solid-state transmitters, however. Some solid-state RF amplifier designs were only marginally reliable, and early ones, especially FM amplifiers, were inefficient. Early transistorized AM transmitters suffered from poor reliability, especially during lightning storms or high VSWR conditions. A problem with solid-state FM transmitters has been their higher initial cost. In manufacturing terms, doubling the power of a tubeless FM transmitter means doubling the number of components.

Nevertheless, more recent advances in MOSFET amplifier transistors and in circuit design, layout and cooling have brought solid-state RF amplifiers into the mainstream. They are now much more reliable than tube systems, and they are becoming more and more efficient. Manufacturers also are working hard to bring the cost of RF amplifiers down to the point at which high-power, solid-state FM transmitters are more competitive with tube designs.

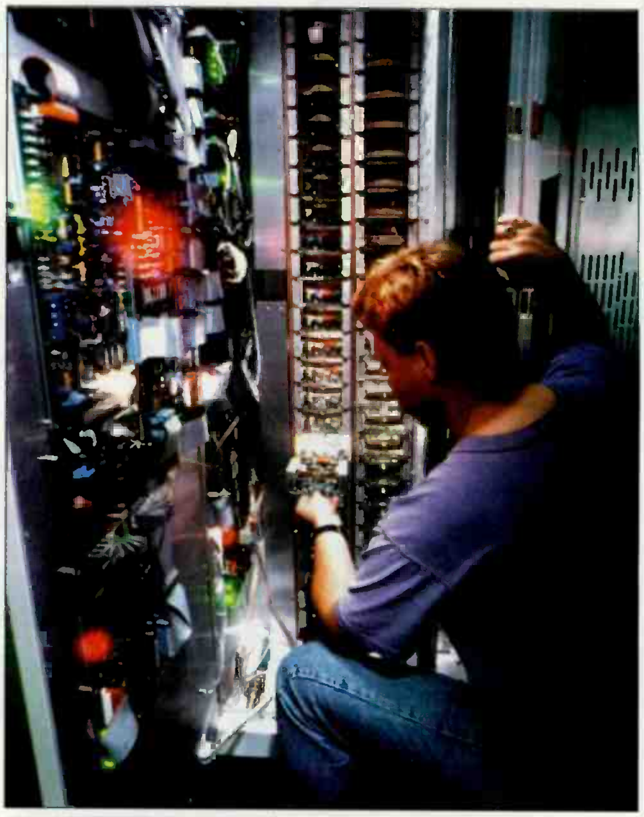
Solid-state AM transmitters

For AM applications, the cost of building a transistorized transmitter is similar to that of a tube-type transmitter. The manufacturers' costs are roughly similar for both types, no matter what the power level or transmitter size.

Electrical efficiency is usually much better with solid-state devices than with tubes at medium-wave frequencies. Typical electrical efficiencies (AC input to RF output) are from 60% on the smaller transmitters to more than 75% for those of 1kW or more. One manufacturer's design using digital modulation of the AM carrier wave is rated at more than 85% efficiency from AC input to RF output. When comparing solid-state and tube equipment, the bigger the transmitter, the greater the electrical cost savings over time.

Early attempts (10 to 15 years ago) at solid-state AM transmitters often met with disappointment, especially in terms of reliability. Thanks to genuine advances in MOSFET manufacturing technology, these systems are intrinsically more stable and robust. In fact, sometimes a transmitter manufacturer can "upgrade" a particular amplifier design simply by changing an older design MOSFET for a newer one with little, if any, other circuit changes.

Also contributing to improved transmitter reliability is a better understanding of how to use and protect the active components in the amplifier and modulator circuitry. Recent research and development has refined output-amplifier designs to strengthen their resistance to high VSWR conditions and lightning strikes. Brute-force methods using gas-



The solid-state design of this Harris DX series AM transmitter allows a single RF amplifier module to be used throughout the transmitter.

discharge devices and Schottky diodes are now in common use. At least one manufacturer is implementing Class E amplification with a component layout inherently resistant to damage from high VSWR and lightning.

Solid-state FM transmitters

Every major transmitter manufacturer offers completely solid-state FM systems. For stations needing 50W to 10kW, a solid-state transmitter is available practically off-the-shelf. However, some companies' solid-state product lines stop at 1kW, 5kW or 7kW power levels. This difference in upper limits to solid-state offerings among manufacturers has much to do with the market's desire for solid-state amplifiers vs. the relatively high cost of systems over about 5kW.

Solid-state FM transmitters are not yet as practical and efficient as AM units at higher power levels. As with AM solid-state transmitters, higher and higher power levels are achieved by combining the outputs of multiple RF power amplifiers. While it's possible to combine the outputs of enough FM amplifier modules to reach high power levels, the expense of doing this currently outweighs the benefits at powers much above 5kW.

The reasons for this become clear when you compare two typical tube-type transmitters from the same product line with different power levels – say, a 3kW and a 10kW model. Externally, the two units are almost indistinguishable. Internally, only the power supplies and tubes are different. Both transmitters have almost exactly the same parts count. Tripling the output power from 3kW to 10kW will not triple the manufacturing cost nor the retail selling price in this product line.

Now make the same comparison with a solid-state FM

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transmitter line. Because it is built in a modular form, the parts count *will* nearly triple when making the same jump in power. The splitting and combining networks will be larger and more complex for the larger transmitter, and there will be more power supplies (although they will be similar to each other, thereby providing some redundancy). Naturally, the cost differential between lower and higher power levels will be substantial for the solid-state system.

Another disadvantage among solid-state FM transmitters is a lower AC-input to RF-output efficiency for some systems when compared to some tube-based models of similar power levels.

The Continental 816R series is an example of hybrid FM transmitter design. It combines a solid-state exciter and an IPA with a tube final stage for powers ranging from 21.5kW to 35kW.

The advantages of solid-state FM transmitters mirror those of the AM designs (redundancy, much lower voltages, fewer critical power supplies and better, more predictable performance), and these will outweigh the disadvantages over time in many applications.

Current solid-state FM transmitters also exhibit excellent synchronous AM noise figures. Manufacturers often specify a figure of -55dB to -60dB below equivalent 100% modulation. Actual synchronous AM noise figures are often -65dB to -70dB. These figures are usually a vast improvement over real-world figures obtained from tube-type transmitters.

Hybrid FM transmitters

Most manufacturers still offer solid-state/tube-hybrid transmitters, especially at power levels of 5kW and higher. A hybrid design offers most of the advantages of solid state without the high cost associated with the higher power levels.

A typical hybrid FM transmitter will

New developments in transmission

use a transistorized intermediate power amplifier (IPA) stage to amplify the signal from the station's FM exciter and drive the final PA stage. This technique works well for both of the two most common FM final-stage designs in use today — *grounded grid* and *tetrode-tube.*

There are two advantages to using a solid-state RF driver for a tube final. One involves the same benefit noted earlier: fewer tubes and a reduced need for a variety of high-voltage power supplies.

