Radio Guide

Radio's Technology Forum

November 1995

New Internet Web Sites

Our **Radio Guide** and **Radio Shopper** Home Pages are up and running on the Internet World Wide Web (WWW), at the **broadcast.net** domain. Our WWW addresses are:

For Radio Shopper:

http://www.broadcast.net/radio/rshome.html

For Radio Guide:

http://www.broadcast.net/radio/rghome.html

You can leave subscription information and requests, tech tips, and contract engineer listings on these pages. However, you can still use our direct Internet e-mail address to contact us with this, and other information:

Radio Shopper/Guide E-Mail:

radio@broadcast.net

On page 9 of this month's **Radio Shopper**, you can read more about the **broadcast.net** Website. It can be accessed at:

http://www.broadcast.net/

Here, you can browse through multiple sites (including ours), and access information ranging from AM/FM database searches (with maps), to the latest FCC texts and releases, directly from Washington D.C. If there's one place to go on the World Wide Web, the **broadcast.net** is it. From this Web Site, you can "travel" to almost any broadcast-related Internet Web Site in existence.

As you've probably heard, the Internet is a powerful tool for information exchange. At **Radio Guide and Radio Shopper**, we'll be using it frequently, to keep you up to date on the latest radio technical developments.

Ray Topp (publisher)

Here's How to Reach Us . . .

INTERNET: Radio@broadcast.net
COMPUSERVE: 71203,2341
TOLL-FREE BBS: 800-811-4045
TELEPHONE: 507-280-9668
24-HOUR FAX: 507-280-9143

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More Satellite Information
More Internet Information

Radio Guide

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Radio Guide Publication

Raymond Topp *(editor and publisher)*

511 18th Street SE, Rochester, MN 55904
Phone: 507-280-9668
Fax: 507-280-9143

Our Contributing Technical Writers

Jim Somich - Radio Engineering Services

1208 Stoney Run Trail,
Broadview Heights, OH 44147
Phone: 216-546-0967

John Bredesen - KLCC, Eugene, OR

3120 Nob Court, Eugene, OR 97405
Phone: 503-485-6869

Gordon Carter - WFMT, Chicago, IL

34 North Madison Ave., LaGrange, IL 60525
Phone: 312-565-5032

Andy Butler - Broadcast Electronics Inc.

3712 Ridge Road, Annandale, VA 22003
Phone: 703-739-5474

Frank Berry Ph.D.

190 112th Ave. N, #708
St. Petersburg, FL 33716
Phone: 813-577-0041

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The SBE Forum

By Ray Topp — Editor/Publisher

SBE Elects Terrence Baun as 1995-1996 President

The Society of Broadcast Engineers (SBE) has elected its officers and board of directors for 1995-1996.

Terrace M. Baun of Milwaukee, Wisconsin was elected President of the Society. Baun is Principle of the contracting firm, Criterion Broadcast Services. Baun's previous national involvement with the Society has included serving as its Vice President for two terms. He has also been a member of the Board of Directors and Chairman of the Chapter Liaison and Industry Relation Committees. Baun has been a member of the SBE since 1976 and is a Certified Professional Broadcast Engineer. He was named SBE's Engineer of the Year in 1992.

Edward J. Miller, CPBE, Engineering Manager of WEWS-TV 5 Scripps Howard, of Cleveland, Ohio was elected Vice President. Miller has most recently served SBE as a member of the Board of directors and as Chairman of its Sustaining Membership Committee.

Elected Secretary of the Society was Martin "Sandy" Sandberg, CPBE, and engineering consultant in Dallas, Texas. Sandberg has been a member of the SBE Board of Directors and has chaired its By-Laws and International Committees. He is a charter member of the SBE.

Troy D. Pennington, CSRE, Chief Engineer of WZZK-AM/FM, WODL-FM in Birmingham, Alabama, was elected Treasurer. Pennington has served on the Board of Directors and has been chairman of the Finance and Awards Committees.

Elected to two year terms on the Board of Directors were: James T. Bernier, CSTE, Director of Station Operations, WTVH/Granite Broadcasting, Syracuse, New York; Marvin Born, Vice President of Engineering, Dispatch Broadcast Group, Columbus, Ohio; James "Andy" Butler, CSRE, Communications System Engineer, Public Broadcasting Service, Washington, D.C.; Richard L. Edwards, CPBE, President, TowerCom Ltd., Ft. Lauderdale, Florida; Robert Reymont, CPBE, Director of Radio Engineering, Nationwide Communications Inc., Mesa Arizona; and Larry J. Wilkins, CPBE, Director of Engineering, Colonial Broadcasting, Montgomery, Alabama. Filling an unexpired term on the Board is W. David Johnson, CBT, Audio Visual Supervisor, CompuServe, Inc., Columbus, Ohio.

— From SBE National, John Poray, CAE, Executive Director —

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Oops . . . A Special Editorial Note:

In last month's October-95 issue, a "Technical Trilogy," on page 3, was attributed to John Stortz. That was incorrect, as the true author of the article pointed out to me.

Mike Langner, of KHFM/KHFN, Albuquerque, New Mexico, let me know that, unless someone else was living his life over again, he was the actual author of the article.

Sorry Mike . . . and John. We'll try to keep our stories — and authors — straight from now on.

Of course, now we have to decide which one gets a "prize." I think it's only fair to let them both have one . . . right?

Ray Topp (publisher)

Allied Expo '95 to Feature Workshops, Seminars, Equipment Exhibits, and More.

Harris Allied will sponsor Richmond Expo '95, a two-day event, combining equipment exhibits, seminars, and workshops, December 4-5 at the Leland Hotel in Richmond, Indiana.

The annual event will feature a variety of activities for broadcast engineers, management, programmers and producers. Participants scheduled to appear include: John Battison, P.E.; Eric Rhoads, publisher of Radio Ink; Geoff Mendenhall, VP/radio RF product line manager for Harris Allied; John Riser of the FCC; Jay Rose, producer and Orban DSE-7000 expert; and Jerry LeBow of Sage Alerting with the latest on EAS.

