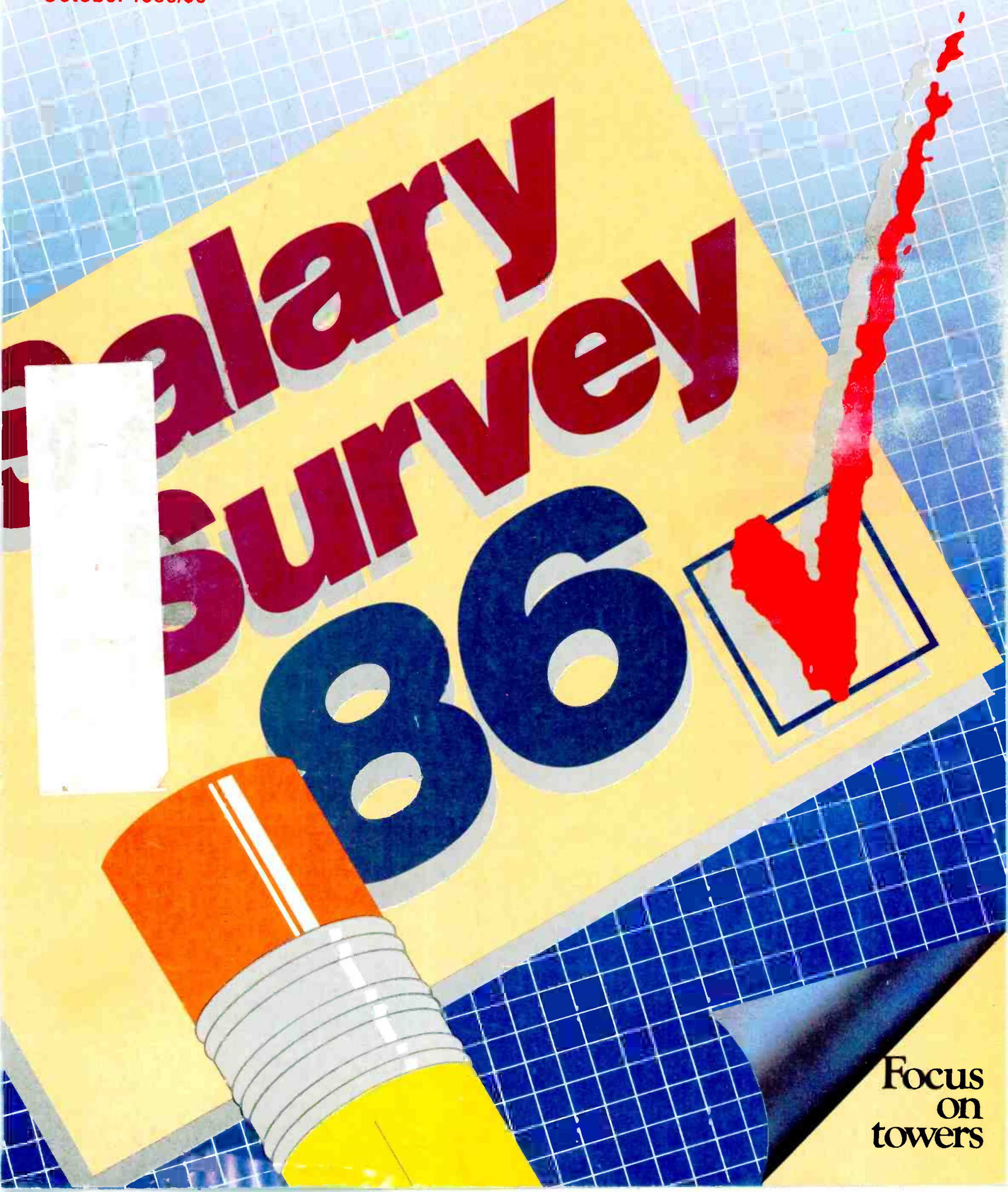
BROADCAST engineering®

October 1986/$3



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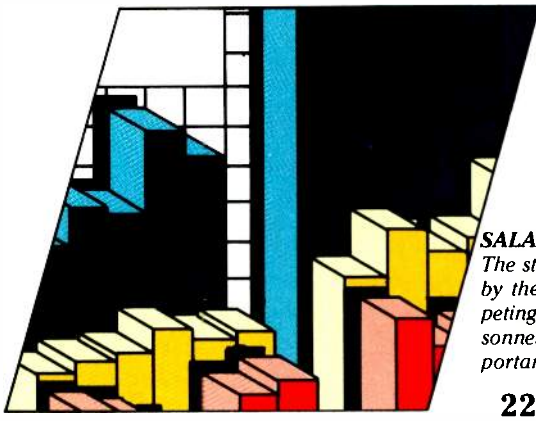

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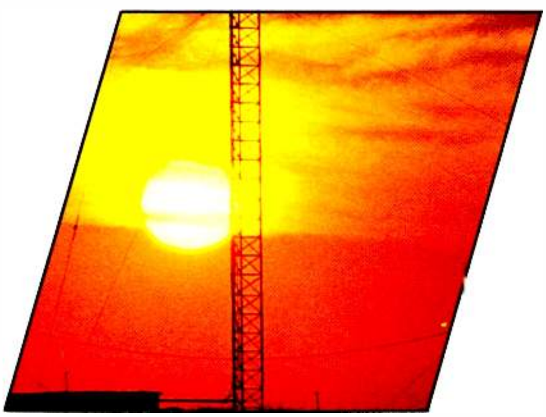

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BROADCAST ENGINEERING

SALARY AND MONEY MANAGEMENT:

The state of the economy for broadcasters is measured in part by the salaries paid to the station personnel. Effectively competing in the marketplace involves more than just salaries. Personnel effectiveness and operations management also play important parts.

FOCUS ON TOWERS

The broadcast tower usually receives the least amount of attention, yet represents a large financial investment and the greatest liability for the station. Knowing more about the tower can help reduce the liability and lessen the chance for structural failure.

OTHER FEATURES:

ON THE COVER

Check to see how your paycheck compares with other radio and TV personnel in the broadcast industry. The **BE** salary survey gives a detailed breakdown on pay scales and fringe benefits for engineering, operations and management. The cover illustration was conceived by graphic designer Tim Lynch.

DEPARTMENTS

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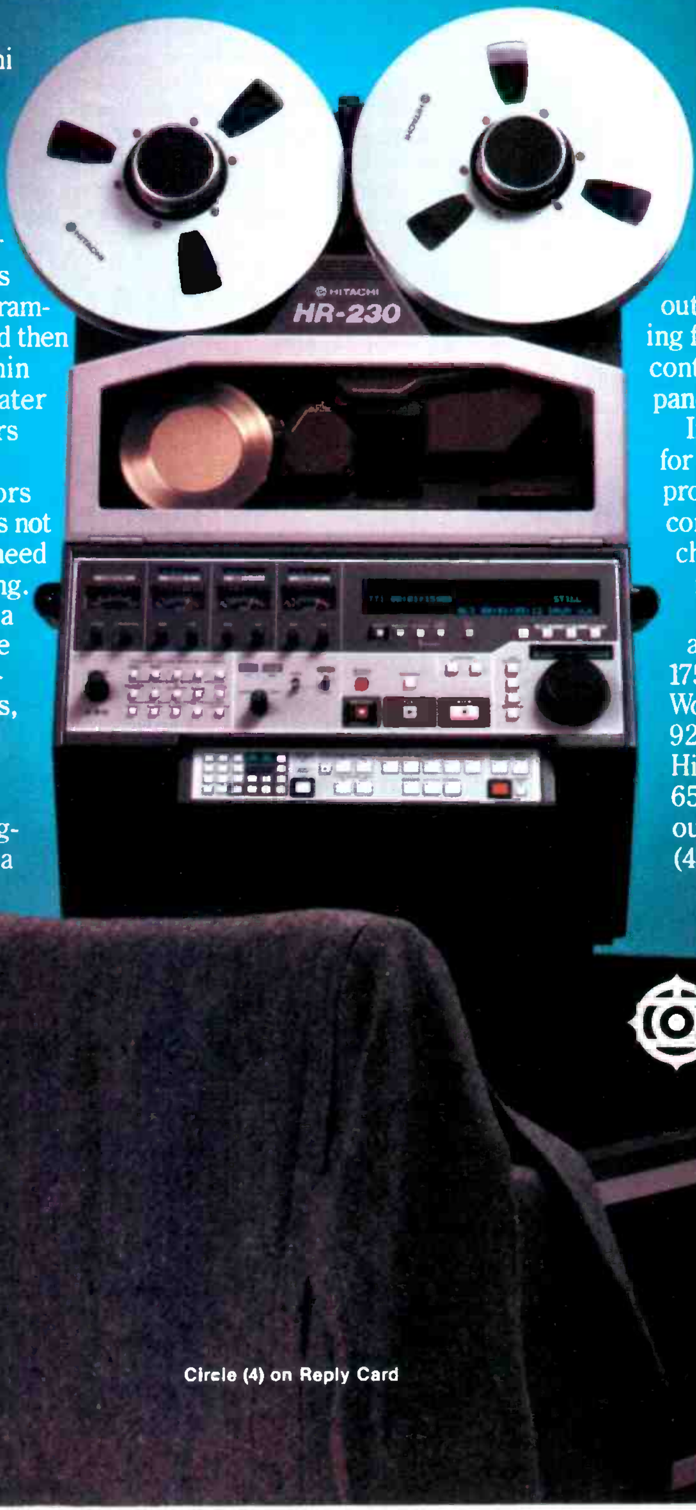

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News

NAB requests action on AM improvement

NAB has asked the FCC to act promptly on several recommendations aimed at improving AM radio.

The association pointed out in its filing that its petition last year outlined a number of factors supporting relief for, and improvement of, AM radio. NAB also enumerated the many AM improvement efforts of its own and in conjunction with the other organizations involved in the National Radio Systems Committee.

NAB's comments called for FCC action that would:

- Eliminate or reduce manmade interference to AM broadcasting.
- Allow nighttime operation by Class III daytime-only stations at "second hour" post-sunset power levels and power increases to full-time Class III stations, where such increases meet existing interference protection criteria.
- Permit the use of synchronous AM transmitters to aid penetration of the stations' markets.
- Initiate a rulemaking proceeding to evaluate the sufficiency of existing FCC second-adjacent channel interference protection ratios.
- Initiate a rulemaking proceeding to explore changes to the commission's main studio and local program origination rules.