The second benefit comes from greatly increased bandwidth in the IPA. In many FM transmitters, a tube IPA stage is the source of greatest restriction in RF bandwidth, due to the high-Q circuits often used in its input and output. Poor RF bandwidth results immediately in poorer AM synchronous noise performance and can thus degrade stereo separation and FM subcarrier performance.

Modern solid-state IPA amplifiers are broadband enough to be used across the entire FM broadcast band. Therefore, they provide no restriction whatsoever to the modulated FM carrier and can faithfully pass a quality, wideband signal to the final tube. The final tube's grid circuit becomes the limiting factor to RF bandwidth when a solid-state IPA is used. In most modern designs, however, this does not create a significant restriction.

Another benefit to hybrid FM transmitter design is the ability to patch around a non-working amplifier section. Because a 50Ω input and output impedance is fairly standard for all amplifier stages, you can bypass a failed stage and remain on the air at a reduced power level. This capability has been further enhanced over the past few years as solid-state amplifier stages have become more standardized. The input and output of each stage is generally available via BNC or type N connectors.

Digital FM exciters like the Nautel NE-50 are typically available with either analog or AES/EBU digital audio inputs.

Digital FM exciters

Arguably, the most significant recent improvement in transmission technology is the digital FM exciter. Built around the *numerically controlled oscillator* (NCO), the digital FM exciter offers a clear improvement in audio quality and definition over analog designs.

Numerous problems associated with analog modulated oscillators are eliminated because the process of creating a frequency-modulated carrier wave is accomplished entirely in the digital domain. Even the creation of the unmodulated carrier wave is performed digitally. Naturally, the output of a digital FM exciter is an analog RF signal, suitable for driving practically any FM transmitter.

Audio and other performance specifications for digital FM exciters are equal to or better than analog exciters. The real benefit, though, is in listening. Perhaps the most noticeable change reported by listeners is the absence of the "swishy" sounds that were often heard on an unmodulated carrier from an analog exciter.

Cleaner or tighter low-frequency performance is another frequently noted improvement, most likely resulting from the elimination of what's often called *AFC bounce* in analog FM exciters. This phenomenon is difficult to quantify or measure, but becomes obvious when comparing digital and analog FM exciters. The deep bass response of the digital exciter is improved because there is no conventional AFC circuitry for the audio to fight against. (Remember, with an analog FM exciter, the audio is trying to shift the carrier frequency away from the center frequency while the AFC circuitry is trying to keep the carrier frequency on center.)

Finally, a digitally modulated FM exciter makes possible an entirely digital air chain. Using AES/EBU signal paths through the audio processing and STL paths, it's now possible to modulate the FM carrier with basically the same bitstream that is coming out of the CD player or other digital audio source.

Transmission line

One recent advance in RF transmission line incorporates a new EIA flange manufacturing technique. The new construction style is said to virtually eliminate impedance discontinuities at the flange joint.

This type of rigid transmission line is being marketed primarily to TV broad-

casters in anticipation of ATV transmission. However, its usefulness to FM broadcasters is obvious, especially when considering the multiplexing of two or more FM stations on one transmission line.

Using transmission line with a section length that is a multiple of a station's carrier wavelength will usually result in VSWR buildup. This requires stations on certain frequencies to use odd-length rigid transmission line sections. When stations combine at a common tower/antenna site, it may be difficult or expensive to find a line length that is suitable for all stations involved.

The newly designed transmission line connectors reduce or eliminate this problem so that one length of line is suitable for all of the stations using a common line.

Towers and support structures

Combining FM-antenna elements with the intended support structure at the antenna factory traditionally leads to more predictable antenna performance. Often, antenna makers test and/or adjust a new antenna on tower sections that are only similar and not exactly like the ones that will be used on site.

At least one antenna manufacturer is also fabricating antenna support structures and encouraging their use in the field. Advantages of such a unified approach include reduced interference with the antenna's omnidirectional characteristics, more predictable VSWR figures, reduced antenna pattern-study costs, and lower weight and windloading compared to typically used standard 24-inch tower sections.

Many of the improvements in RF transmission technology can be implemented by stations one at a time. For example, setting up a digital audio chain need not be done all at once. Many broadcasters have already begun to upgrade their transmission systems. With each new component or equipment upgrade, noticeable improvements can be realized. This step-by-step approach is a sensible and affordable path to better broadcasting.

Kirk Harnack is president of Harnack Engineering, Inc., an international contract engineering firm based in Memphis, TN.

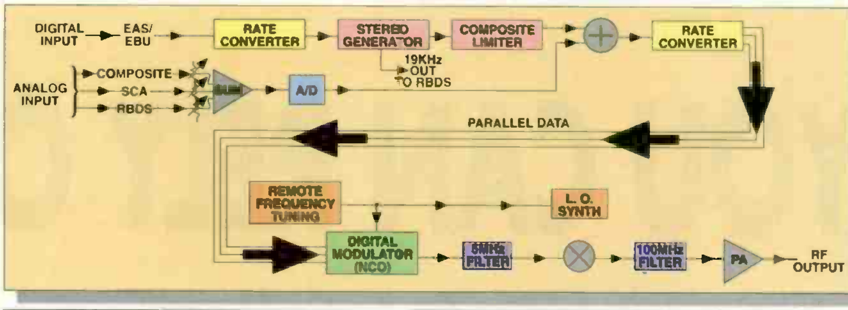

Figure 1. A basic block diagram of a typical digital FM exciter.

For more information on AM & FM transmission equipment, circle (101) on Action Card. See also "RF Products," pp. 79-84 of the 1996 *BE Buyers Guide*.

Leasing tower space

By Doug Vernler

For broadcasters who own their own transmission facilities, leasing space is a good way to earn supplemental income. A number of important issues need to be considered before undertaking this kind of venture, however.

A good starting point for rental rates is $1.00 per foot per month, although rates can run considerably higher in highly populated areas. Higher rates can also apply if you are able to provide dry rack space in an adjacent building. The size of the antenna may also affect the rent you charge. For example, a 12-bay FM antenna will take up about 110 feet of vertical tower space and, therefore, it should draw a premium over what you'd charge for a small 2-way antenna at the same height.

Next, consider the capacity of the tower. That 12-bay antenna on a 1,700-foot tower, including its transmission line, will weigh in near 8,500 pounds (the equivalent of 17 Harley Davidson 1200 CC motorcycles). Make sure you know how much additional weight and windload your tower will handle, including worst-case icing or storm conditions. No money is worth a collapse.

Generally, you should require the tenant to have an engineering study performed by a licensed mechanical engineer who is experienced with towers. Often, the tower manufacturer will provide this service for about $2,000. The tenant should be just as interested in having a safe tower as you are, so you shouldn't meet much resistance here.