In addition to free continuing education programs, technology demonstrations and equipment exhibits, Harris Allied will provide lunch and dinner on December 4 and lunch on December 5. Reservations will be required. A complete schedule of special hotel rates, and Expo '95 reservations forms, are available by phoning Harris Allied's Broadcast Center in Richmond at 800-622-0022.

The RCA BTF-1D and the Plate Multipliers

Mike Callaghan — Glendale, California [mike@hottips.com]

In 1972, when I owned part of KEWE, in Camarillo, CA, we were using an RCA BTF-1D. This is a single tube transmitter that used a 4CX-1000 tetrode to boost the 10 watts out of the exciter to somewhere around 1,000 watts into the antenna.

For weeks, all the readings from the remote control were normal, but if you stood in front of the transmitter, the Plate Voltmeter read "0." Obviously, there was a problem with the Plate Voltmeter . . . I mean, there was plate current and power output, so the plate voltage *had* to be there.

RCA used to build up the plate multiplier resistor out of a bunch of small resistors, and connect them all in series on a P.C. board. The connections at the end of these would fail. The easiest way to find the open connection was to bypass all the interlocks in the transmitter, turn off all the lights in the room, and then run the transmitter with the doors open. Then you'd look for a tiny blue arc on the end of the resistor with the bad connection. Once you had found it, you'd fix your eyes on that spot, and someone else would turn the lights back on so you could see which resistor it was.

A friend of mine, Dennis Dreier, and I went up to the mountain to tackle the problem. We shut the station off, opened the doors, and started bypassing the interlocks. I used a block of wood and electrical tape for the low voltage interlocks, and, having nothing else, a pack of Marlboro 100's to hold open the high voltage shorting bars.

The time had arrived. We were ready. After rechecking the interlocks, I put Dennis behind the transmitter, and switched off the lights. "Dennis, are your eyes getting used to the dark?" "Yep..." "OK — remember what you want to look for is a tiny little blue glow." "OK" Dennis sounded impatient to get started. The filaments warmed up... "OK, Dennis here we go, now watch *real* close..."

I turned on the plates. There was a click, and then a hum... and then suddenly BOOM!!! This incredible explosion and a huge flash of light filled the room. The transmitter was still going "Klanga, Klanga, Klanga" as it tried to come up.

I ran to turn on the lights and pull the breakers. The room was still filling with smoke. "Dennis, are you all right?" I heard nothing but a stony silence. Scared to death, I walked around behind the transmitter and there was Dennis leaning back against the wall, his pupils the size of saucers.

Monstrous clouds of thick grey smoke were coming from inside the transmitter. I looked in and saw burning Marlboros everywhere. And not just lit at the end — these were burning all along their length at once.

I'd forgotten about the gold foil inside the cigarette pack. When the high voltage came up and punctured the paper wrapper, the foil had vaporized and torched all 20 Marlboros at the same time.

It took us a good half hour to clean the filters, wrappers, and ashes out of the transmitter. And you can bet that the *next* time someone looked for the "little blue arc"... it was going to be *me*! RG

An Introduction to Directional FM Antennas

Jim Somich — Radio Engineering Services, Broadview Heights, Ohio [216-546-0967]

Directional FM antennas are used in short-spaced allocations where it is necessary to direct power away from another station's protected contour. In some cases, directionals are also used to direct power away from large bodies of water, etc., and re-direct it over useful coverage area.

Technically, all FM antennas are directional to some degree. This is due to the fact that FM antennas are mounted on some structure. Unless that structure is made of a non-conductor, such as wood, some pattern distortion, or directionalization is realized.

This secondary form of directionalization is not recognized by the FCC. Because of this loophole in the rules, some stations are able to maximize coverage toward an area of interest by actually exceeding their licensed ERP in one direction.

This can be accomplished by measuring an omni-directional antenna when mounted on various structures and using this information in determining antenna orientation.

A licensed directional FM antenna is specified by the consultant when short-spacing demands protection of another stations contour. A licensed directional antenna cannot exceed the licensed ERP in any direction. Because of this fact, it is not usually desirable to specify a directional antenna unless absolutely necessary.

The horizontal radiation of any FM transmitter antenna can be distorted by adding parasitic elements to the antenna array. These parasitics can take many forms, but are usually horizontally mounted rod elements mounted just below or behind the driven antenna bay. The parasitics, as their name implies, receive no power from the transmitter. Rather, they absorb power from the system thereby distorting the circular radiation pattern.

The vertical radiation pattern can be distorted by varying the mounting distance between the bays and the mounting structure (pole or tower).

FCC Requirements

A directional antenna is an antenna that is designed or altered for the purpose of obtaining a non-circular radiation pattern. Applications for the use of directional antennas that propose a ratio of maximum to minimum radiation in the horizontal plane of more than 15dB will not be accepted.

Directional antennas used to protect short-spaced stations, that have a radiation pattern which varies more than 2dB per 10 degrees, will not be authorized.

Scale vs. Full-Size Measurements

It is possible to develop a directional pattern using one or more full-sized bays. Some engineers feel this is more accurate than scale modeling. But antenna engineers have been successful in producing excellent full size patterns by using testing range antennas substantially smaller. One manufacturer uses one-quarter scale antennas (at 4X the licensed frequency) and achieves excellent results.

It is also possible to directionalize an antenna purely through calculation and transferring this data to the full-sized antenna. This method is more popular in Europe where large antenna ranges are not common.

Scale model testing allows the manufacturer to utilize a much smaller antenna range. Ground effect is also minimized because the ground can be up to four times closer to the antenna than when the bays are full-size. Interference from on-air FM stations is also not a problem with scale testing because the frequencies used are much higher.

The Process

The engineering consultant will specify a theoretical pattern that will satisfy the Commission with respect to protecting the contours required. This pattern will be plotted on polar paper and tabulated over 36 or more radials in both the horizontal and vertical polarizations.

It is then the job of the antenna manufacturer to duplicate the theoretical pattern as much as possible. In reality, the real-world pattern may look substantially different from theoretical but it must still meet certain criteria to be accepted for licensing:

1) Horizontal radiation must not exceed the ERP of the station in any direction.

2) Vertical radiation must not exceed horizontal radiation.

3) The maximum allowable radiation on any radial must not be exceeded.