NAB also asked the commission to consider the initiation of a rulemaking proceeding to provide AM broadcasters with additional flexibility and cost savings in station ownership. This would focus on the agency's duopoly, one-to-a-market and cross-interest rules.

However, NAB said the FCC should either defer or reject some concepts in its staff report. NAB strongly opposes the concept of ancillary use of AM broadcast main channels for non-broadcast purposes. It also asked the agency to defer consideration of whether there should be a review of the service balance among various classes of AM stations on domestic clear channels.

Interim light sought for RF lighting devices

The FCC has been asked to adopt an interim limit for radiated emissions from lighting devices pending further study. The request was made by the NAB, who also suggested specifying one limit for both consumer and non-consumer use in order to avoid confusion. The filing is in connection with NAB's ongoing AM improvement activities.

At issue is the interference caused to AM radio reception by RF lighting devices. In its filing, NAB supports the interim use of a $4.5/f(\mathrm{MHz})\ \mu V/m$ limit in the frequency band 0.45MHz to 1.705MHz to be measured at a distance of 30m.

The association noted that the commission and NAB found that RF lighting devices were capable of interfering with AM reception. NAB believes that without further study it is unclear whether any of the suggested limits would adequately protect AM listening and that the issue of appropriate limits is complex. However, NAB said, it is self-evident that some limit is necessary now to enable manufacturers to begin production of RF lighting devices while affording some degree of interference protection to AM reception.

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BROADCAST engineering

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Certification: Growing stronger

If you are not SBE-certified—look out. Your economic potential may be limited. This year's salary survey shows significant differences between SBE-certified and non-certified engineer's salaries. Even more important, the difference between these two salary categories is growing. The median engineering salary for those holding SBE certification was 26% *greater* than the comparable non-certified engineering salary. Last year, the difference was 18%.

Other data from the survey are just as impressive. The SBE-certified radio engineer is paid 40% more than a non-certified engineer. The same comparison for TV engineers shows a 19% advantage for those holding SBE certification. When compared across all markets, for both radio and television, there is a 26% advantage in salary to those holding SBE certification. To the radio engineer, this means an extra $9,000; to the TV engineer, $6,350.

SBE-certified engineers also receive larger increases in salary. The certified radio engineer's median salary increased by 17% from the 1986 level. No increase was shown for the non-certified radio engineer. In a comparison of all categories, the median SBE-certified engineering salary was 13% higher than last year. The corresponding non-certified engineering salary was only 6% higher.

Another important fact emerged from the survey data. SBE certification continues to show strong growth. Today, almost 25% of all radio engineers hold SBE certification. In the top 50 markets, one-third of all radio engineers hold SBE certification.

During the last year, the total number of engineers holding SBE certification has increased by 21%. The number of SBE-certified TV engineers has increased by more than 25%. On the radio side, there was a 14% increase.

As evidence of industrywide acceptance, SBE certification is now a regular part of employment advertisements. This fact is even more significant because these ads are often placed by non-engineering personnel.

The median age of the broadcast engineer is falling. As such, the higher salaries cannot be attributed only to more experienced engineers holding SBE certification. Now, the younger engineers also know the value of SBE certification.

Young engineers entering broadcasting realize that without experience, they have no tool with which to advance in the industry. The old FCC first-class license used to fill that role. If one had that license, it was assumed that the person had a certain level of technical competence. Today, without some evidence of ability, it is difficult to advance. This is where SBE certification can help.

Certification provides a measuring stick by which employers can compare prospective employees. When two equally qualified people apply for an advanced position, but only one is SBE-certified, that one may receive extra consideration.

There is little reason for waiting to obtain SBE certification. In fact, waiting may cost you money. With the demise of the FCC first-class license, SBE certification has become an important evaluation tool for both new and current employees.

You can't buy SBE certification. You have to earn it. The answers can't be memorized from a study guide. You have to study and learn from both books and experience. But it's worth it. SBE certification pays.

Study will address signal scrambling

By Harry C. Martin

The scrambling of satellite signals and access to them by home satellite dish owners is the subject of an inquiry by the FCC. The inquiry, which began in August, was initiated in response to a congressional request made in June.

The objective is to determine whether dish owners have reasonable access to scrambled programming at competitive prices. The following specific areas will be covered:

• *Descrambling equipment.* The commission will study the development, price and availability of equipment as well as whether a de facto standard for scrambling is being created by the marketplace.

• *Developments to date.* The commission will ascertain the scrambling timetables of various satellite programmers, the prices they charge and the extent to which a group of channels can be ordered from a single source.

• *Competition.* The commission will examine competition among satellite programmers as well as their competition with other program sources.

• *Public benefits of scrambling.* The commission will study the extent to which viewers might benefit in terms of new programming being produced as a result of the revenue generated from subscriber fees. Also under this category, it will study whether scrambling provides appropriate compensation for copyright owners. The role of scrambling in encouraging the development of DBS also will be assessed.

• *Network feeds.* The commission will examine the networks' preference to distribute exclusively via affiliate stations and incentives for the networks to reach wider audiences through direct satellite distribution to home receive stations.

• *Legal issues.* Finally, the commission will seek comments on whether it has authority to set technical standards for scrambling, to regulate rates or to regulate the structure for distribution of satellite programming. Other legal matters under study are the applicability of Section 605 of the Communications Act (which prohibits unauthorized interception of signals) to network feeds and the impact of copyright law on superstations.

The intent is to develop a record on these issues so a decision can be made whether to adopt rules or to recommend congressional action in the scrambling area.

Martin is a partner with the legal firm of Reddy, Begley & Martin, Washington, DC.

ATIS being explored

A proposal has been made by the commission to establish an automatic transmitter identification system (ATIS) signal on all satellite uplink stations. Relatedly, the agency is asking for comments on the desirability of establishing an ATIS system for all radio transmitting devices in all services.

ATIS is accomplished through assignment of a unique, unchangeable identifying number to each transmitter at the time of manufacture. A transmitter's ATIS *signature* is automatically modulated onto the unit's transmissions and provides positive identification through correlation of the identifying number to a database.

The ATIS proposal for satellite uplinks was spawned by the "Captain Midnight" episode, in which an operator inserted his own brief message into Home Box Office's satellite-delivered programming. ATIS would provide an effective identifier to help cope with increasing intentional and unintentional interference of this sort. Under the commission's plan, satellite uplink stations would be required to include an ATIS signal in their transmissions after Dec. 31, 1987.

With respect to other services, comments were requested on the cost of ATIS to users, both for hardware and the ongoing need to maintain accurate and up-to-date codes. The commission will cooperate with industry groups in all services to help coordinate the establishment of standard codes and circuits.

Standards for devices to be amended

In a rulemaking notice issued in August, the commission announced plans to subject all terminal devices that are owned by cable operators and external to a TV receiver to a single subpart of the rules. Under current rules, terminal devices owned by cable systems are subject to Part 76 technical standards; those devices owned by subscribers, even though they may be the same type of equipment, are subject to different standards under Part 15.

The proposal is to apply Subpart H of Part 15 to all external cable terminal devices to end the disparity. Subpart H, which deals with TV interface devices, provides field-strength emission limits, connecting cable output signal level limits and transfer switch and line-conducted interference standards. The commission's proposal is intended to eliminate potential confusion with respect to the applicable standards for terminal devices.

In cases of interference, responsibility would be assigned to the party operating the device. Information concerning the interference potential of the device would have to be provided to the user. Cable system operators would be responsible for suppressing interference by terminal devices and would be permitted to disconnect malfunctioning devices. Finally, the commission proposed that all terminal devices comply with the self-testing verification procedures provided for in Part 2, Subpart J of the rules.

Reversal on SCA rules

The U.S. Court of Appeals for the District of Columbia has rescinded FCC rules pre-empting state regulation over common-carrier paging services operating on the subsidiary communications channels (SCAs) of FM stations.

In 1984 the commission ruled that local regulation over such services conflicted with its broad authority to license channels and allocate spectrum resources efficiently. The court disagreed, saying that the agency's authority did not extend to strictly *intrastate* common-carrier services regardless of the fact they are provided through federally regulated broadcast channels. As a result of the court's ruling, stations offering paging services through their SCAs now must comply with state regulations applicable to other communications common carriers. Non-common-carrier uses of SCAs are not affected by the court's ruling.

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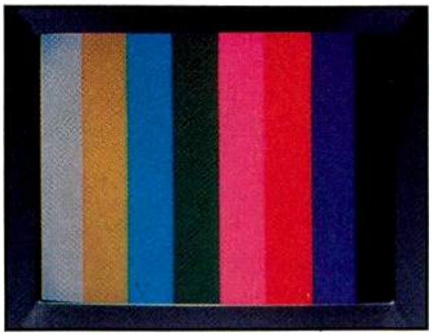
VBI, ATIS and more

By Carl Bentz, TV technical editor

What can you do in 63.5μs? That's the time required for one horizontal line of a TV picture. It may seem short, but the scan time for one line is sufficient for some interesting applications, particularly during the vertical blanking interval (VBI).



VBI text services

Not too long ago, teletext promised a new kind of information service. The concept evolved from two different European developments. One form uses the TV signal to distribute graphics and text information to viewers' receivers. A constant datastream, transmitted in a VBI line, allows the viewer to select from various subject matters.

The other service connects the user's telephone and an interfaced CRT with a database to bring the user information on assorted topics. This post-office-controlled system resembles CompuServe in many ways, being almost encyclopedic in its scope of subject matters. Information is sent from the database only when requested by the user.

Teletext has never become the household word promoters had hoped, but it has brought a new interest in the VBI. Many became aware of the potential commercial value of the unused horizontal lines and a flurry of activity resulted. Magazine formats brought news, calendars of events and other subjects with graphics and text. Time brought an awareness that the U.S. market was not ready for the service.

VIRS, VITS and line 21

The presence of digital data encoded into the VBI period posed a potential for interference to vertical interval reference and test signals and line 21 captioning. The proposed text services needed multiple VBI lines of high-speed data. Lines 10 to 18 and 20 were reserved for such uses. The fast data rise and fall times and their harmonics were not to affect signals in other lines or the normal TV picture or the TV aural signal.