You also need to decide who will pay the electrical costs. For a large TV or FM system, the tenant will usually be responsible for its own electric bills. For smaller communication systems, you may decide to allow the renter an electrical hookup from your existing power system at the site. In that case, you can increase the rent slightly to accommodate for the new power drain. You may still want to install a separate meter on any tenants' feeds — it's the only good way to have an accurate accounting of their power use. This installation cost will vary from $250 to $750 per meter, depending on the location and the amount of power involved.

Protecting yourself

Write a clause in your lease agreement that requires your tenants to pay for the correction of any interference they may cause to your service or other services on or near the tower. Specify the period of time after notification within which the tenant must fix the problem. Another clause should require tenants to conform with the ANSI standard for exposure to non-ionization radiation. In some cases, this may mean shutting down while work is being performed on the tower.

Detail your security issues. Who gets access to your building? How many keys will you issue? What kind of notification do you want when tenants work on their antenna? How do you want their tower workers to be insured against liability?

Remember that you are still responsible for tower maintenance. The more weight you have on your tower, the more important regular maintenance becomes. The FCC has begun a new program to register tower owners. If they don't know who you are already, they will soon. If you let your tower lights go out, your *tenant* may knock on your door because the commission can hold both licensees responsible (even under the new program).

Finally, plan for an automatic yearly rate increase. You can use the Consumer Price Index or just add a flat 4% to 6% each year. A 5-year contract with an option to renew for another 5-year term is common, and it is generally advantageous to both parties.

Renting excess tower capacity can be a great way to expand your incoming revenue stream. Just make sure you do it right so you can sleep at night.

Doug Vernler is the director of broadcasting services for the University of Northern Iowa, Cedar Falls, IA, and a consulting engineer.

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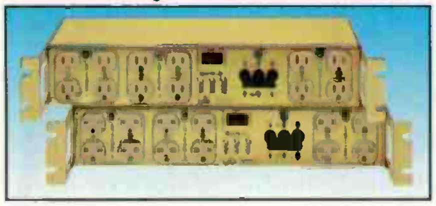
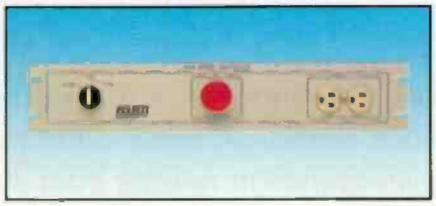
Recessed Single Phase Power Controller



Rack mounted. Designed to fit standard 19" wide EIA STD. Standard and optional features including EMI/RFI filter, spike and surge suppression, 12 front panel mounted NEMA outlets, remote I/O ports, current protection up to 24 AMPS. Other features include three sections of four outlets either all switched or two switched and one unswitched, Multiple Time Delay® power-up/down, various current/voltage ratings.

Circle (35) on Action Card

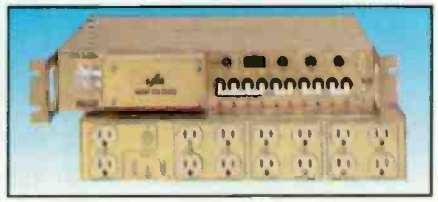
Remote Power Control Panel



Centralize your system's power controls. Controls all Power Conditioners with standard industry configuration 3-pin remote connectors. Panels for both standard and latch type controllers. Needs only 3-1/2" height. Includes a utility convenience outlet, red EPO mushroom switch and reset (on/off) switch. Finished in light textured gray, FED-STD 595 #26559.

Circle (36) on Action Card

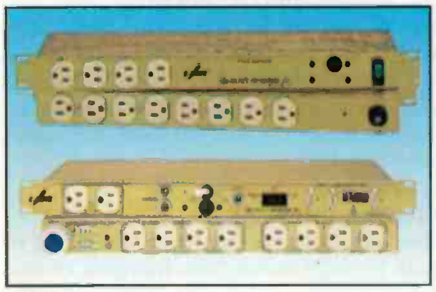
3-Phase Power Controllers



Rack mounted. 3-1/2" (2U) high. Depths from 8-1/2" to 14-1/2". Includes spike and surge protection, EMI/RFI filter, remote I/O connectors for power on/off, EPO and power-up of additional equipment down line; precision electromagnetic circuit breakers and power indicator lights. Options include Multiple Time Delay® power-up between sections, receptacle type and output voltages of 125 or 208 VAC. Designed to meet UL 1950 and CSA 22.2-950.

Circle (37) on Action Card

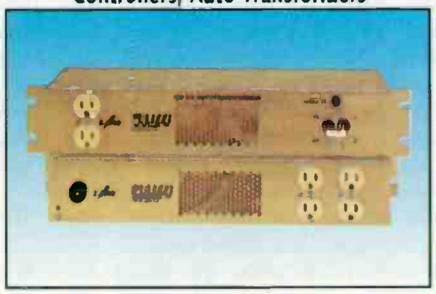
Flush Mounted, Thin Line Power Controllers



Ideal for restricted space applications. Large selection with up to 16 IEC type outlets. Many optional features including current/voltage rating, quantity and type of outlets, switched/unswitched sections, Multiple Time Delay®, EMI/RFI filtering (standard on some series), remote I/O ports and latching function.

Circle (38) on Action Card

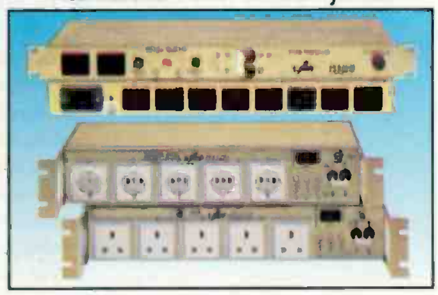
Step Up, Step Down Voltage Controllers, Auto Transformers



Change European voltage to 125VAC or step up domestic voltage to accommodate 220VAC. Current ratings from 10 to 30 AMPS, 750 to 2880 Volt AMPS. Up to 12 NEMA or IEC receptacles. Optional protection from spikes and surges, EMI/RFI filter. Only 3-1/2" high (2U).

Circle (39) on Action Card

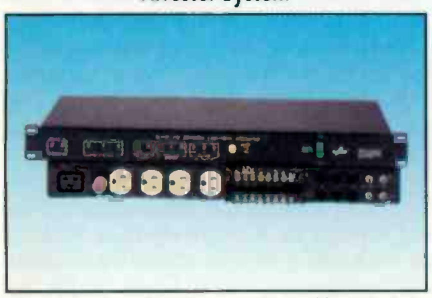
International Power Control Systems



Controllers with IEC, "SCHUKO", British, German and other International receptacles. All units meet IEC 950 safety requirements. Includes voltage sensitive, voltage selectable and fixed voltage controllers. Up to 16 receptacles in 1U high. Some with Multiple Time Delay® or individual outlet control.