4) The practical antenna must exhibit an RMS power average not less than 85% of theoretical. That is, when you average the field in all radials, horizontal and vertical in both the theoretical antenna and the practical antenna, the practical must be at least 85% of the theoretical value. This assures that the antenna will be efficient.

An application for a directional antenna must include:

1) A complete description of the proposed antenna system, including the manufacturer and model number of the proposed directional antenna.

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Directional FM Antennas

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2) A relative field horizontal plane pattern of the proposed antenna. A single pattern encompassing both the horizontal and vertical polarization is required, rather than separate patterns for horizontal and vertical patterns.

A value of 1.0 must be used to correspond to the direction of maximum radiation. The plot of the pattern must be oriented such that 0° corresponds to the actual azimuth with respect to true North.

3) A tabulation of the relative field pattern. The tabulation must use the same zero degree reference as the plotted pattern and must contain values for at least every 10°. In addition, tabulated values of all maximas and minimas, with their corresponding azimuths must be submitted.

4) Sufficient vertical patterns to indicate clearly the radiation characteristics of the antenna above and below the horizontal plane. Complete information and patterns must be provided for angles of +/- 10° from the horizontal plane and sufficient additional information must be included on that portion of the pattern lying between +10° and the zenith, and -10° and the nadir, to conclusively demonstrate the absence of undesirable lobes in these areas.

See 73.316 for other requirements that apply to directional antenna systems.

The manufacturer of the directional antenna will provide a proof of performance document that meets the requirements of 73.316, but it is still important for you to understand the Commissions' requirements.

Antenna Pointing

The azimuth of the directional antenna will be specified by the antenna manufacturer to achieve the required pattern. It is vital that a surveyor be employed to certify that the pointing is correct. An affidavit from a licensed surveyor is required as part of the licensing of the directional antenna.

The surveyor will do a sun-sighting or polaris-sighting to determine true North. Later, when the antenna is being installed, he will use this information to sight the new antenna and direct it's orientation correctly. It is desirable to mark the front of the antenna with black dots or some other target for the survey to sight.

E-Mail Your Tech Tips to:
radio@broadcast.net

Applying For Your License

Once you have your antenna mounted properly, collect the antenna proof (from the manufacturer), the surveyor's certificate, and a statement of your qualifications. Submit these exhibits along with a properly completed 302-FM and the required fees.

Equipment tests may be conducted during the experimental period while waiting for your Program Test Authority. Program test authority is not automatic when a directional antenna is specified.

Coverage Confirmation

Some antenna manufacturers will provide a Received Signal Level Map as part of the antenna proof. This is a computer generated map that considers terrain in calculating the RSL likely to be received within a specified radius of the antenna. This is very useful when "driving the antenna."

When coverage does not meet expectations, the RSL map can often confirm or deny a problem within the system vs. terrain, height or power deficiencies. RG

Unattended Operations — Electrical Safety

John Bredesen — Chief Engineer, KLCC, Eugene OR [503-726-2224 or e-mail jab@efn.org]

Past articles in **Radio Guide** have detailed the new EAS alerting system along with the implementation timetable. We've passed the first deadline (July 1st) which required modification or adjustment of existing EBS decoders in order to respond within 3-4 seconds. The next deadline *was* to have been July 1, 1996, at which time new EAS equipment was be installed. However, according to a Report (DC 95-128), issued by the FCC October 16th, the date for equipment installation as been delayed until January 1, 1997. It's probably a good thing because, to my knowledge, there is no equipment available a short 7-8 months before everybody was to have it installed!

Additionally, *''Upon review, the Commission declined to incorporate the RBDS in the EAS rules. The Commission also declined to make modifications to the FM broadcast rules to accommodate RBDS...''*

In another Report (DC 95-123): *''The FCC has waived its rules in order to permit unattended operation of broadcast stations and to update broadcast station transmitter control and monitoring requirements.*

Specifically, pursuant to Section 318 of the Communications Act of 1934, as amended, the Commission waived the requirement for duty operators at broadcast stations. Further, the Commission eliminated the need for station operators (where optionally employed) to hold the Restricted Radio Telephone Operator Permit (RP); and updated the rules relating to transmitter monitoring to bring them up to date with respect to the capabilities afforded by modern electronic technology.

The Commission noted that in many areas of broadcast operation, automation is seen as affording more accurate and controlled operation than that performed by humans. Additionally, unattended operation is seen as permitting the more effective use of financial resources to enhance other station operations and services. Such operations, the Commission stated, is seen as potentially improving the viability of financially marginal stations.

The Commission stated that the new Emergency Alert System (EAS), unlike the EBS, is designed for automatic operation and therefore does not require human involvement. However, because of the numerous petitions for reconsideration of the EAS Report and Order, the availability of EAS equipment has been delayed. The Commission believes it should afford licensees the maximum possible latitude in satisfying present EBS and future EAS responsibilities, having in mind the ingenuity that can often be brought to bear in resolving such problems.

Accordingly, the Commission will permit unattended operation in advance of implementation of the EAS, provided that licensees implement an effective method of complying with current EBS requirements and responsibilities. The Commission cautioned licensees that the implementation of an informal method or methods of automating the EBS is not a substitute for implementation of the EAS. The Commission encouraged licensees who currently participate in local EBS alerts to continue to do so through whatever means they may employ to partially or fully automate their EBS functions.''

ELECTRICAL SAFETY

Every broadcast engineer is in a potentially dangerous profession because of the day to day proximity to, and the need to work with — you guessed it — electricity: that invisible force which moves a large part of our society, runs our breadmakers, wrist watches and CD players. The force that provides us with a livelihood. The force that will kill you if you become careless.

I became aware of the physical feel of this force at age three, when I stuck my finger in an empty light socket (at least according to my Grandmother. I've been zapped several more times in my three score years, and it's not pleasant. But I probably don't have to tell you that. Let's look at some of the ''whys'' of the dangers in our trade.

Our bodies are complex electro-biological miracles, and one of the primary dangers in our business is related to the ''electro'' aspect. Electrical signals are transmitted electro-chemically throughout our bodies via nerves. If anything interferes with these signals, either internally or externally, it can be fatal. Arguably, the most vulnerable organ to electrical shock is the heart, mainly because in order to work properly, it must ''beat'' in a very organized manner.