VITS, the first VBI service instituted by the FCC, was required for all remote-operated stations. A combination of test signals encoded into the unused video real estate offers a means to monitor the overall TV system. Signal levels, reference phases and frequency response indicated the performance characteristics by using a single line in both fields. To view the signals advantageously required waveform and vector monitors with line select capabilities.

The concept is practical if used properly. In theory, network program VITS signals could establish a reference for automatic signal control at local transmitters. The capability was never fully developed. In fact, to the chagrin of many local station engineers, network VITS was declared unreliable by the commission for maintaining improper peak white levels and other parameters given to stations that tried to track the network signals.

VIRS came in response to receiver manufacturers. TV sets with a line 19 selecting decoder tracked a reference signal for luminance and black levels as well as subcarrier and chroma phase. The VIRS information could automatically correct the parameters in the receiver for more constant picture quality.

Neither VITS or VIRS (they are no longer required) are digital, but line 21 captioning to assist the hearing impaired is. (ABC, NBC and PBS used one system, while CBS tried another approach.) Called closed captioning, a datastream becomes visible only on sets with appropriate decoders. Closed captioning avoids aesthetic degradation of the images for non-impaired viewers.

Captioning can provide an improved understanding of the programming by the general viewing audience. If the original program audio is in a foreign language (as in operas, films, international news interviews), *subscripts* or *open captions* can be helpful.

Captioning requires a special effort to make sure that appropriate text appears on-screen at the correct time. Receiving the captions requires a decoder, which unfortunately has been quite expensive. Work continues in order to produce a more economical decoder.

Thwarting Captain Midnight

When PBS instituted a satellite program-distribution network, a need was seen to identify the active uplink ground station. Plans called for encoding a series of ID bits onto a VBI line. The ID makes it easier to determine offending carriers when more than one uplink illuminates a satellite transponder simultaneously, either accidentally or deliberately.

At a local level, source IDs prove useful when many remote sources feed a central location. A video ID signal in the VBI informs the director of the origination of each picture.

The use of VBI identification may become mandatory, depending on the outcome of the FCC's Docket 86-337. In August, the commission issued a notice of proposed rulemaking and notice of inquiry to establish an automatic transmitter identification system (ATIS) for all radio transmission equipment. Comments must be filed by Oct. 20 with reply comments due by Nov. 19. Interested individuals may contact the FCC by writing to: Office of the Secretary, Federal Communications Commission, Washington, DC 20554.

Questions may be directed to Sue Earlewine, chief, public contact branch; 202-634-1940; and John Hudak, chief, signal analysis branch; 202-632-6977.

This action responds to the Captain Midnight type of encroachment on satellite-relayed CATV transmissions, to the expansion of spectrum usage and to apparent deliberate acts of interference to aviation communications. The docket contains proposed rules to be instituted in Part 25 (video satellite uplinks). For all other radio services commentary discussions are sought.

The document proposes that an identifying device become an integral circuit of the transmitter to provide a distinct signature to all transmissions from that RF system. Although the broadcast industry is not cited as a major problem, voice transmissions from 25% or more of the Private Land Mobile Radio Service are unidentified. Not a panacea by itself, ATIS could become an RF license plate on a worldwide basis and a deterrent to deliberate attempts to interference.

Why should broadcast stations be included in this system? Participation by all RF transmitters will aid in solving co-channel and other interference sources, whether deliberate or accidental. For television, a VBI ID code is practical and achievable. But consider a potential future option in the scanning digital TV tuner. You ask for the station call letters by voice. The intelligent receiver seeks the ID code and tunes to the selected program. It is possible.

Learning the basics

By John Battison

Last month we discussed antenna tuning units (ATUs) and learned why they are necessary. A 90° phase shift tee network is popular for both non-directional and directional stations. Of course, when designing a phasing system, the design engineer always takes the phase shift of the ATU into consideration. In fact, the phase shift in the tee networks is an important factor in the phasing system design. The fact that all the arms have the same numerical reactance value, although the *signs* may be different, makes the design and construction of 90° tee networks easier. (See Figure 1.)

It is easy to see whether a network is leading or lagging by examining the series arms components. If the series arms contain inductive reactance, the system is phase retarding. If the system arms contain only capacitors, the system is phase advancing, although the latter may still use a coil for fine-tuning the reactance.

Sometimes during a severe lightning storm, an ATU can be damaged. This damage often consists of blown-up (literally) capacitors. The wise engineer will have made a listing of the components, their values and ratings.

The first step is to calculate the network input current. Assume you are working with a 5kW station with 70Ω impedance.

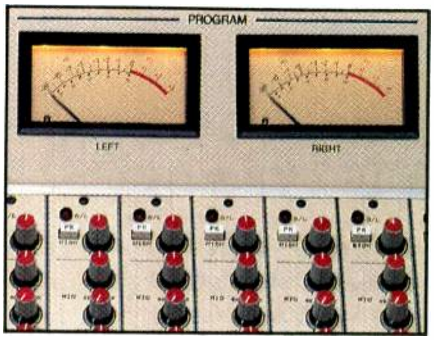
$$I = \sqrt{P/R}$$
$$\text{therefore: } I = \sqrt{5{,}000/70}$$
$$I = \sqrt{71.43}$$
$$I = 8.45\text{A}$$

Thus, 8.45A will be flowing through Z1, the input leg. The inductance should be large enough to carry this continuously without modulation. It should also have sufficient low-loss and current capacity to handle 125% modulation on a regular basis and allow for peaks of 200%. This current would also flow through any capacitor that might be in the input leg if the network were a phase-advancing network.

You can calculate the antenna current from the same equation. This time the current equals:

$$I = \sqrt{5{,}000/61}$$
$$I = \sqrt{82}$$
$$I_{ant} = 9.05\text{A}$$

But what is the current through the shunt leg capacitor? This is important because an underrated capacitor here can lead to a breakdown—usually in the middle of a cold, wet night.



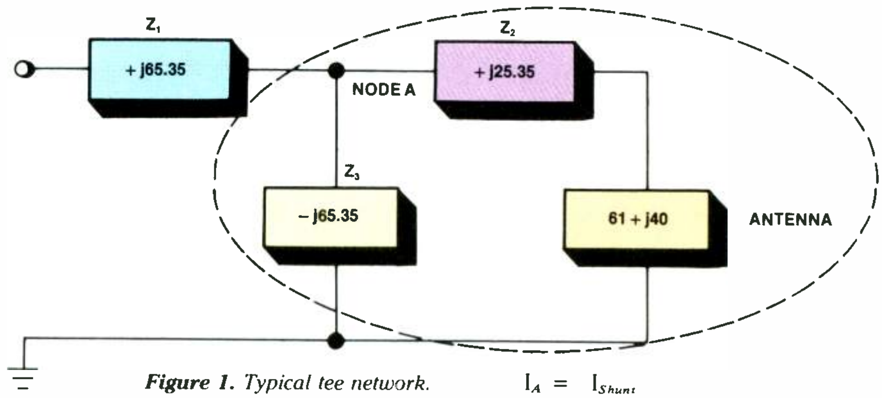


Figure 1. Typical tee network.

Refer to Figure 2. At this point, there are two impedances in parallel. One is the antenna impedance. The other is the shunt leg. From the (long-forgotten) rules for finding the current, multiply total current by the impedance of the other leg, then divide by the total impedance of both branches. In the antenna branch you have:

$$I_{ant} = \frac{I_{IN}(Z_A)}{(Z_A + Z_B)}$$

Checking the antenna current, you find:

$$\frac{(8.45)(j65.35)}{(-j65.35 + 61 + j65.35)}$$

$$= \frac{8.45\,(j65.35)}{61}$$

$$= j9.05\text{A}$$

In this case, generally ignore the *j* operator and refer to the antenna current as 9.05A. The previous process simply multiplied the numerical part of the j term by the input current and divided by the antenna resistance. This value agrees with the antenna current that was calculated using RF power and antenna resistance, as it should.

Obtaining the current through the shunt leg becomes a little more complicated. (See Figure 2.)

$$I_A = I_{Shunt}$$
$$= \frac{(8.45)(61 + j65.35)}{61}$$

This is the only place where you have to use anything other than simple arithmetic. To perform the calculation, convert the antenna impedance from rectangular to polar notation. This can be done on your slide rule or calculator. Most calculators today have simple instructions for the conversion, so we won't go into that here.

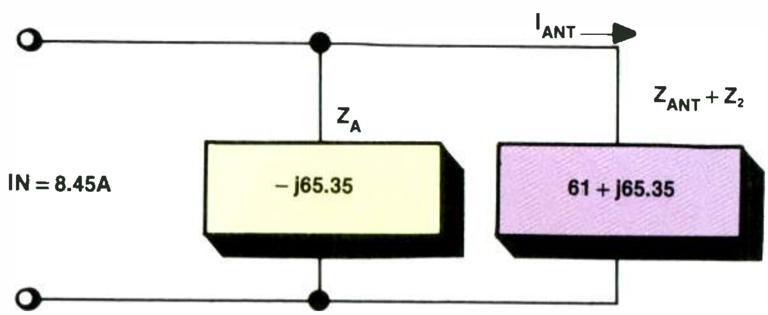


Figure 2. Here the tee network has been simplified into two parallel current paths, the antenna and shunt legs.

After the conversion, 61 plus j65.35 becomes $89.4\angle 47^\circ$. Therefore, I_{Shunt} becomes

$$\frac{(8.45)(89.4)}{61}$$

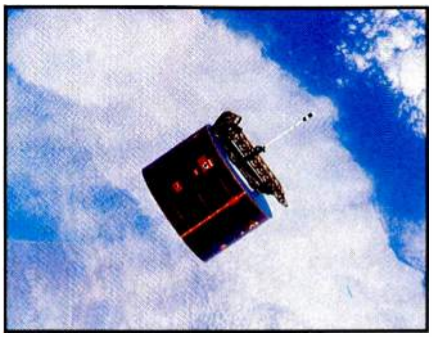
Don't worry about the impedance angle at this point. You are only interested in the real term, resistance. In this case, I_{Shunt} turns out to be 12.4A with a phase angle of $\angle 46.97^\circ$. Armed with this information, you can now determine the capacitor rating.

Battison, BE's consultant on antennas and radiation, owns a radio engineering consulting company in Columbus, OH.