Circle (40) on Action Card

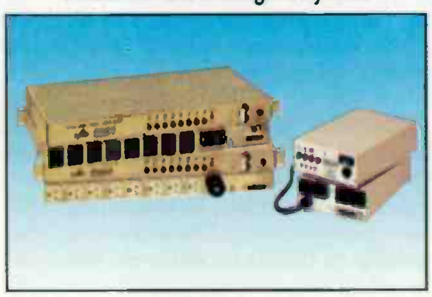
Satellite Antenna Lightning Arrester System



The solution to multiple line protection problems. Protects all circuit functions, including motor drives and sensors, linking a satellite tracking station with a remote receiver. Can withstand spikes and surges as extreme as lightning strikes on AC power, RF and telephone lines. Provides EMI/RFI filtering on low frequency circuits. NEMA connectors available for AC lines, RJ45 for phone and data lines, terminals for motor drive and sensor circuits as well as "F" type connectors for coaxial cables. Convenient, easy to install 19" rack mountable steel enclosure is a slim 1.75" high, 6" deep.

Circle (41) on Action Card

µP Controlled RS232 Remote Power On/Off Intelligent System



Pulizzi's advanced design, Intelligent Power Controllers® allow access and individually controlled power distribution from a remote location, even with a laptop computer, through a RS 232 communication link. A factory programmed microprocessor continuously monitors and reacts to customer specified parameters. Options include local control, IEC or NEMA receptacles, password security, multi-unit addressability, "watch dog" (self-boot) function, spike and surge suppression, EMI/RFI filter, customer specified power up sequencing.

Circle (42) on Action Card

Custom Designed Systems

Can't find the Power Distribution Unit (PDU) you need? Pulizzi Engineering, with over 20 years experience, can design and manufacture the exact PDU you want and meet agency requirements. Eliminate the time and costs to design, fabricate and wire in-house power controllers. Let Pulizzi Engineering do it for you, better, faster and less expensively. Call us at the design stage and let us show you how a Z-Line PDU can more than pay for itself when it comes to total system cost.

Circle (43) on Action Card

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Circle (44) on Action Card

Feature:

Audio control systems

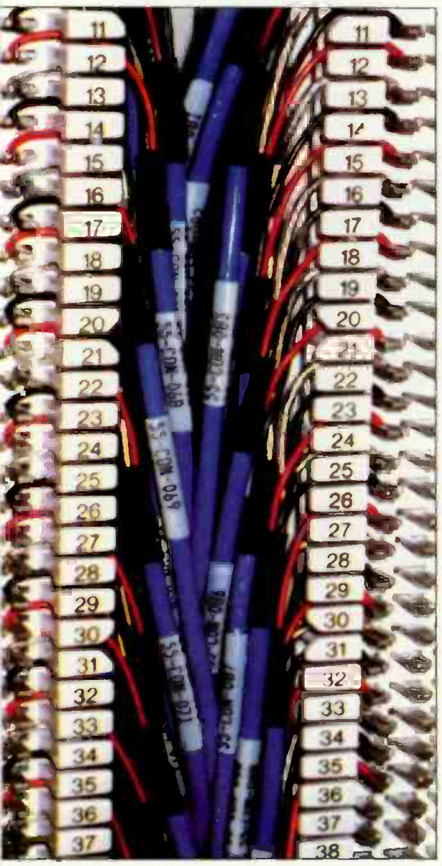
Managing multiple signal paths will challenge future facilities.

Much of tomorrow's radio will originate from "multicasting" facilities. Studios are likely to use a variety of control surfaces and storage equipment ranging from conventional analog devices to radical new digital systems. A facility's basic audio infrastructure will have to provide high quality, extreme reliability and great flexibility for accommodating change.

By Dan Woodard

It's quickly becoming reality: most broadcast facilities will soon be multistation operations. This trend, not unique to the broadcast community, exploits good business opportunities by consolidating, merging or buying out the competition. More and more, broadcast engineers will be expected to design for consolidated operations, either by upgrading and adding space to existing facilities, or by designing new, tightly integrated ones.

This will particularly affect the design for routing of audio and other signals. It can take form in either of two arrangements: 1) If your operation acquires another station in the same market, and the acquisition will remain in its existing facility, some type of audio, data and control interconnection between the separate sites will be required; 2) If the acquisition will be moved into a merged (multistation) facility, more elements can be economically shared, but the infrastructure of the facility will have to be up to the task.



Living in separate houses

The audio paths between the separate facilities will be used for exchanging program material, such as commercials, satellite feeds and simulcast programming. These can be dedicated analog or digital program circuits leased from telco, intercity radio relays or data-compressed dial-up digital (ISDN) paths.

Existing switching and mixing systems can probably continue to be used at both locations, although a few I/O positions may need to be reassigned to accommodate the heavy traffic between facilities. Crosstalk also should be checked, and appropriate measures taken to eliminate any signal leakage.

Non-audio data exchange will be necessary because the traffic and music logs will probably be produced at one location and forwarded to the other. This could be as simple as installing a remote printer linked by a dial-up modem. It could also be handled by sending messages through one of the on-line service providers or by installing dedicated circuits to extend the reach of a local area network (LAN) that's already installed at one of the locations. Another option involves auxiliary data packets on the digital telco lines (T-1, DSO or ISDN) used for audio transfer between locations.

The merged facility

Whether intended from the beginning or learned by experience, the merging of stations into a common facility is probably the ultimate method of gaining advantage through consolidation.

You can expect the consolidated facility to include a lot of digital audio storage. That is the only way to realize significant reduction of equipment and efficiency of operation. For example, commercials, news actualities, PSAs and the like need to be dubbed only once, then distributed digitally to all stations in the facility, thereby conserving time, materials and human resources. Likewise, the archiving process can be reduced to a single, space-efficient and easy-to-administer operation.

A key element to the success of a merged facility is the design of an efficient interconnection among its various studios. Without such a workable system in place, the stations' satellite equipment, news feeds, traffic reports, public affairs programming and other shareable resources cannot be optimally used. A relatively large, centralized audio routing switcher is probably the best foundation for such an operation. In addition to allowing easy sharing of common resources, it will also greatly reduce wiring costs for the facility.