When that beat is upset by an outside influence, such as by electrical shock, the heart muscles no longer work as a team to pump blood, but rather individually contract, or twitch. That event is known as ventricular fibrillation, and in most cases will continue until resuscitation efforts are made. If the resuscitation is not begun within minutes, death will result.

Years ago, studies were performed to determine what magnitude of electrical currents are necessary to cause injury or death. Ohm's Law appears in the equation because the amount of current through a conductor, in this

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Electrical Safety

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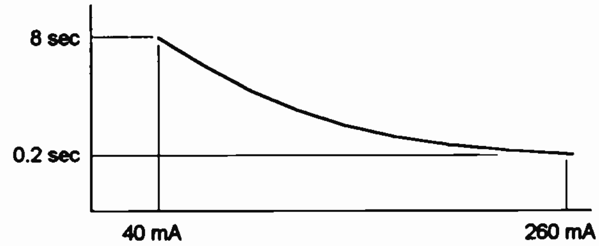
case the human body, depends upon both the resistance of the conductor, and the applied voltage. These studies have shown that the resistance of the body (measured from hand to hand) range, under ordinary conditions, from 500 ohms to over 600K ohms, depending on several factors, such as the moisture on the surface of the skin, muscular build, and interestingly enough, the applied voltage. It seems that higher voltages can break down the surface of the skin, reducing the resistance very quickly after the application of the offending voltage.

Anything which lowers the resistance to the skin results in increased current for a given voltage. I suspect most of you will work around the 12 volts in your car or in a small solid state device without a thought of getting a shock. My threshold to detecting the telltale tingle of a shock is about 25 volts under normal conditions. Yet if you touch the terminals of a 9 volt battery to your tongue, you sure can feel it. Perhaps it's because the tongue is more sensitive to current, but I suspect it's also because the saliva acts as an electrolyte and greatly reduces the resistance. I can recall reading years ago that the record *low* voltage to cause the death of a person was about 10-12 volts, perhaps even lower. This person worked in a plant where electro-plating was done and he fell into a vat of electrolyte. There are no absolutes when it comes to electrical danger.

One very practical piece of advice I can give you is to REMOVE all rings, watches and other metallic adornments BEFORE beginning work around potentially lethal voltages. It's quite common for the skin under a ring or watch band to be moist from perspiration. When you combine that with the fact that these metallic surfaces are relatively large, you have the makings of a disaster if you should contact a voltage source.

I have also read that 120 VAC, the stuff we deal with everyday at home or at work, is the most lethal voltage there is because more people in the North American continent are killed by that voltage than any other. That is undoubtedly true, since more people are killed by 120 volts because of how *common* it is, not necessarily because of how *lethal* it is compared to other voltages. But it is still a statement worthy of our attention. Because it is so common, it's supremely easy to become careless when working on the bench or within a piece of equipment where the highest voltage is "only 120 volts." The advent of solid state equipment, with its attendant low operating voltage, sometimes makes us forget that there is apt to be 120 volts to the primary of the step-down transformer in the power supply, and probably a fuse and on-off switch, also with exposed 120 volts. (This is the one redeeming factor for these disgusting "wall warts" which seem to be proliferating like rabbits on equipment where the manufacturer is too cheap to put in a real power supply!)



Electrocution Threshold (Adult)

The graph above shows the "time/current" effects on the body. According to the curved portion, electrocution can occur as quickly as 200 milliseconds with about 260 milliamps applied, or as long as 8 seconds with a mere 40 mA. (260 mA is less than the current drawn by a 40 watt light bulb!) If a hand to hand resistance of 3000 ohms is presented to 120 volts, a current of about 40 mA will flow through the body.

Where the current flows in the body has a great deal to do with how lethal it is. Note that the graph is for a hand to hand application which results in current flowing through an arm, through the chest cavity, to the other arm. The heart is directly in that path. Also potentially very lethal is a current path from an arm to the opposite leg, which, once again, will result in current passing through the area occupied by the heart. Numerous instances have been reported of persons coming into contact with quite high voltages, with the resulting high current, and surviving. It's quite probable that electrocution didn't occur because the current path didn't involve the chest cavity, but rather a single arm or leg. Severe burns or loss of a limb are apt to be the result of that exposure.

There is another interesting danger when working around exposed voltage. When a current flows through a muscle, it causes the muscle to contract. Current flowing through an arm will cause the muscles controlling the fingers to contract, which in turn will cause the fingers to grip the conductor if initial contact is made with the inside of the hand! Tests have shown that a current as small as 10 ma will result in some persons not being able to voluntarily release their grip, and 15 mA results in 50% not being able to release their grip! The moral here is to approach a live conductor, if possible, with the back of the hand, as silly as that scenario seems. It could save your life.

We'll explore this subject of electrical safety more next month.

Meanwhile, I wish you a happy Thanksgiving! RG

1+1+1 = 3 (Sometimes)

Gordon Carter— C.E., WFMT, and Owner, Professional Audio Services [312-565-5032]

Over the past several months the radio station I work for has been building a new studio facility. This is a totally new portion of a building, built to our specifications. Most of the equipment is also new. This has taken up most of my time, making it impossible for me to have time to write for this publication. On the other hand, it has given me quite a few ideas that will appear on this pages in the future.

One of the more interesting problems we have encountered during this project involved one of our consoles. First, some background.

The station I work for is a classical music station in a major city (if you must know which one, look at the credits). In addition to playing pre-recorded music, we also produce and distribute a number of programs for use by other stations. One of the mainstays of our facility, for years, has been a music performance studio. When we elected to move, it was decided early on that we should have such a space (bigger and better if possible) at our new location. In order to use such a studio we need a large recording console. This console is the one we are discussing in this article.

After the construction was completed we began installation of the equipment, one room at a time. When the wiring for the control room that services the performance studio was complete, we began to check everything out. The console was new and had been fully tested at the factory before delivery, so we expected that the only problems we would find would be some random errors in the interconnecting wiring. As we began testing, we noticed that the hum level of the console was considerably higher than anticipated. As we began to eliminate possibilities, we found that the hum was present when no faders other than the master were open. We immediately began to suspect either a problem in the console or a grounding problem.