Antennas to conform to standards

By Elmer Smalling III

The FCC requires that any antenna to be employed in the transmission at an earth station in communication satellite service should conform to the following standards:



- Outside the main beam, the gain of the antenna shall lie below the envelope defined by:

$$G(dBi) = 29-25\log\theta,\ 1° < \theta < 48°$$
and
$$G(dBi) = -10dBi,\ 48° < \theta < 180°,$$

where θ is the angle in degrees from the axis of the main lobe and dBi refers to gain in decibels, relative to an isotropic radiator.

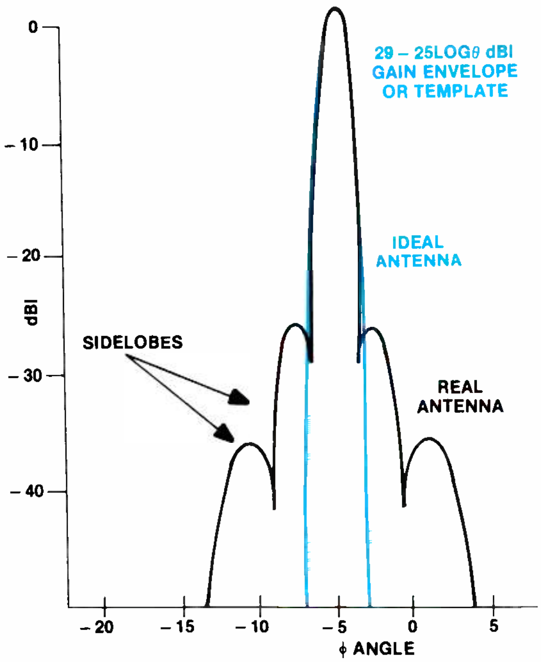


Figure 1. An ideal antenna sidelobe response (blue) compared with real antenna characteristics.

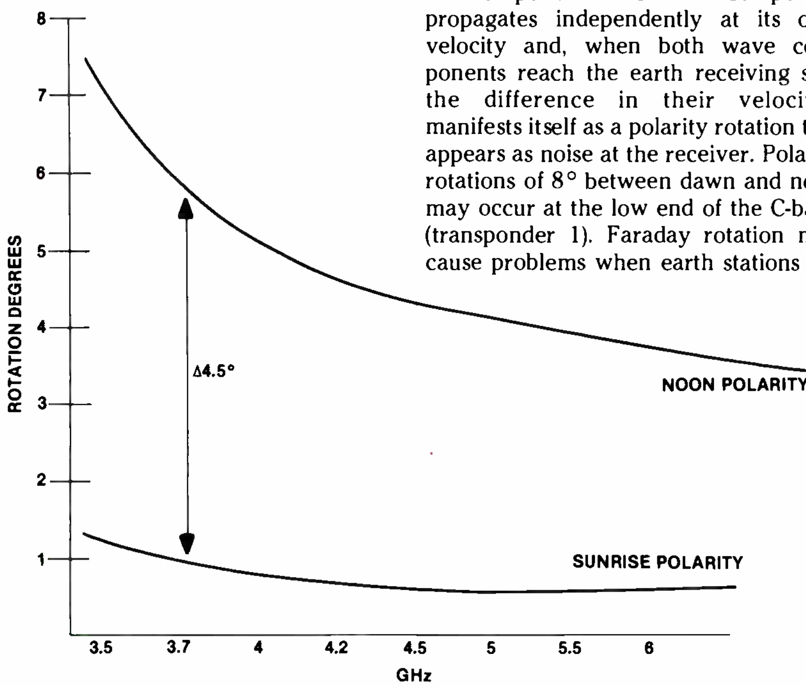


Figure 2. Faraday rotation characteristics vary with frequency and time of day.

The rule continues that the peak gain of an individual sidelobe may be reduced by averaging its peak level with the peaks of the nearest sidelobes on either side or with the peaks of the two nearest sidelobes, provided that the level of no individual sidelobe exceeds the gain envelope by more than 6dB.

In April 1983, the FCC replaced the constant 32 in the sidelobe envelope definition with the constant 29, which generates a narrower antenna beam width. This change responded to the reduction of satellite orbital spacing allocation to 2°.

Because the θ of the formula is the degrees from axis or boresight, the negative dBi (decibels above isotropic) should get larger as the angle increases in a perfect, directional antenna. (See Figure 1.) This means that an antenna designed to the $29-25\log\theta$ envelope will transmit a narrow, steep-skirted beam and will be less susceptible to interference from adjacent, off-axis signals.

In the real world, it is difficult to manufacture a perfect antenna because of a number of factors that contribute to an increase in beam width or sidelobe power. These include small diameter, poor feed support structure geometry, antenna surface perturbations and antenna geometry trade-offs. The $29-25\log\theta$ envelope was mandated by the FCC to give antenna manufacturers a specification limit and to reduce the amount of uplink or downlink interference in the increasingly populated satellite belt.

Faraday rotation

As signals from a satellite pass through the ionosphere, they are rotated by a small amount, depending upon the frequency and time of day. The ionosphere separates linearly polarized waves into two components. Each wave component propagates independently at its own velocity and, when both wave components reach the earth receiving site, the difference in their velocities manifests itself as a polarity rotation that appears as noise at the receiver. Polarity rotations of 8° between dawn and noon may occur at the low end of the C-band (transponder 1). Faraday rotation may cause problems when earth stations are designed too close to the recommended figure of merit G/T. (See Figure 2.)

Scintillation fading

Scintillation fading is caused by local changes in barometric pressure, temperature and general homogeneity of the atmosphere. Often an operator may detect rapid fluctuations (from 40 to 60 times per minute) with amplitude variations to 8dB. These scintillations or fluctuations are caused by the change in the refractive index of the atmosphere. This type of fading may reduce the usable bandwidth of a system, as a result of changes in the arriving wavefront. As is the case with Faraday rotation, a system with ample headroom will be the most reliable.

An invitation

If you have questions you would like answered in this column or wish to see a discussion in any particular area of satellite communications, please write to "Satellite Technology," **Broadcast Engineering,** P.O. Box 12901, Overland Park, KS 66212.

Smalling, BE's consultant on cable/satellite systems, is president of Jenel Systems and Design, Dallas.

Part 1

Circuits

Inside digital technology

By Gerry Kaufhold

Just over a decade ago, manufacturers of video and broadcast equipment began to incorporate digital computer technology into previously mechanical control functions. At about the same time, some courageous pioneers were developing circuitry that used digital technology to digitize, store and process video information. Those with super-budgets who bought this new technology found that experienced analog-maintenance engineers needed retraining to fully understand this new technology.

Today, a spot inventory of almost any teleproduction or broadcast facility will reveal that a majority of hardware relies on digital control, digital signal processing or both. As many engineers discovered when solid-state devices replaced established vacuum tube technology, the best way to make progress with the new technology is to compare and contrast the new with the old. Let's take a look at the signals.

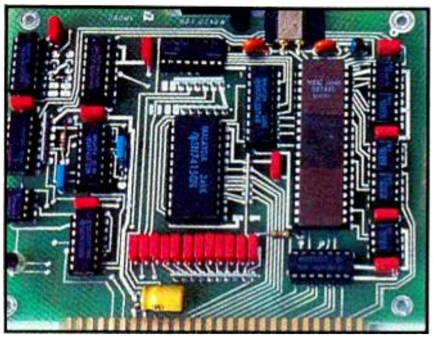
Digital vs. analog

An analog signal is continuous. As the parameters of the signal change, there is no break in the signal. Drawing a curved line without lifting the pen from the paper provides a graphic representation of an analog signal.

A digital signal is not continuous. In fact, a digital signal has only two active states; *high* (1 or on) or *low* (0 or off). As illustrated by drawing the continuous curved line on paper, plotting points along that curved line represent its digital equivalent. Of course, more dots will increase the accuracy, and naturally, more dots mean more circuits.

Consider the single-stage common emitter circuit shown in Figure 1. This typical amplification stage must be biased at or near the analog operating point shown in Figure 2. Usually the operating bias is about half of the power supply voltage to assure that the output will not be clipped or distorted by transistor saturation if the bias plus the signal is too low, or by cutoff if the bias plus the signal is too high. Input and output impedance is critical because the signal

Kaufhold is staff engineer for KAET-TV, Tempe, AZ.



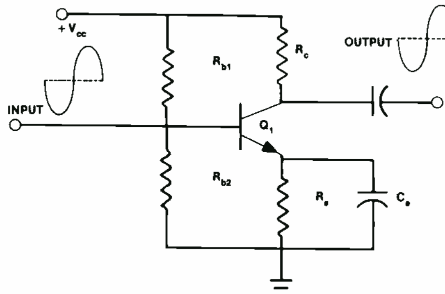


Figure 1. NPN common emitter analog amplifier stage with stabilized bias.

Operating point $= \frac{V_{cc}}{2}$

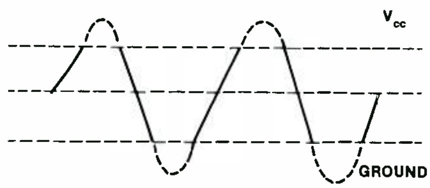


Figure 2. Clipping of an analog signal when transistor saturates at ground and cuts off at V_{cc}.

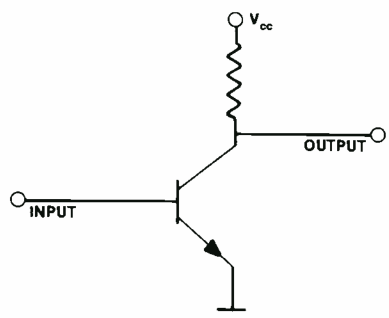


Figure 3. A simple NPN common emitter inverting gate.

levels are an important factor for proper operation. Note that the common emitter also acts as a phase inverter because the input and output are 180° out of phase with each other.

The principle of saturation and clamping is the foundation of digital circuitry. All digital circuits are called gates. Figure 3 shows a simple NPN common emitter inverting gate. Note that this gate is similar to the common emitter analog amplifier, but is missing the feedback resistor network. This is a primary characteristic of a switching circuit.

Applying a positive voltage to the base of Q1 will saturate the transistor causing Vcc to drain to ground, creating a *low* state. A negative voltage applied to the base will isolate Vcc from the drain, creating a *high* state. Consequently, most digital circuits are bistable, meaning they are stable only during the presence or absence of a signal. Because a common emitter has been used for the digital switch, a phase inversion will be seen at the output.