Designing the system

When starting the design phase, set aside an adequate amount of time and staffing to determine exact requirements. How do all of the various departments interact from the time a salesperson turns in an order until it is aired? How many minutes of audio storage is

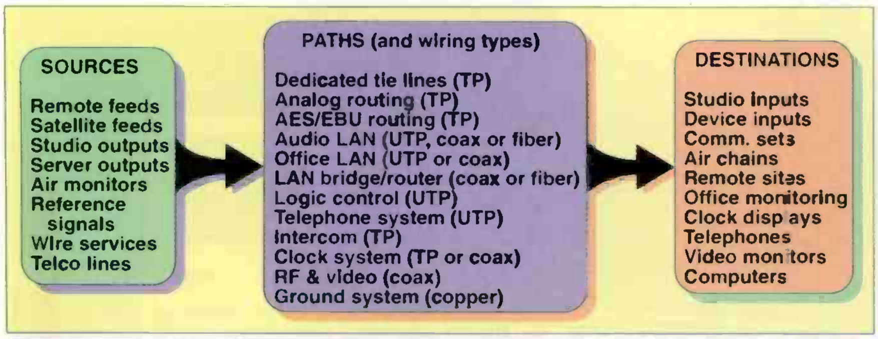


Figure 1. A comprehensive control and routing system will include all of the elements in this diagram. (TP = twisted pair (shielded); UTP = unshielded twisted pair)

required for music, commercials, sound effects, jingles and news feeds, and how much of this is duplicated among the multiple stations? How will the various departments exchange information on the new system? Will a LAN be used to load the traffic and music logs into the system and retrieve as-played logs? If so, who needs read, write or delete rights at their workstations? Will the sales department need to play digitally stored commercials to clients without tying up production rooms? How will the satellite equipment be controlled to receive all of the various feeds? Is it possible to build one master log template to control the automation system, routing switcher, satellite equipment and broadcast transmitters? If so, who will be responsible for preparing or changing that log and how are on-the-fly changes made after the log is finalized?

Also consider future possibilities. If a drastic programming format change occurs or another station is purchased, how easily can it be accommodated? What about redundancy? If one large storage pool and one large switcher is used, how many radio stations will be without programming when it fails?

Allow for integration

Live copy for announcers can appear on a video display terminal at the operating position. Consoles and automation systems can also have their control systems integrated. For instance, an interface can be established so the "next to air" source on the automation system illuminates a "ready" or "channel on" light on the appropriate console input. Then pressing that input's "channel on" or "start" button on the console starts that source on the automation system. When it is finished playing, that console input is muted by the automation system, and so on.

Another configuration may scale down or possibly eliminate the audio console in some rooms. Consider that most digital audio providers have programmable crossfading built into the system, and they provide firmware to control a number of the more popular audio routing switchers. With the computer controlling source selection and start/stop control, the console may only be necessary (or simply preferred) for live talk shows and remotes, or for backup if the digital system crashes. These multiple configurations for different programs or operator styles can be preset and stored in such an integrated system, and recalled with a single keystroke or button push.

Digital audio systems will also allow production control rooms to be made smaller. Most of the digital audio workstations that appear in production studios provide some means of internal mixing, reducing the number of console inputs necessary. All of the cart machines can be eliminated because the produced spots will be automatically routed through the networked computer system for airing.

Negotiations are under way between some non-real-time digital audio distribution networks and digital automation system vendors that will soon allow a direct and transparent background upload from these networks onto a variety of automation servers. While this will still require the attention of the traffic and continuity departments, it will lessen the need to dedicate production rooms, audio signal paths and personnel to dub externally produced material.

Don't forget communications paths. A well-designed intercom is indispensable in a consolidated facility. Because resources will be shared, intercommunication will play a role in how smoothly the various air staffs can carry out their extended duties. If it is economically feasible, investigate a programmable switcher type of communications system. It provides ways to partition work groups, thereby reducing unnecessary party-line traffic. It can also be reconfigured instantly to accommodate changing needs.

Getting down to details

After identifying the studio functionality and equipment, you should have a good idea of the interconnection requirements. Plan on some dedicated audio paths and LAN interconnects, but incorporate as much as possible into an audio routing switcher. When the inevitable future changes occur, they can be easily and quickly implemented by reprogramming the switcher. Even if the switcher does not include programmability, it is less painful to make a few

Many of today's studios control audio signals with a "hybrid" approach, combining conventional mixers with computer-based storage.

wiring changes in the back room than to disturb the whole radio station by pulling in additional wiring. Also plan for failures in this switcher. Include dedicated audio pairs for everything that you can't live without, and perhaps some manual patching.

Regarding size of the switcher, a good rule of thumb is to count the number of paths required now and double it. You may not need to fully load the matrix to that extent now, but make sure the frame can handle the eventual load (or can easily be expanded to that size).

A related concern is whether to choose an analog or digital switcher. If possible, take the Deion Sanders approach and do both—configure a small AES/EBU router and a large analog matrix with tie lines between them. Intelligent control of both sections will allow any source to be routed to destination, whether analog or digital. Modular design of both sections allows for a gradual phase-over as the conversion to digital equipment continues.

Besides audio, other cabling will be needed. Several coax cables can distribute antenna and video signals, while 25-pair telephone cable terminated on punch blocks at each end can provide low-cost control paths. Coax or twisted pair LAN cable will be needed to interconnect computer platforms. The latter may carry real-time digital audio, non-real-time audio (file transfers) or non-audio data.

Try to choose a central location for the switching equipment room and plan on a star type of interconnection. Serious consideration should be given to locating as many of the computer CPUs as possible in this room, using VGA/keyboard/mouse extenders to individual workstations. (This brings up yet another wiring requirement.) A single uninterruptable power supply, HVAC system and RF shielding can be designed for this room to meet the needs of your most critical equipment.

After defining your requirements, prepare a system bid document with your requirements plainly stated. Include an interconnection diagram of how you think your combined facility should be arranged. Also be sure to specify excellent crosstalk performance. Then request proposals from as many vendors as possible.

Finally, remember that change will be rapid in tomorrow's radio facility. On-air and production rooms will be continuously reconfigured as new audio systems are developed, or as station formats change, or even as new on-air talent is hired. Multiply this turnover by the number of stations in a multicast facility and you can see that tomorrow's engineers will keep busy. A well-designed, forward-thinking and versatile signal-path infrastructure will be invaluable to the facility and its staff in facing this challenge.

Dan Woodard is engineering manager at CBS/Group W, Houston.

For more information on audio routing, switching and mixing equipment, circle (102) on Action Card. See also "Mixers, Audio" and "Routing Switchers," pp. 69-71 of the 1996 BE Buyers Guide.

Continued from page 14

Overvolting (i.e., running the filament at a level higher than this optimum voltage) will raise the filament temperature and reduce the tube life through excessive emission. *Undervolting* will result in "stripping" the filament by forcing it to emit without sufficient heat to produce an adequate electron flow. This also will result in reduced tube life.

Common tube problems

When directly heated tubes were introduced, it was found that the new "mains-powered receivers" tended to suffer from hum. This was caused by the AC in the directly heated filament modulating the RF or audio voltages being handled by the tube.