We designed the facility with an eye toward providing proper power and grounding to eliminate or reduce hums and ground loops. Power was separated into utility and technical supplies. The utility power is for lights and convenience outlets and is derived from the three-phase mains in the normal manner, with every third breaker working from the same phase. The technical power has its own step-down transformer; the primary is three-phase and the secondary is 110 volt single phase. All outlets on the technical power have isolated grounds, with a separate #10 ground wire feeding a ground buss at one point only.

To check out the problem with the console, we began disconnecting everything from the console that was possible. We finally had nothing connected to the console but the test equipment. We made sure it was plugged into the same outlet and tried every grounding trick we could think of. Nothing made any difference.

We took a break, and when we came back the hum was gone. Further testing would not make it return. A while later, with no warning and no inducement from us, the hum returned. Then, because we had no better idea, we tried plugging the console into the utility power. Surprise! The hum level went down, but was not gone. This was an improvement but it wasn't right.

We called the console manufacturer and they sent out a technician to look at the console. He tried a number of tricks, including replacing the output module, but nothing worked. We continued to investigate the problem, but nothing seemed to work. The hum would come and go when it wanted to, but we could do nothing to influence it. We even tried shielding the console with a large piece of steel, but nothing worked.

By now we had moved into the new space. The staff was in their offices. We had shut down the old facility and were operating from the new (albeit incomplete) facility. Time was rapidly moving to the day when we were scheduled to have our first live broadcast from the new studio and we still didn't have this hum problem licked. We were just about to the point where we would have to use it, hum and all, and deal with the problem later. Not exactly what we wanted to do, but probably better than nothing.

Then, as we were once again trying to see what was happening, the hum level changed right before our eyes. Out of the corner of my eye I noticed that someone had turned on the lights in the performance studio just as the hum level changed. While this wasn't much to work with, it was a start.

We made a study of the influence the lights had on the hum level. The lights in the studio are on four circuits. Each circuit contains nine to ten, 150 watt bulbs in ceiling fixtures. We did not put any dimmers anywhere in the studio, to eliminate the possibility of buzz generated by the dimmers. As we tried various combinations of the four circuits on and off, we found that different combinations created different but predictable hum levels. In fact, one combination of two circuits on and two off was just as good as having all the lights off.

This data led us to believe that the problem was somewhere in the wiring of those light fixtures. We investigated the electrical panel and found that one circuit was

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1+1+1 = 3 (Sometimes)

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on phase A, two were on phase B, and one was on phase C. Two circuits were on the first set of breakers and two were on the second set. When the two on phase B were on the hum level was as low as if none were on. We checked the circuits with an Amprobe clamp-on current meter. The current through the neutrals did not match the circuits that were turned on. We then checked a little further with the Amprobe and found that the *metal conduits* carrying the wiring for those lights registered over 10 Amps of current when the lights were on.

We then contacted the electrical contractor who wired the facility. This contractor is experienced in broadcast installations and recognizes the importance of proper grounding for audio and video equipment. When I showed him the results of our testing he confirmed that something was not right. In our conversation he indicated that this was more common that one would like, but would easily pass electrical inspection (it already had). When he checked it out, he found that when it was wired the neutrals were reversed.

The electrical codes allow for a common neutral for the three phases of an electrical panel. In other words each set of three breakers can have one neutral. You can get away with this because of the phase relationship of the three phases.

The total current through the neutral actually decreases as the current in the three circuits becomes more nearly equal. However, the neutral should be in the same conduit as the three hot wires. Since the current drawn by the hots is being returned in the neutral, the total magnetic fields should cancel.

In this case the neutral for the first set of breakers was in the conduit with the hots for the second set and the neutral for the second set was in the conduit with the first set. Since they were reversed, the magnetic fields would not cancel and current was then being induced into the conduit.

The conduits were connected to the structural members of the building and this was apparently creating hum everywhere. I am not sure exactly how this was all getting to the console, but reversing the neutrals corrected the hum.

Now that you have read this you are probably wondering what it all has to do with normal day-to-day engineering at a normal radio station. Perhaps nothing, but perhaps everything. First of all, if nothing else, this is a good example of diagnostic troubleshooting.

Yes we did have a lucky break by noticing that the lights were affecting the hum, but that only made the process faster.

A few specific applications:

1. Never assume that something will work right just because it is new or has been checked out by the manufacturer. In this case the equipment was fine, but we would not have known there was a problem had we not been checking out everything. Of course, someone would probably have noticed when it would have been the most embarrassing.

2. When you are looking for the cause of a problem, assume nothing. Had we assumed that the electrical wiring was right, we would not have found the problem.

3. Use every clue available, even though it may not make sense at first. The fact that the hum was lower on the utility power than on the technical should have told us to check out the electrical wiring more closely. We looked at the grounding, but didn't check the neutrals or hots. Had we done that we could have saved some time.

4. If you aren't familiar with the local electrical codes or the theory of three-phase power, learn it. Knowing how AC three-phase power works enabled us to find the cause of the problem. While our electrical contractor did not give us any problems, knowing the electrical codes would have given us some leverage had we needed it.

I hope this experience will help save you from wasting a lot of time on your next troubleshooting problem. RG

FCC Waives Rules: Permits Unattended Operation

As Obtained From the FCC Internet Web Site — http://www.fcc.gov

Report No. DC 95-123, Action in Docket Case, 10/06/95 Commission Waives Rules to Permit Unattended Operation of Broadcast Stations; Updates Broadcast Station Transmitter Control and Monitoring Requirements (MM Docker No. 94-130)

The FCC has waived its rules in order to permit unattended operation of broadcast stations and to update broadcast station transmitter control and monitoring requirements.

Specifically, pursuant to Section 318 of the Communications Act of 1934, as amended, the Commission waived the requirement for duty operators at broadcast stations. Further, the Commission eliminated the need for station operators (where optionally employed) to hold the Restricted Radio Telephone Operator Permit (RP); and updated the rules relating to transmitter monitoring to bring them up to date with respect to the capabilities afforded by modem electronic technology.