There is a third, inactive state, called tristate. This occurs when the device is in a high-impedance state so that it does not interface with other active gates. In the tristate mode, the output of the gate will appear to be tied *high* through several megohms.

Timing is everything

Digital signals contain two kinds of information: state and timing. The time when a digital signal arrives contains as much information as its state.

Unlike analog counterparts, many different signal sources may be connected to a single gate. Because typical digital signals are of short duration, it is also possible to multiplex many different gated outputs on a single parallel bus structure. Just how this multiplexing is accomplished will be addressed in a future column.

The important facts to remember are that in an analog circuit the collector voltage must stay within the analog operating state. In a digital circuit, the collector voltage is either near cutoff or near saturation. The seemingly overwhelming complexity of digital circuitry is not from complicated new age circuits, but from many simple circuits.

Editor's note: This is the first of a series of "Circuits" columns designed to increase the broadcast engineer's knowledge and understanding of digital electronics. Next month, various types of gates and their functions will be examined.

Part 2

Troubleshooting

Repairing digital systems

By Ned A. Soseman, video technical editor

At about the time digital circuitry was being developed for broadcast and video applications, designers of test equipment were finding ways to incorporate digital technology into test equipment. Beyond multimeters and frequency counters, the digital storage oscilloscope is one of the spin-offs of computer technology that has many useful applications in the broadcast and teleproduction plant.

Inside the DSO

A digital storage oscilloscope (DSO) is a conventional oscilloscope with a built-in computer. (See Figure 1.) The value of the DSO is its capability to capture and retain signals and waveforms. It is especially useful for capturing 1-shot non-recurring signals. Because of the digital circuitry, other features such as pre-trigger and roll modes are possible, each having its own application in a maintenance environment. Like a traditional oscilloscope, the DSO has conventional inputs and front-panel controls. In addition, the DSO has memory as well as CRT and recorder outputs.

Memory (or storage capability) is a feature that can be useful to isolate the cause of an intermittent problem.

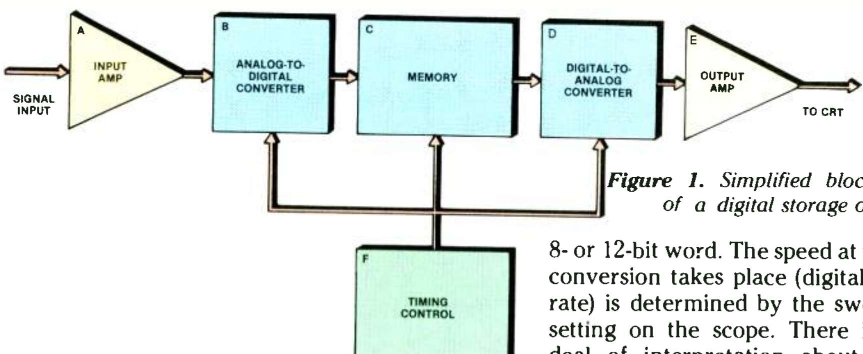
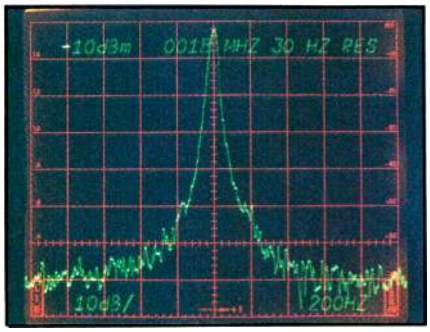


Figure 1. Simplified block diagram of a digital storage oscilloscope.

Because the DSO can be set up to trigger under a specific set of conditions, it can be left unattended to babysit a circuit and wait for trouble to occur. This pre-trigger mode enables the user to observe disturbances on a signal line before a failure or problem happens. Small disturbances noted on a signal before an event can give clues as to why the problem occurred. (See Figure 2.)

The roll mode provides a means of looking at long-term variations in a signal. The sampling rate is slowed down so that information gathered over a period of minutes or hours can be displayed on the CRT. For babysitting a



power line, for example, the roll mode may be used, making the DSO like a strip chart recorder without the miles of paper. (See Figure 3.)

The output of the DSO allows waveforms retained in memory to be saved in hard-copy form on an X–Y recorder, or passed along a data bus such as RS-232 or GPIB.

Specifying a DSO

Purchasing a DSO requires a knowledge of features and specifications that are unique to the DSO. In addition to the traditional specifications of the oscilloscope (an analog device), the new specs refer mainly to the memory and digital capabilities of the unit.

Effective digital bandwidth or useful storage bandwidth refers to the bandwidth of the scope when used in the digital (storage) mode. An analog-to-digital converter transforms the analog signal at the input to a digital (usually 8- or 12-bit word. The speed at which this conversion takes place (digital sampling rate) is determined by the sweep speed setting on the scope. There is a great deal of interpretation about this particular specification. It is probably best to find out what the maximum sampling rate is and make your own judgment as to what the digital bandwidth is. Then, you can decide how many points of each complete cycle you must store in memory to retain a usable waveform.

When considering effective digital bandwidth, beware of its true meaning. Some DSOs employ a sampling feature that enables repetitive signals to be captured and stored. This will be of little value if you are looking for a non-repetitive event. Because a sampling rate is used, also be aware of the time interval that occurs between samples. For example, if a 1MHz rate is used, a sample is taken each microsecond. If a transient of less than 1μs duration occurs, it may be missed by the scope.

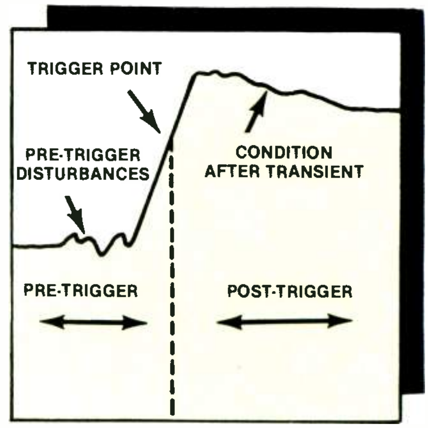


Figure 2. The triggering point may be placed anywhere on the screen. This enables the study of pre-trigger disturbances, which may give clues for troubleshooting intermittents.

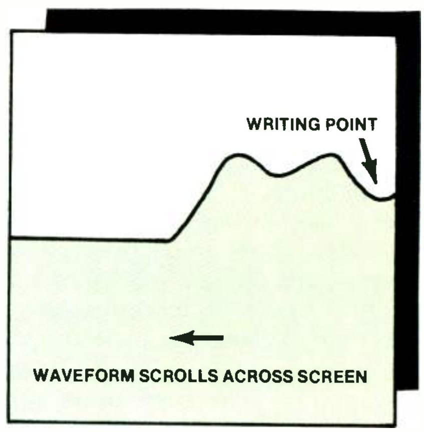


Figure 3. Slowly occurring changes may be charted on the DSO using the roll mode. Data is written from the right side of the screen to the left, as it is with a strip chart recorder, but without the paper.

Word size tells how many voltage levels can be resolved. For critical measurements, a 12-bit word capability may be required. However, an 8-bit word size will resolve a signal into 256 levels.

In a world where managers and clients have no patience for intermittent problems, a DSO can give the maintenance technician an opportunity to stay one step ahead of potential catastrophy.

Part 2

Management for engineers

Develop a style to call your own

By Alfred P. Hahn

Last month we discussed how easy it is to fall into the trap of an ineffective management style. If you take the *King Kong* approach, you're being too heavy-handed, and if you adopt a *one-of-the-guys* attitude, you're being too easygoing. Developing an effective management style isn't necessarily easy, and it doesn't happen overnight. Becoming a successful manager of people can take at least as long as it does to become a successful manager of equipment.

One of the necessary elements to becoming an effective manager is multidimensional behavior. This doesn't mean you must become a schizophrenic. Multidimensional behavior is simply the ability to deal with different issues and situations in different ways. To do this, you need a *tool box* or variety of responses upon which to draw.

The managerial tool box

You can develop some of these managerial tools through job experience. Unfortunately, the school of hard knocks may be detrimental to your career. Some people develop good interpersonal skills as they progress through their careers. For them, the conversion to management is relatively easy. For those who did not develop the necessary *people skills* (and in the broadcast engineering area, there are many), additional training is mandatory.

The best way to receive this training is in a classroom setting. Courses in management skills may be offered by your company, a local community college or a professional organization. A good shopping list of basic training skills might include time management, delegation, psychology of management and management by objectives (MBO).

Time management

Inexperienced managers can often benefit from a class in time management. A course on this subject is useful because time is often a manager's most scarce commodity. The *in-basket* exercise helps to illustrate the importance of using your time efficiently.

In the exercise, trainees are given an in-basket full of papers and allowed 15 to 20 minutes to deal with its contents. Each basket contains a couple of buried bombs. These bombs are critical make-or-break problems and are hidden under layers of routine paperwork and sometimes fascinating details. Trainees who squander their time by using a first-come, first-served approach never find the bombs and, therefore, flunk the exercise. These people are simply unable to complete the work.

One time-management aspect that doesn't come easily to everyone is the capacity for multitrack functions. Engineering managers, particularly in large stations, often have to juggle several tasks at one time. An operations manager may be called upon to make decisions on future remotes or studio productions in the middle of a crisis.

Management by objectives

The novice manager can also benefit by understanding *management by objectives* (MBO). MBO is a tool managers can use to make objective judgments in subjective situations.

Let's say you've been promoted to operations manager and your buddy, Joe, isn't switching the afternoon soaps too well. Joe may not be open to your criticism if he thinks he deserved your promotion.

If you sit down with him over a cup of coffee and say, "I've been watching the afternoon shows and I don't think you're doing as well as you could," you are immediately putting Joe on the defensive. A more effective method would be to state an objective observation, such as: "Joe, I received three complaints last week from traffic about make-goods. Normally we'd have none during the afternoon strip. Is there some problem I can help you with?" Putting the problem to Joe in this non-judgmental manner gives him the opportunity to explain what happened and to accept your assistance in solving the problem.