The hum problem caused tube manufacturers to develop the *indirectly heated* tube. The cathode became a small cylinder with a coiled filament inside of it. This cylinder is coated with thoriated, carburized material, and it is electrically insulated from (and heated by) the filament wire coiled inside it. Because the cathode is insulated from the heater, there is no varying AC field around the cathode that could cause hum. In most cases, this solves the problem.

The second problem that develops in power tubes is *gassing*. Despite the most rigorous efforts in manufacture, there always seems to be a little residual gas left in a tube. These gases react with the heated filament and tend to increase the speed of decarburization. A small metal plate is included in the manufacturing process to help get rid of these gases. This plate is called a *getter*, and it is heated during processing and evacuation. This causes it to react with and absorb most of the residual gases, thus extending the tube's life.

When a tube becomes gassy, a blue glow like St. Elmo's fire dances around the elements with the modulation. This is especially noticeable in modulator stages.

Some engineers make a habit of using "time expired" PA tubes in modulators as a way of economizing. This may not be good practice from a qualitative point of view. If a tube can't provide enough emission in a PA stage, it probably can't do much better in a modulator stage, so audio quality will suffer. Nevertheless, it's an attractive option when budgets are low.

A different world

The move toward solid-state devices began in earnest during the late 1960s, and today, it has almost completely eliminated the vacuum tube from the scene — except for a few specialized pockets, like high-powered transmitters. Times have certainly changed over those intervening years. While electronics courses back then had tubes as their core curriculum with solid-state as an appendix, today it's quite the opposite. Veteran radio engineers now express shock when they look in recent editions of the "ARRL Handbook" and find only a few transmitting tubes and CRTs listed. In earlier years, this book was filled with pages and pages of tube types and bases.

The electronic principles set in motion by vacuum-tube amplification remain as a foundation for most semiconductor-based operations today. The differences between the technologies are really found in their physical parameters, such as size, stability, efficiency and maintenance requirements. The advantages in these areas are what has driven the evolution toward solid-state systems in many — but not yet all — applications.

Those interested in learning more about tubes should contact Varian Power Grid Products for their publication, "Extending Transmitter Tube Life."

RF Engineering: Power tubes

For more information on power tubes, circle (100) on Action Card. See also "Tubes, RF Power Triodes, Tetrodes," p. 84 of the 1996 *BE Buyers Guide*.

Reader Feedback:

Dear Skip:

I enjoyed your editorial in the November/December issue. You always have an accurate insight into the state of the industry and express it well.

I'd like to congratulate you on making an important observation. You are the first person I've seen who has expressed in writing the obvious fact that the IBOC system will involve trade-offs as compared to Eureka. At the 1993 SBE Convention in Miami, one of the scientists developing one of the several IBOC systems, while positive about his system, expressed as a foregone conclusion the fact that his system could never be as robust as the Eureka system — it's carrying the baggage of the simultaneous analog transmission, and it must fit into a space of only 200kHz. It can never be as impervious to multipath as the Eureka system.

Any time there is the requirement of downward compatibility, it limits the technical performance of the system under development. The FM IBOC system will be saddled with the requirement to perform in digital stereo, analog stereo and analog monaural. And, consider the absurd concept of digital AM — it needs to be downward compatible all the way to a 1920's crystal set!

The real issue is the protection of the status quo. The same forces were at play during the introduction of FM in the 1930s. The established AM broadcast community led by David Sarnoff managed to suppress the introduction of FM for 10 years, and then forced a change of frequencies that made everything obsolete that had been built before that date. These steps so crippled the new technology that it really never came into its own until the 1960s.

The radio listener was the loser. The same marketplace forces two generations later are trying to force an IBOC technology upon the industry, with the primary intent of protecting its investment. The radio listener again will be the loser. We'll spend the next decade developing and implementing an inferior technology, while the rest of the world races ahead with Eureka 147. We could end up being the laughing stock of the planet.

If the industry is going to proceed with its quest for the IBOC "holy grail," it needs to go forth with its eyes open, knowing that there could be serious trade-offs. I thank you for bringing this to the industry's attention.

(Meanwhile, the other all-radio publication continues to print frequent articles bashing the Eureka system and ignoring the technical realities. I guess that's what happens when you have a technical publication that is not written by technical people.)

In closing, let me state that you have created an excellent publication, with solid articles that serve the industry well. Thanks for your efforts!

John F. Schneider, president
RF Specialties of Washington, Inc.
Seattle, WA

Ask Dr. Radio

Gary Peterson of Tom Ingstad Broadcasting, Rapid City, SD, asks:

How does "incidental AM" (synchronous AM noise) cause or worsen FM multipath distortion?

Geoff Mendenhall, vice president and radio product line manager at Harris, Quincy, IL, replies:

I must tell you that in my opinion, incidental AM of FM transmitters does not have much effect on multipath distortion. Although many broadcast engineers believe that incidental AM either creates or exacerbates FM multipath distortion, I can find no scientific reason to substantiate this belief. Here is why:

Statistically, there are relatively few locations where "true" (broadband) RF fading of an FM signal from multipath cancellation is deep enough to cause the receiver to fall below the FM limiter threshold.

More common is *selective* fading of composite baseband components, such as the stereo pilot, when two or more signals with different multipath-induced delays do not cancel at RF, but are demodulated together. Most multipath distortion heard in a vehicle is caused by this selective baseband fading, which is caused by multiple delays in the modulation information rather than by true RF fading.

The incidental AM of an FM transmitter effects only true RF fading, because it adds to or subtracts from the signal level at the receiver. But RF fading caused by multipath has variations of many dB while the power output variation of an FM transmitter with incidental AM of -40dB (ref 100% AM) is less than 0.1dB. The change in signal level caused by the transmitter is minuscule compared with the variations due to multipath propagation.

Tests made on various FM receivers indicate that the narrow bandwidth of the IF filter (compared to the transmitter) cause the incidental AM to increase to less than 20dB below equivalent 100% AM modulation before the signal is demodulated. Therefore, the transmitter only adds a small amount of incidental AM compared with the receiver IF.

I have done computer modeling on the effect of incidental AM vs. *group delay distortion* on FM modulation performance. Incidental AM has much less effect on FM modulation performance than asymmetrical group delay.

I believe the reason transmitter tuning seems to affect received signal distortion is due to unequal group delay of the upper FM sidebands vs. the lower sidebands. Tuning for minimum incidental AM may also result in the transmitter being tuned for nearly symmetrical group delay. In other words, minimizing incidental AM may be an indirect way of equalizing the group delay. The best way to optimize FM modulation performance and minimize distortion is to tune for symmetrical group delay directly.

Send your questions for Dr. Radio to:
FAXback: 913-967-1905
Internet: beradio@intertec.com
CompuServe: 74672,3124

EIA enters second phase of RDS program

Radio station general managers in radio markets 11 through 25 have received Radio Data System (RDS) sign-up kits from the Electronic Industries Association (EIA).