The Commission noted that in many areas of broadcast operation, automation is seen as affording more accurate and controlled operation than that performed by humans. Additionally, unattended operation is seen as permitting the more effective use of financial resources to enhance other station operations and services. Such operations, the Commission stated, is seen as potentially improving the viability of financially marginal stations.

The Commission stated that the new Emergency Alert System (EAS), unlike the EBS, is designed for automatic operation and therefore does not require human involvement. However, because of the numerous petitions for reconsideration of the EAS Report and Order, the availability of EAS equipment has been delayed. The Commission believes it should afford licensees the maximum possible latitude in satisfying present EBS and future EAS responsibilities, having in mind the ingenuity that can often be brought to bear in resolving such problems.

Accordingly, the Commission will permit unattended operation in advance of implementation of the EAS, provided that licensees implement an effective method of complying with current EBS requirements and responsibilities. The Commission cautioned licensees that the implementation of an informal method or methods of automating the EBS is not a substitute for implementation of the EAS. The Commission encouraged licensees who currently participate in local EBS alerts to continue to do so through whatever means they may employ to partially or fully automate their EBS functions.

Action by the Commission October 2, 1995, by Report and Order (FCC 95-412). Chairman Hundt, Commissioners Quello, Barrett, Ness, and Chong.

News Media contact: Patricia A. Chew at (202) 418-0500.

Mass Media Bureau contact: Jim McNally at (202) 776-1671.

FCC Rules on Kahn POWER-side™

Motorola tried to deny broadcasters the right to increase coverage by using SSB — Kahn POWER-side™ equipment. But the FCC specifically ruled that the "Kahn POWER-side system ... may continue to be operated ..." as a mono improvement system. So you can now use POWER-side with Kahn independent sideband exciters to immediately increase coverage to listeners using any and all type of AM receivers.

Federal Communications Commission FCC 93-485:

21. Kahn "POWER-side" Operation. Several parties express concern over the continued acceptability under our rules of operating using the Kahn POWER-side AM single-sideband system. POWER-side operation, as distinct from Kahn stereo operation, involves an AM transmitter with two independent sidebands, containing identical program material, but with intentional level and frequency response differences. This system is implemented with a Kahn independent sideband stereo exciter and is claimed to have certain advantages for reception with monophonic receivers, particularly in adjacent-channel interference situations. CTI and Furr argue that adoption of the proposed standard would prohibit such an implementation. Motorola maintains that the Kahn POWER-side mode of operation is not stereophonic and questions its legality under the present rules.

22. Our AM rules do not include a definition of the term "stereophonic." However, generally accepted definitions of stereo service infer two or more channels of audio information designed to produce and audio "image" when demodulated by an appropriate receiver. On this basis, we find that stations employing the Kahn POWER-side system are not subject to the provisions of the stereophonic transmitting standard adopted herein and may continue to be operated, provided that the program material fed to both channels of the exciter is identical in content.

Preparing Your Station for DAB

Andy Butler — B&G Consultants, Annandale, Virginia [703-739-5474]

I've long admired **Radio Guide** for its clear minded editorial policy: "If the information won't be useful to a working engineer in the very near future, it doesn't belong in the magazine." I was a little surprised when Ray asked me to start writing some columns about DAB/DAR. It's interesting stuff, but that cake is far from baked! After some discussion, I saw his point.

We can't plan the future of our facilities or coach our clients on their plans if we don't know what's coming. To serve that goal I will try to avoid discussing the intriguing infighting and posturing that is at the core of the DAB contest and concentrate on the things you can do today to get ready.

Is DAB really coming? I think the answer is yes. The efficiency of digital transmission is too powerful to be ignored. Setting aside the audio quality improvement evident in all of the AM and FM systems, the ability to transmit additional audio services and the extended data capacity most systems support are more than sufficient motivating forces to drive the technology. The question isn't "will it happen" but "which technology" and "when."

It seems that I should be able to add at least one of the systems to my existing signal without having to get FCC approval? From a strictly technical viewpoint that might be true for at least one of the In-Band, On-Channel methods, but unless Congress makes some very unexpected changes in the revised Communications Act legislation you will need to license any new services. The FCC is still charged with insuring that scarce spectrum resources are used "in the public interest."

In the latest Advanced Television Notice of Proposed Rule Making, the Commission has reaffirmed its belief that this requires that they evaluate each potential use for every capability in a given spectrum space. At a minimum they will want to know exactly what services you plan to deliver and who would benefit from those services.

In some cases they may extract a spectrum usage fee for any portion of your signal that is not available directly to the general public.

How soon will I need to budget for DAB? At this point it is very difficult to predict. The EIA/NAB laboratory testing has been completed but there are some questions about the results of some tests for inband systems. Field tests were expected to begin in San Francisco in September but due to a number of logistical problems it now appears that they may not get started until November or December. This situation is further complicated by the impending sale of the station that is the host site for the tests, to an owner that is not expected to support the testing. If the tests cannot be finished, they would all have to be repeated in a new location.

Assuming the tests can be completed, the results would be reported to the sponsoring organizations near the end of the first quarter of 1996. If the results are conclusive, the sponsoring committees might be able to make recommendations to the Commission by the middle of 1996. At that point the Commission could begin the necessary rule making. Issuing the required notices then, taking and processing comments, would typically take a year to eighteen months. This would place the first opportunity for most broadcasters to apply for the new service in the fall of 1997.

This timetable is optimistic. It is very likely that the process will take longer. We'll take a little longer, too. Next month we will consider the changes you may have to make to successfully "host" DAB at your station(s). RG

ISDN for Broadcasters — Part 3

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A Glossary of Terms

ADPCM - *(Adaptive Differential Pulse Code Modulation)* - Popular technique for audio data reduction. Future digital audio samples are predicted based on past performance, and difference between predicted and true value is transmitted. Basis of G.722 and APT-X algorithms, this coding process produces high quality with very little time delay.

Aggregation - The process of compensating for differential delay between two digital phone channels (see inverse multiplexing).