MBO is also helpful in one of the most difficult tasks: self-evaluation. To use it, you must first develop some objective criterion, some element of your work that can be reduced to numbers. Examples might be the number of equipment reports per week, a maximum number of make-goods per month or average turnaround time for equipment repair.

Delegation

Delegation is a particular challenge to managers in the broadcast industry. They're inclined to reach for the soldering iron and do a quick job themselves. Although instinctive, that's absolutely the wrong thing to do.

Delegation is probably the greatest management tool that exists. However, it is not practiced well enough by everyone, from the first-line managers to company presidents. That is one reason why first-level managers either fail or never go higher—they won't let go of their soldering irons. The significant thing about being a manager is that you succeed through the work of others. The day you start doing their jobs is the day you begin to fail.

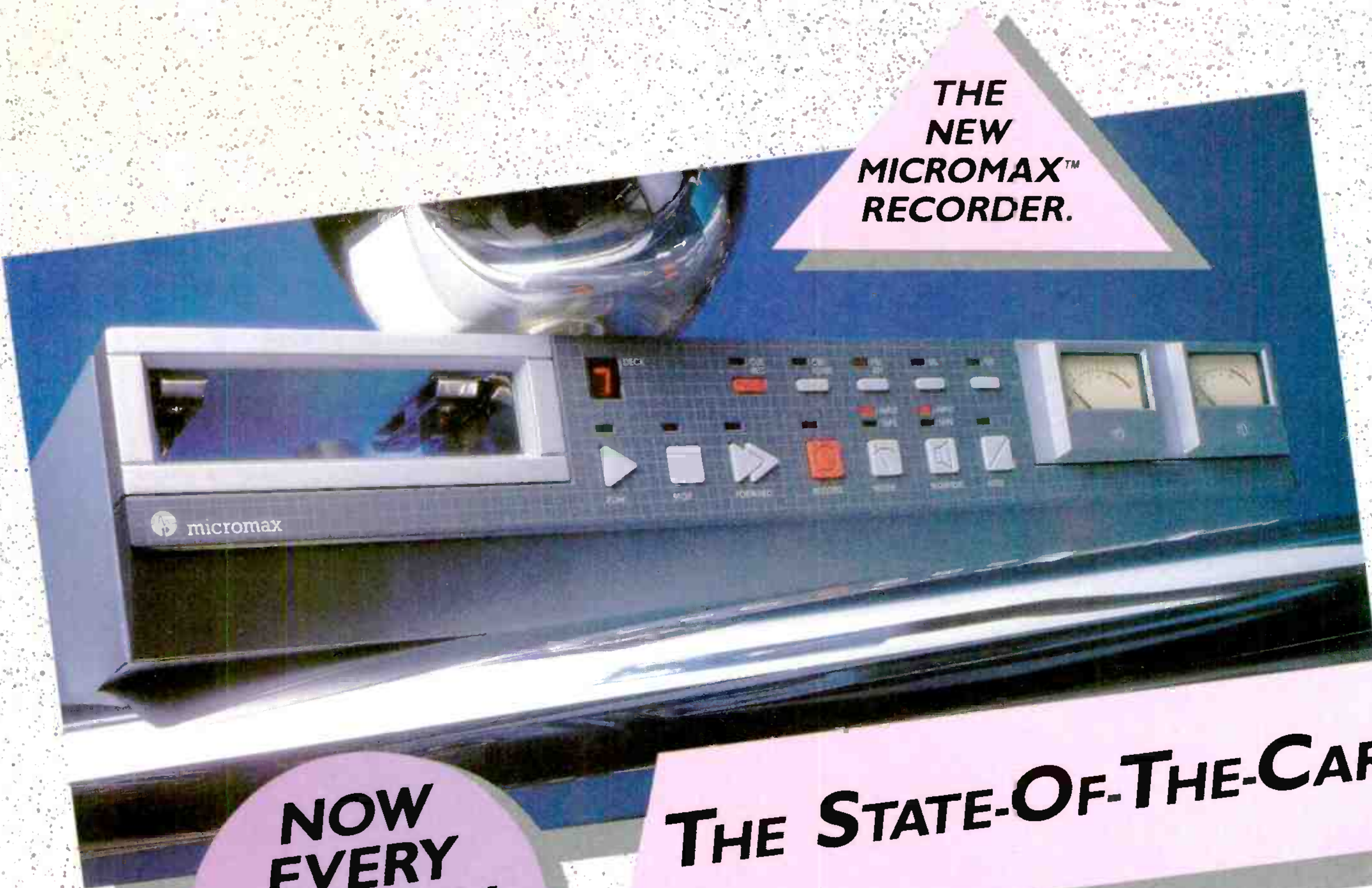
Teaching by example is something different. It is also different when someone is sick and you show a willingness to chip in to get the day's production done. Pitching in to deal with abnormal circumstances shows you are willing to shoulder your share of an unusually heavy workload. The rest of the time, however, you should be delegating.

A related failing of the new manager is not trusting people enough to let them do a job. You have to be willing to stay out of the way and let others occasionally fail. Inexperienced engineers-turned-managers often feel that they can do a particular job better than someone else. Although that may be true, it also may be true that the other person was simply doing the job in a *different* way than you would. Don't close your eyes to completing tasks in non-standard ways. Often, those workers in the trenches come up with unique and innovative solutions.

If you want to succeed, give your staff members a chance to succeed. The more responsible and skilled they become, the easier your job will become. So, the next time you are tempted to step in and do it yourself—don't. Let your staff make the decision. The results may surprise you.

Hahn is president and founder of Support Technologies, Portland, OR.

Editor's note: This month's column was adapted from the article "Personalizing Your Management Style," which originally appeared in the July 1986 issue of *Microservice Management* magazine, an Intertec publication.



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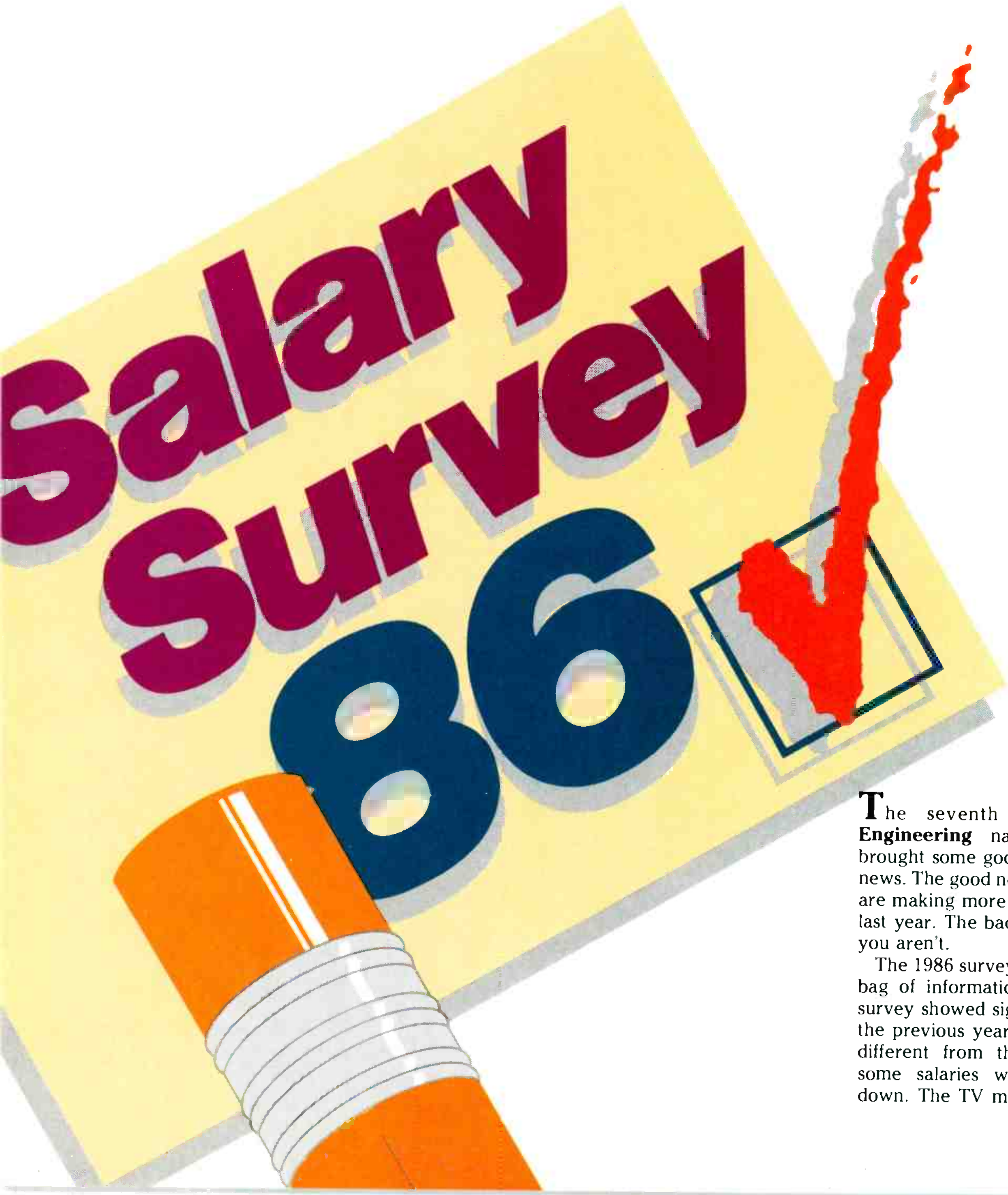
1986 Salary Survey