The sign-up kits are part of the EIA's plans for phase two of its nationwide program offering RDS encoders, radios and software at no out-of-pocket cost to top 25 market FM broadcasters.

In phase one, the EIA campaign visited stations in top 10 markets and signed more than 100 FM stations. The EIA RDS sign-up kit is part of a new streamlined method of signing stations in the 15 remaining markets targeted for the program.

As part of the package, stations received an RDS encoder, MusicBoard automation software, an RDS-equipped home or car radio, promotional spots and the use of a Belar RDS monitor.

FM broadcasters interested in receiving more information on the EIA's program should call RDS program manager Steve Hill at (212)986-6668.

RealAudio version 2.0 released

Seattle-based Progressive Networks has released version 2.0 of its RealAudio software for real-time downloads of on-line audio. The new version promises improved audio quality via 28.8kb/s or higher connections, although some early listeners report little change from the previous incarnation. Version 2.0 also allows RealAudio *encoding* to take place in real-time, a significant improvement over version 1 (which required several multiples of an audio segment's running length for processing), enabling live RealAudio transmissions on-line.

News:

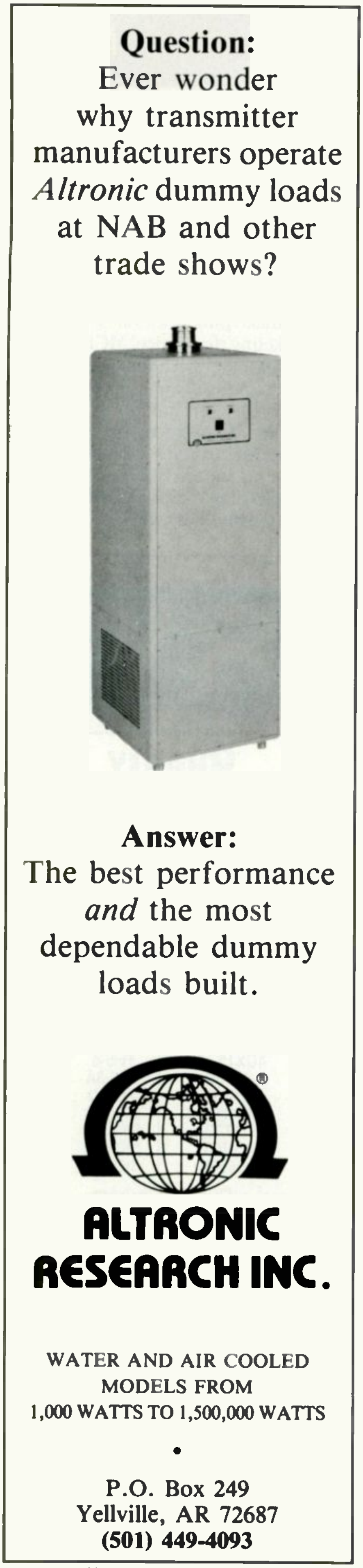
MCI's MUSIC NOW service involves stations

MCI has launched MUSIC NOW, a service that allows consumers to shop for music by listening to 20-second cuts of current releases over the phone. Listeners call an 800 number and work their way through voice menus to hear the styles or artists they're interested in, and can then make purchases via credit card.

In marketing the service, MCI is working with about 100 stations in the top 30 markets. In exchange for spot-buys and other cash or in-kind incentives, stations provide promos and voice talent for the MUSIC NOW menus.

At present, the service organizes its music in six categories: rock, pop, country, jazz, R&B and alternative.

The GALLERY



Circle (25) on Action Card

Business/People:

BUSINESS

Harris Corporation Broadcast Division's Cambridge, UK, operation and **National Transcommunications Ltd. (NTL)**, UK, jointly introduced a digital audio broadcast (DAB) trial service.

Harris supplied NTL with one of its new DAB 2000 transmitters (for Eureka 147 service in the VHF band), which NTL used to retransmit local commercial radio services to the Birmingham area until the end of 1995. The transmitter was then moved to London, where it is now running more technically complex trial commercial radio services.

Spectral Inc., Woodinville, WA, formed an alliance with **Broadcast Electronics**. Now Spectral's Prisma editing system can be used to produce sound files for use with Broadcast Electronics' AudioVAULT system, and then transfer them seamlessly via a wide area network.

Otari, Foster City, CA, opened a new southeast sales office in Cummins Station, a region in Nashville. The office contains a show/demo room, which serves as a working studio for Otari products.

Also, Otari reported significant sales of its STATUS console, the newest addition to its mid-priced recording consoles.

Orban, San Leandro, CA, announced the first network link of its DSE7000 digital audio workstations with digital on-air playback systems by KSBL, Santa Barbara, CA, and WSBT, South Bend, IN.

Differential Corrections, Inc. (DCI), Cupertino, CA, signed a public partnership agreement with the North Dakota Department of Transportation to provide digital data services using Radio Broadcast Data System (RBDS) technology. RBDS will allow the state to improve the way it performs numerous functions, including city surveying, bridge and road maintenance, law enforcement and vehicle tracking.

DG Systems, San Francisco, and **Hughes Network Systems**, Washington, DC, agreed to a partnership. The companies will combine core technologies to create a solution that integrates satellite and terrestrial communications.

Also, DG Systems added a 4,000th radio station, WIFX-FM, Whitesburg, KY, to the company's nationwide digital network. Through the network, the company electronically distributes radio spots and new music singles, such as recent releases from Garth Brooks, Reba McEntire and The Beatles Anthology.

Media Capital Associates, Scottsdale, AZ, was recently formed. The privately financed leasing company was created to meet the demand for more customized leasing programs.

The Eimac division of **Communications and Power Industries (CPI)**, San Carlos, CA, signed an agreement with Richardson Electronics Ltd. for distribution of Eimac power-tube rebuilding services.

PEOPLE

John Patton was named executive vice president at Modulation Sciences Inc., Somerset, NJ.

David Beesley will head the Advanced Media Products Division at HHB, London, UK.

Circle (26) on Action Card

Compact disc recording system

SuperScope

Marantz Professional CDR620: a compact disc recorder that incorporates 1-bit A/D to D/A converters, a sample rate converter, digital audio delay and automatic track incrementing and indexing from CD, DAT, DCC and MD; the user-friendly CDR620 can be used as a stand-alone recorder or integrated into a studio's digital audio workstation system through use of the built-in SCSI-II interface; the SCSI-II interface allows recording of data in a variety of formats, including CD-ROM (XA), Photo-CD, CD-I, Video-CD and CD-DA; the CDR620 includes a number of user-programmable settings for maximum flexibility, such as digital fade-in/fade-out with adjustable time, auto track increment level, audio delay, calibrated input sensitivity and mute time.