Algorithm - A sequence of steps, like a recipe, to process audio. Usually run on a DSP chip, algorithms are most often based on audio data reduction standards like G.722 or ISO/MPEG Layer II.

apt-X - Proprietary ADPCM algorithm popular among codec users.

Analog - When referring to a telephone signal, analog signals alter some aspect of themselves (usually amplitude) to represent changes in what they represent. They also change level continuously, moving through an infinite number of intermediate values as they do so.

Asynchronous - Type of data transfer where no clock is provided between sender and receiver. Usually requiring overhead data for stop, start, and parity functions, this type of transfer is most suitable for the speeds below that of ISDN, like those on a serial port of a personal computer.

BER - *(Bit Error Rate)* The quality gauge of a digital telephone channel. Determines, on average, the ratio between bits which will be transferred correctly, and those that will be transferred in error.

B channel - On ISDN, this is the user channel which may be used for voice, data, or packet data. The channel runs at 64 kb/s and is full duplex. BRI ISDN contains two "B" channels.

BONDING - *(Bandwidth ON Demand Interworking Group)* -A standard for inverse multiplexing incorporated by terminal adapter manufacturers. Aligns two or more "B" channels to achieve a higher data rate channel.

BRI - *(Basic Rate Interface)* - The most common configuration of ISDN, allowing the user two independent "B" channels and a slower speed "D" channel for signalling.

Bitrate - The speed of a digital telephone channel in bits transferred/second.

Central Office - *(CO)* The telephone company facility located at the end of your local loop. Usually contains a switch connected to trunks.

CSU/DSU - The device located on the user end of a DDS or SW56 link. It buffers data on and off the line, and provides diagnostic functions for troubleshooting, as well as dialing functions for switched services.

Carrier System - Used by the telephone company within their network to transfer multiple, independent channels on a single physical medium, like a wire or fiber optic cable.

Circuit Switched Data - The capability of a digital telephone channel to provide a steady throughput of data, using the same digital channels it uses to carry voice along its network. CSD calls may be established to different locations for different lengths of time, just like voice calls.

Centrex - A service often bundled with ISDN allowing for a private branch exchange without special user telephone equipment. A Centrex user gets his own outside phone number, but may access other Centrex lines on his exchange with just a call to their extension.

Circuit Switched Voice - The most common use of the telephone network, this is the ability to place analog voice calls. One of the capabilities of ISDN.

Channel Bank - The device on the end of a T1 carrier link, it multiplexes voice and data channels onto and off of the carrier.

Codec - *(COder/DECoder)* - For our purposes, this is the device which takes in audio, runs it through a compression algorithm, and outputs data for connection to a telephone network. Also, takes data from the network and converts it back to audio.

Compression - Another term for Digital Audio Data Reduction. Taking digital audio and removing redundant or non-perceived information in order to reduce the amount of data for transfer over digital phone lines.

CPE - *(Customer Premises Equipment)* - That equipment attached to the phone line which is located at the user's site.

"D" channel - On ISDN, this is a 16 kb/s digital link which is multiplexed along with the "B" channels. Mostly used for overhead functions like dialing and signalling, some ISDNs are capable of carrying Packet data on it as well.

DCE - *(Data Computer Equipment)* - Devices (like CSU/DSUs and TAs) which interface DTEs to digital telephone circuits.

DS0- Telephone company term for an individual digital channel (64 kb/s) running along their trunks.

DTE - *(Data Terminal Equipment)* - Devices (like codecs) which are connected at the end of the digital link, behind the DCE.

Data Rate - *See Bit Rate*

Data Reduction- *See Compression*

Demultiplexing - The process of taking individual data out of a multiplexed data stream at the appropriate destination.

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ISDN For Broadcasters

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Digital - A signal which always maintains one of two discrete states. Information may be encoded onto it using techniques like PCM. Digital signals are inherently resistant to the effects of noise in telecommunications channels.

Digital Signal Processing - *(DSP)* The process of taking signals which have been sampled at discrete times and quantized, and performing functions which are difficult or impossible in the analog domain. These functions are usually performed on fast, efficient DSP Processing chips.

E1 - The European equivalent of T1, this is a carrier system which allows 30 digital voice channels to be multiplexed on a single medium.

Euro-ISDN - ISDN, when implemented in Europe, was originally implemented differently in each country. Euro-ISDN is an attempt to standardize and remove these differences, allowing terminal equipment to operate in different countries.

EIA-530 - Protocol for transferring data between TAs (or CSU/DSUs) and codecs. Used on all Comrex codecs. Easily adaptable to the other common standards, V.35 and X.21.

Feature group D trunks - Name given by telephone companies to trunks designed primarily to carry Circuit Switched Data.

Four wire - Usually referring to a switched 56 or DDS line, this type of circuit uses a separate wire pair for sending data and a separate pair for receiving

G.722 - An audio coding algorithm (and international standard) which allows 7 kHz audio transmission on a 56 or 64 kb/s digital channel. Very popular for commentary due to its low cost and high deployment.

H.221 - An international standard allowing for synchronization of digital audio and video services on digital phone links. Also provides the ability to inverse multiplex.

ISDN - *(Integrated Services Digital Network)* - World-wide standard for digital telephony. Integrates voice communication with Circuit Switched and Packet Switched Data.

ISO/MPEG Layers II, III - Audio coding algorithms which provide wideband (15-20 kHz) mono or stereo audio on a variety of digital data rates at varying quality. Based on perceptual coding techniques, these algorithms determine what audio can be perceived by the human ear, and encode only those portions, thereby reducing data rate. Layer II is the most popular of these algorithms, implemented by dozens of manufacturers of ISDN equipment.

Inter-Lata - In North America, a call (analog or digital) which is placed between local telephone company's calling areas. These calls are usually handled by a long distance carrier, rather than the local phone company.

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Inverse Multiplexing - A form of multiplexing that synchronizes the data being transported so that they arrive in the same arrangement in which they were sent. Usually involves aggregation and monitoring of circuit integrity. i.e.: A 128 kb/s data stream can be divided to travel on two 64 kb/s "B" channels and then is rejoined to form 128 kb/s at the other end.