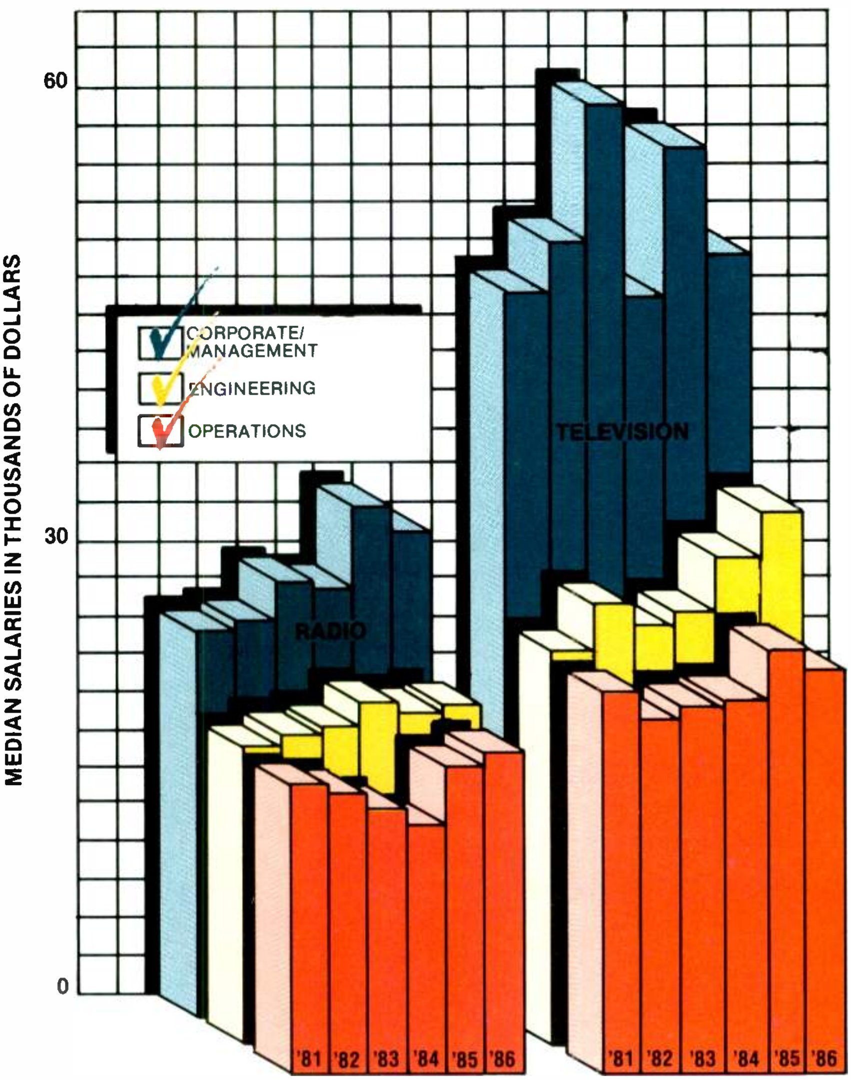
By Brad Dick, radio technical editor

Technical salaries are up and SBE certification continues to show strong gains.



The seventh annual **Broadcast Engineering** national salary survey brought some good news and some bad news. The good news is that some of you are making more money than you were last year. The bad news is that some of you aren't.

The 1986 survey proved to be a mixed bag of information. Just as last year's survey showed significant changes from the previous year, this year's was quite different from the last. Even though some salaries were up, others were down. The TV manager median salary,



which went up 25% last year, dropped by 12% this year. Fortunately, in most cases, the engineering salaries were up.

The survey

The study is designed to enable you to compare your salary and benefits with a cross-industry survey. The information gleaned from the survey provides a good picture of what is happening within the industry in terms of employee compensation. Not only does the survey allow you to compare your salary against national statistics, but you can also look at non-salary items such as medical benefits and pension plans.

Today's employee compensation packages are more complex than ever before. Salary is merely one element within that benefit package. If you've ever received a yearly statement of what your company pays you in terms of benefits, you realize how important these factors can be.

Tabular results

The details of the 1986 **BE** salary survey are summarized in the following tables. Table 1 covers the management and corporate staff; Table 2 details the results for the engineering and technical staff; and Table 3, the operations staff. Tables 4 and 5 present a tabular summary of significant salary data for the past two years. Table 6 summarizes the median salary for all three job categories for television and radio over the past four years. Table 7 covers some other aspects of broadcast shown by the survey.

Keep in mind that the tables report *median* salaries. These figures may be quite different from average salaries. The median salary is the midpoint for the group considered. Half of the group has a higher salary, and half has a lower salary than the median value. The median value provides a better statistical representation of the overall data and is used throughout this report.

The 1986 **BE** study was scientifically conducted by the marketing research department of Intertec Publishing, under the direction of Kate Smith. On July 9, 1,715 questionnaires were mailed to recipients of **BE** on an "nth name" basis. On Aug. 21, 643 completed forms had been returned, providing a response rate of 37.5%. The data contained in this report are based on these responses.

The good news

Engineering salaries tended to move upward this year. Last year's radio engineer median salary was $23,000. This year, the median salary moved up slightly, to $23,650, which represents a 3% increase. This small increase offsets the 3% drop in radio engineering salaries seen last year. Although a 3% increase might not seem like much, remember that inflation is now lower than in previous years. Although the increase is not as high as you might like, at least it's not a drop, as in 1985.

TV engineers fared even better. Last year, they saw a 9% increase in their salaries. This year, the TV engineer median salary increased by 11% to $34,000. The change represents an extra $3,400 in the overall paycheck.

The only other group seeing an increase in salary was radio operators. From a base of $20,000 last year, the median salary increased by 2% to $20,350. The radio operators received the

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TABLE 1.—MANAGEMENT STAFF PROFILE*

	ALL MARKETS	TELEVISION							
	Total %	Total TV %	Top 50 %	Top 100 %	Below Top 100 %	Total Radio %	Top 50 %	Top 100 %	Below Top 100 %
Salary Level									
Less than $15,000	6.9	.....	.....	.....	.....	10.8	10.0	10.0	11.1
$15,000 to $24,999	15.6	3.4	3.8	.....	4.8	22.6	.....	.....	31.9
$25,000 to $34,999	20.0	12.1	11.5	18.2	9.5	24.4	20.0	20.0	26.4
$35,000 to $49,999	22.5	32.8	23.1	36.3	42.8	16.7	5.0	30.0	18.1
$50,000 to $74,999	20.6	31.0	34.7	27.3	28.6	14.7	30.0	20.0	9.7
$75,000 or more	12.5	19.0	26.9	18.2	9.5	8.8	35.0	10.0	1.4
Not given	1.9	1.7	.....	.....	4.8	2.0	.....	10.0	1.4
Median =	$39,350	$50,750	$58,250	$48,200	$46,700	$31,400	$62,500	$42,500	$27,400
Received Salary Increase During Past Year	58.2	72.3	76.9	63.7	71.5	50.0	75.0	60.0	41.7
Percentage of increase									
Less than 5%	5.0	3.4	7.7	.....	.....	5.9	10.0	.....	5.6
5% to 9%	28.1	48.3	46.2	45.5	52.4	16.7	30.0	40.0	9.7
10% to 14%	14.4	8.6	3.8	9.1	14.3	17.6	25.0	20.0	15.3
15% or more	9.4	10.3	15.4	9.1	4.8	8.8	10.0	.....	9.7
Not given	1.3	1.7	3.8	.....	.....	1.0	.....	.....	1.4
Median =	9.2	8.7	9.4	8.5	8.4	10.6	9.6	8.0	11.6
Fringe Benefits Received (Adds to more than 100% due to multiple answers)									
Medical insurance (paid)	85.0	93.1	96.2	81.8	95.2	80.4	95.0	90.0	75.0
Dental insurance (paid)	35.0	55.2	76.9	36.4	38.1	23.5	50.0	30.0	15.3
Life insurance (paid)	61.3	81.0	88.5	63.6	81.0	50.0	65.0	50.0	45.8
Sick leave	76.3	98.3	100.0	90.9	100.0	63.7	65.0	80.0	61.1
Vacation	88.8	98.3	100.0	90.9	100.0	83.3	80.0	90.0	83.3
Stock purchase plan	13.1	19.0	26.9	9.1	14.3	9.8	20.0	.....	8.3
Profit sharing plan	21.3	27.6	38.5	36.4	9.5	17.6	15.0	10.0	19.4
Savings plan	11.9	22.4	26.9	18.2	19.0	5.9	15.0	10.0	2.8
Pension plan	32.5	58.6	65.4	63.6	47.6	17.6	30.0	30.0	12.5
Bonus	33.1	36.2	34.6	27.3	42.9	31.4	45.0	40.0	26.4
Trade show/convention/ seminar expense paid	59.4	67.2	76.9	81.8	47.6	54.9	65.0	70.0	50.0
Tuition refund plan	18.8	32.8	42.3	9.1	33.3	10.8	25.0	10.0	6.9
Automobile furnished	49.4	53.4	46.2	54.5	61.9	47.1	40.0	30.0	51.4
Years in Present Job									
1 to 2	29.2	25.9	26.9	18.2	28.6	31.4	35.0	50.0	27.8
3 to 4	11.9	8.6	11.5	9.1	4.8	13.7	5.0	20.0	15.3
5 to 9	26.3	29.3	23.3	18.2	38.0	24.5	20.0	10.0	27.8
10 to 14	8.8	6.9	11.5	9.1	.....	9.8	15.0	10.0	8.3
15 to 24	14.4	20.7	19.2	27.2	19.1	10.8	10.0	10.0	11.1
25 or more	8.1	8.6	3.8	18.2	9.5	7.8	5.0	.....	9.7
Not given	1.3	.....	3.8	.....	.....	2.0	10.0	.....	.....
Median =	6.6	7.7	7.1	12.5	7.2	5.8	6.3	3.0	6.3
Years in Broadcast Industry									
Less than 5	5.6	1.7	3.8	.....	.....	7.8	10.0	10.0	6.9
5 to 9	10.0	5.2	3.8	9.1	4.8	12.8	15.0	10.0	12.5
10 to 14	11.9	12.1	15.4	9.1	9.5	11.8	.....	20.0	14.0
15 to 24	31.3	29.3	23.2	18.2	42.9	32.3	35.0	20.0	33.3
25 or more	38.1	46.5	50.0	63.6	33.3	33.3	30.0	40.0	33.3
Not given	3.1	5.2	3.8	.....	9.5	2.0	10.0	.....	.....
Median =	20.7	24.7	25.7	32.5	21.9	18.7	18.4	17.5	19.0
Do Part-Time or Free-Lance Work	26.9	24.1	19.2	45.5	19.0	28.4	35.0	20.0	27.8
Education									
High school	16.3	12.1	7.7	9.1	19.0	18.6	10.0	.....	23.6
Two years of college	16.9	10.3	7.7	18.2	9.5	20.6	25.0	10.0	20.8
Four years of college	37.5	39.7	38.5	45.4	38.1	36.3	30.0	70.0	33.3
Post-graduate college	26.3	34.5	42.3	27.3	28.6	21.6	25.0	20.0	20.8
Voc/tech school	11.9	13.8	15.4	.....	19.0	10.8	10.0	.....	12.5
Not given	2.5	1.7	3.8	.....	.....	2.9	10.0	.....	1.4
Age, Years									
Under 25	2.5	1.7	3.8	.....	.....	2.9	5.0	.....	2.8
25 to 34	15.6	3.4	3.8	.....	4.8	22.5	5.0	20.0	27.8
35 to 44	29.4	27.6	19.2	18.2	42.8	30.5	35.0	20.0	30.5
45 to 54	20.6	22.4	26.9	27.3	14.3	19.6	20.0	30.0	18.1
55 or over	30.0	43.2	42.5	54.5	38.1	22.5	25.0	30.0	20.8
Not given	1.9	1.7	3.8	.....	.....	2.0	10.0	.....	.....
Median =	45.8	52.3	52.9	55.0	46.7	42.7	45.0	48.3	41.4