Circle (152) on Action Card

Codec

AETA

Scoop Reporter: a codec capable of sending and receiving 7.5kHz quality audio over a single analog telephone line; an exceptionally low delay makes the codec ideal for live broadcast situations; features include a built-in microphone amplifier and an input mixer for Mic 1, Mic 2 and AUX that can operate from AC or for up to two hours from built-in batteries; the Scoop Reporter uses the latest digital signal-processing technology to achieve a better than 10:1 compression ratio with a delay of 30ms; the DSP device is capable of 60 million mathematical operations per second and uses a complex algorithm that models the way the human vocal cords resonate to form speech; the codec communicates a simplified data string at 24kb/s or 26kb/s using its built-in V.34 modem.

Circle (150) on Action Card

Bargraph meters

Audio Technologies Inc. (ATI)

BGD200 and BGD400: dual and quad bargraph meters that can display up to 12 critical audio lines in a single rack space; remote shared power allows the 3-color VU or PPM meters to be mounted directly under video monitors without the possibility of magnetic interference; available in 2-channel horizontal and 4-channel vertical configurations with either VU or PPM ballistics; the intense, multiple-color, 10-segment displays are visible even in bright sunlight; VU models display a signal range of -20dB to +3dB around 0VU; PPM models cover -15dB to +12dB; zero reference levels for both models are selectable to -10dBu, +4dBu or +8dBu with front-panel trimmers for fine adjustment; balanced, high-impedance inputs can bridge even -10dBu semi-pro unbalanced lines without loading.

Circle (153) on Action Card

Universal digital audio format converter

Otari

UFC-24: a universal digital audio format converter that can convert up to 24 channels of audio at one time and simultaneously output up to five different formats; the UFC-24 comes standard with the capability to convert 24 channels of ADAT/RADAR, TDIF-1, PD or SDIF-2 with AES/EBU as an option; the UFC-24 can be linked, allowing digital audio to be transferred from any one source format to various machines, such as DTR-900s, 3324/48s and multiple ADATS and DA-88s; a single UFC-24 can output 96 channels of digital audio across four different formats; with the AES/EBU option, the UFC-24 can output 120 channels of digital audio across five different formats.

Circle (154) on Action Card

New Products:

Modular digital multitrack

Fostex

▶ CX-8: a modular digital multitrack that combines full ADAT-compatibility with improved tape transport performance, an enhanced user interface, and balanced +4dBu outputs; the CX-8 provides eight tracks of digital recording on S-VHS tape; it will function with any other ADAT-compatible recorder as master or slave unit in expanded systems for up to 128 tracks of total recording capacity; a new die-cast tape transport is incorporated with fast wind times; an ergonomically designed front panel allows easy access to 44 function buttons while the large multimode fluorescent display provides at-a-glance information on track levels, tape position and recorder status.

Circle (155) on Action Card

Mic and line pre-amps

Studer

▼ D19 series: a range of mic and line pre-amps; the D19 MicAD features a high-quality 8-channel mic pre-amplifier system with 20-bit digital output, designed to complement digital audio workstations, multichannel digital recorders, modular digital multitracks and digital mixing and distribution systems; the stand-alone, 2U-high 19-inch rack-mount unit contains eight independent audio channels with separate XLR inputs for mic and line connections; digital outputs feature four AES/EBU connectors: a multichannel output in ADAT optical, SPDIF or TDIF is optional.

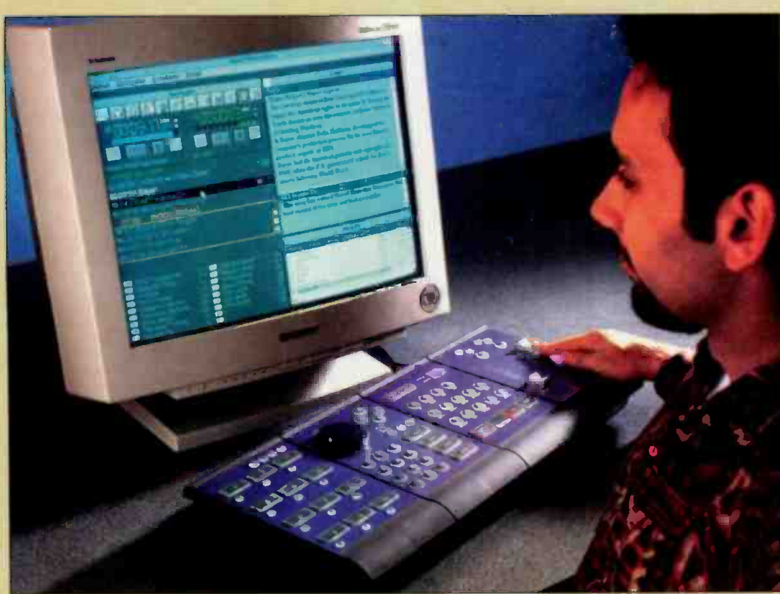
Circle (156) on Action Card

Digital recording console

Yamaha

• 02R: a digital recording console featuring architecture that consists of 24 analog inputs and 16 digital tape returns for a total of 40 inputs, eight digital bus outputs, eight digital direct outputs and eight aux sends; key features include digital I/O using four card slots for Alesis ADAT, Tascam DA-88, RDAT, professional AES/EBU and Yamaha recording formats; analog connection to a multitrack is possible by installing an analog card.

Circle (157) on Action Card



On-air software

Dalet

On Air Navigator: a software application that offers both live assist and full music walk-away automation; the system loads a program log as it has been scheduled; the log can contain different types of events, such as music titles, commercial breaks, external commands, text files for news or weather forecasts; the operator can modify this list at any time by dragging and dropping titles from the database window into the Navigator; scripts, titles and commands are all displayed on a single screen; in manual mode, the titles are loaded alternately to two separate stereo outputs so the DJ can perform crossfades with the mixing console; at any time, the operator can switch into automatic broadcasting mode or manual mode by clicking on a button.

Circle (158) on Action Card

Mixer

Mackie

• **MicroSeries 1202VLZ:** a mixer for studio or remote recording sessions or utility applications that features several new options; mid-EQ on all channels provides full 3-band equalization; mute/alt 3-4 switching on all channels allows the user to disconnect signals from the main mix (mute) by diverting them to a separate stereo output (alt 3/4); other features include 60dB of gain on channels 1-4 via the XLR mic input, "virtual pad" via channels 1-4 line inputs, lo-cut (HPF) filter on channels 1-4 that is identical to the one on the 8-bus and SR series, and control room/phone source switching with level control that allows the user to route signals for monitoring via headphones, speakers and meters (selection can also be routed back to the main mix); other features include PFL solo switches, balanced I/O, effects-to-monitor and XLR main outs.

Circle (159) on Action Card

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