J.52 - An international standard for integrating H.221 inverse multiplexing into ISO/MPEG Layer II digital audio transmission. An attempt to remove incompatibility between manufacturers of Layer II codecs.

Lata - The geographic boundaries in the United States which determine which telephone company is responsible for the call. Inter-Lata calls are usually handled by Long Distance Carriers while Intra-Lata is usually handled by Local Exchange Carriers.

Local Loop - The pair of wires running from the telephone user to the telephone company central office. This may carry analog voice and signalling or, in the case of SW56 and ISDN, may carry digital information.

Loopback - The ability of a piece of equipment on a digital telephone channel to enter a test mode where it will echo any data sent to it in the reverse direction. Useful in troubleshooting digital links. When using audio codecs, users may use loopback tests to hear the audio they are sending into the telephone network.

Multiplexing - The process of combining multiple individual communication channels onto one physical medium. The T1 carrier system digitally multiplexes 24 channels (voice or data) onto a single pair of wires.

NT1 - The device which terminates an ISDN phone line at the users premises. In the U.S. this device is supplied by the customer, and is often built in to the terminal adapter. Outside the U.S., this device is supplied by the telephone company.

PABX/PBX - *(Private <Automatic> Branch Exchange)* An internal telephone system, usually owned by the user. Some modern PBXs are ISDN capable, allowing ISDN access to be routed easily around a building.

Packet Switched Data - Type of data transfer available on ISDN. While packet switching is not applicable to moving audio, it provides a more economical and sensible way of moving computer oriented data. Instead of creating a dedicated data path between the users, data is formed into "packets" and sent into the network with a destination address. Best analogy is that of the postal service, where small individual parcels are sent out with only an address attached.

PCM - *(Pulse Code Modulation)* - Most popular means for encoding audio into digital format. Samples taken at discrete times are quantized and converted to binary.

POTS - *(Plain Old Telephone Service)* - Acronym describing the analog loop based telephone system in use for years.

PRI - *(Primary Rate Interface)* - Larger format of ISDN, carrying 24 "B" channels and a "D" channel. Not widely available or directly applicable to digital audio applications.

Rate Adaptation - The ability of a piece of digital gear to adapt from one user data rate (i.e. the 64 kb/s "b" channel rate) to another (i.e. 56 kb/s codec speed), or from synchronous to asynchronous format and vice versa. Most terminal adapters and some CSU/DSUs are capable of rate adaptation according to international standards like V.110 and V.120.

Quantization - A function in the process of converting analog audio to digital, this step involves "rounding" the sampled value to the proper resolution.

RJ11/RJ45 - Connectors often used to terminate digital telephone services at user's premises. RJ-11 is familiar from analog phone service- a 6 pin modular connector with usually the center two pins in use. RJ-45 looks similar but has 8 pins available, usually with the center 4 in use.

RS232 - Electrical specification for single ended data transfer. Popular for computer serial ports, its unbalanced nature makes it a poor choice for use at ISDN speeds.

Serial Port - Physical connection on a computer, codec, or terminal equipment which allows for the transfer of serial data.

SPID - *(Service Profile IDentifier)* - This is a number used by your terminal adapter to access the "B" channels on ISDN. Usually provided by the phone company, this number must be entered into the terminal adapter before the ISDN can be used.

Switched 56 - Circuit Switched Data service available in North America. A precursor to ISDN, this service is still popular due to slow ISDN deployment in some areas. Switched 56 may interconnect with ISDN.

Switch - Central Office equipment which establishes the physical connection between users. Often ISDN users must program their terminal adapters with the type of switch located at their Central Office.

S/T interface - On ISDN, this is the physical interface after the NT1 and before the terminal adapter. Outside the U.S., this is the interface supplied by the telephone company, since they supply the NT1. In the U.S., since many terminal adapters contain an NT1, this interface may be contained with the TA's circuitry

Synchronous - Data transfer where clocks are run independently alongside data. This type of transfer is used often between terminal equipment and codecs.

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Polarity Measurement

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Tariff - In the U.S., this is a description of telephone services which is filed with regulatory agencies, including rates charged for these services. A service must usually be "tariffed" before it can be provided by the telephone company.

Terminal Adapter- The device on the ISDN line which allows the user to place calls, transfer data on and off the line, and perform diagnostic functions. TAs come with differing functions and capabilities, and their choice requires evaluation of the application.

T1 - Most common digital carrier system within the telephone company, T1 has the capability to digitally multiplex 24 channels onto a single medium, like a pair of wires. T1s may also be the backbone of a private network, like that between a company's corporate offices.

Trunk - Physical links between telephone company offices. Trunks vary from individual voice channels to T1 and more complex digital carrier systems.

Two Wire - Data or voice transmission which takes place in both directions simultaneously along a single pair of wires.

Voice calls - Calls placed on the telephone network (or on an ISDN line) for the sole purpose of transferring voiceband audio between the users.

"U" interface - Terminology for the physical interface at the user end of the ISDN local loop, before the NT1. In the U.S., this is the interface supplied by the telephone company when ISDN is installed.

V.35 - Standard for data transfer between terminal equipment and codecs. Usually implemented on large, 34 pin connectors, V.35 is somewhat outdated and is giving way to newer protocols, like EIA-530.

X.21 - Standard for data transfer between terminal equipment and codecs. Usually implemented on a 15 pin "D" type connector, this protocol is most popular in Europe.

Telephone Numbers

Phone Company	Information	Ordering
Ameritech	1-800-TEAM-DATA	1-800-TEAM-DATA
Bell Atlantic	1-800-570-ISDN	1-800-570-ISDN
Bell South	1-800-428-ISDN	1-800-858-9413
Cincinnati Bell	1-513-566-DATA	1-513-566-DATA
GTE-Contel	1-800-448-3795	1-800-448-3795
NYNEX	1-800-GET-ISDN	1-800-650-ISDN
Pacific Telesis	1-800-472-4736	1-800-472-4736
Rochester Telephone	1-716-777-4501	1-716-777-4501
Southern New England	1-800-430-ISDN	1-800-430-ISDN
Southwestern Bell	1-800-SWB-ISDN	1-800-SWB-ISDN
Sprint (Centel, United)	Try local office.	Try local office.
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