*Management staff: president, owner, partner, vice president, general manager.

n Video
ctions
omas,
i Islands

General Electric
Binghamton, NY

Cleveland
State University
Cleveland, OH

MCNC Research
Triangle Park, NC

Edcom Productions,
Inc.
Cleveland, OH

WBNG-TV
Binghamton, NY

NASA
Palo Alto, CA

Media Artists
Manlius, N

elevision
ury, MD

Newman
Communications, Inc.
Grand Rapids, MI

PSE&G
Newark, NJ

WPGH Television
Pittsburgh, PA

Jet Propulsion
Laboratory
Pasadena, CA

CNA Insurance
Company
Chicago, IL

WIPR-TV
Hato Rey, PR

Square Wh
Productio
Hollywood,

endent
Service
dge, PA

Prime Computer, Inc.
Framingham, MA

Puerto Rican Senate
San Juan, PR

Mamery Productions
Mayaguez, PR

USAA Insurance
Company
San Antonio, TX

University of Texas
Austin, TX

American
Video Cinemas
Lake City, FL

Media Marke
Atlanta, G

Przyborski
rgh, PA

University of Georgia
Athens, GA

Videomaster
of New England
Portsmouth, NH

Vulcan Materials
Birmingham, AL

Boston College
Chestnut Hill, MA

Video Comm.
Montgomery, AL

North American Coal
Company
Bismarck, ND

Speak The W
Church
Minneapolis,

University
ines, IN

Houston Independent
School District
Houston, TX

E.R. Squibb & Sons
Princeton, NJ

Optimetric
Houston, TX

WDSI-TV
Chattanooga, TN

WKOW-TV
Madison, WI

S.C. Johnson & Son
Racine, WI

University of
(Dental Sch
Houston,

err
Company
berg, WI

Main Stream
Communications
Minneapolis, MN

David Hetland LTD.
Fargo, ND

McDonnell Douglas
Aircraft
St. Louis, MO

Calvary
Baptist Church
Jackson, MS

WDAY-TV
Fargo, ND

Harley Davidson
Motor Company
Milwaukee, WI

TAVPRO
Omaha, N

Energy
dge, MA

Nebraska
Public Power
Columbus, NE

WDAZ-TV
Grand Forks, ND

Precision Tapes
Minneapolis, MN

On Q
Video Productions
West Allis, WI

Sandia Laboratories
Albuquerque, NM

Dallas Power & Light
Dallas, TX

LSW Syste
El Paso, T

edia Group
ence, RI

Golden Rule
Insurance
Elkhart, IN

Group W Cable
Chicago, IL

University of Florida
Gainesville, FL

Clark College
Atlanta, GA

KFBB-TV
Great Falls, MT

Priority One
Plano, TX

Carlson Vid
Billings, M

au of
Education
on, MA

St. Joseph Hospital
Kansas City, MO

University of Texas
(Health Service-Center)
Dallas, TX

Video Consultants
Overland Park, KS

Meyer Broadcasting
Bismarck, ND

ARCO Oil & Gas
Company
Dallas, TX

Beard
Publishing Company
Arlington, TX

Gator Produc
Hialeah, F

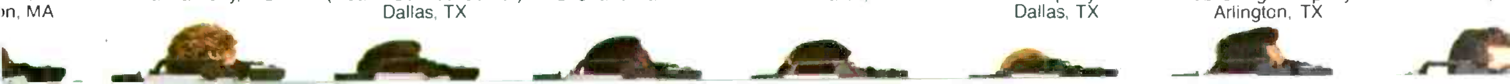

TABLE 2.—ENGINEERING AND TECHNICAL STAFF PROFILE*

	ALL MARKETS	TELEVISION							
	Total %	Total TV %	Top 50 %	Top 100 %	Below Top 100 %	Total Radio %	Top 50 %	Top 100 %	Below Top 100 %
Salary Level									
Less than $15,000	11.2	1.5	.....	.....	6.1	21.4	4.2	10.0	38.1
$15,000 to $24,999	26.1	18.3	7.9	35.7	27.3	34.4	22.9	45.0	39.6
$25,000 to $34,999	26.5	30.6	23.7	32.1	45.4	22.1	20.8	40.0	17.5
$35,000 to $49,999	22.4	29.9	39.5	17.9	18.2	14.5	31.3	5.0	4.8
$50,000 to $74,999	11.6	15.3	26.3	.....	3.0	7.6	20.8	.....	.....
$75,000 or more	2.2	4.4	2.6	14.3	.....	.....	.....	.....	.....
Not given	.....	.....	.....	.....	.....	.....	.....	.....	.....
Median =	$29,800	$34,900	$42,050	$29,400	$28,700	$23,650	$36,050	$24,000	$18,400
Received Salary Increase During Past Year	74.6	83.9	81.6	82.1	90.9	64.9	81.2	70.0	50.8
Percentage of increase									
Less than 5%	17.9	21.9	14.5	32.1	30.3	13.7	12.5	20.0	12.7
5% to 9%	44.4	56.2	61.8	42.9	54.6	32.1	45.8	35.0	20.6
10% to 14%	6.7	4.4	4.0	7.1	3.0	9.2	8.3	5.0	11.1
15% or more	4.1	.7	1.3	.....	.....	7.6	12.5	.....	6.4
Not given	1.5	.7	.....	.....	3.0	2.3	2.1	10.0	.....
Median =	7.1	6.8	7.2	6.1	6.3	7.8	8.0	6.5	8.1
Fringe Benefits Received (Adds to more than 100% due to multiple answers)									
Medical insurance (paid)	82.8	89.1	93.4	82.1	84.8	76.3	97.9	80.0	58.7
Dental insurance (paid)	47.0	56.2	72.4	39.3	33.3	37.4	50.0	35.0	28.6
Life insurance (paid)	62.3	70.8	77.6	64.3	60.6	53.4	64.6	50.0	46.0
Sick leave	80.2	92.0	97.4	82.1	87.9	67.9	89.6	35.0	61.9
Vacation	92.2	97.8	100.0	89.3	100.0	86.3	95.8	90.0	77.8
Stock purchase plan	19.0	27.0	36.8	21.4	9.1	10.7	20.8	15.0	1.6
Profit sharing plan	15.3	13.9	9.2	10.7	27.3	16.8	22.9	20.0	11.1
Savings plan	21.6	31.4	42.1	21.4	15.2	11.5	22.9	.....	6.3
Pension plan	48.5	65.7	78.9	64.3	36.4	30.5	39.6	20.0	27.0
Bonus	14.6	16.1	17.1	21.4	9.1	13.0	6.3	15.0	17.5
Trade show/convention/ seminar expenses paid	38.8	39.4	35.5	42.9	45.5	38.2	62.5	35.0	20.6
Tuition refund plan	32.5	45.3	60.5	25.0	27.3	19.1	29.2	5.0	15.9
Automobile furnished	19.8	13.1	3.9	21.4	27.3	26.7	27.1	60.0	15.9
Years in Present Job									
1 to 2	25.7	18.2	17.1	21.4	18.2	33.6	35.3	20.0	34.8
3 to 4	15.3	16.8	21.1	17.9	6.1	13.7	12.5	5.0	17.5
5 to 9	23.9	27.0	26.3	21.4	33.3	20.6	25.0	20.0	15.9
10 to 14	10.8	10.2	10.5	10.7	9.1	11.5	6.3	15.0	14.3
15 to 24	14.6	14.6	13.2	14.3	18.2	14.5	16.7	20.0	11.1
25 or more	8.2	11.7	9.2	14.3	15.1	4.6	.....	10.0	6.4
Not given	1.5	1.5	2.6	.....	.....	1.5	4.2	.....	.....
Median =	6.7	7.7	7.0	7.5	8.9	5.5	5.0	9.0	4.7
Years in Broadcast Industry									
Less than 5	7.5	3.7	2.6	3.6	6.1	11.5	8.3	15.0	12.7
5 to 9	17.5	19.7	22.4	14.3	18.2	15.3	10.4	.....	23.8
10 to 14	22.0	19.7	21.1	17.9	18.2	24.4	22.9	20.0	27.0
15 to 24	24.3	26.3	27.6	32.1	18.2	22.1	31.3	25.0	14.3
25 or more	27.6	29.9	25.0	32.1	39.3	25.2	22.9	40.0	22.2
Not given	1.1	.7	1.3	.....	.....	1.5	4.2	.....	.....
Median =	16.0	17.5	16.0	20.9	20.7	14.6	16.9	20.0	12.5
Do Part-Time or Free-Lance Work	41.8	28.5	30.3	28.6	24.2	55.7	52.1	50.0	60.3
Education									
High school	21.3	18.2	15.8	21.4	21.2	24.4	10.4	35.0	31.7
Two years of college	33.6	33.6	30.3	32.1	42.4	33.6	39.6	35.0	28.6
Four years of college	28.0	28.5	34.2	21.4	21.2	27.5	37.5	25.0	20.6
Post-graduate college	9.7	9.5	7.9	10.7	12.1	9.9	8.3	5.0	12.7
Voc/tech school	34.9	43.1	42.1	42.9	45.5	36.6	27.1	50.0	39.7
Not given	1.5	1.5	2.6	.....	.....	1.5	4.2	.....	.....
Age, Years									
Under 25	5.6	1.5	.....	3.6	3.0	9.9	4.2	5.0	15.9
25 to 34	32.5	32.1	43.4	17.9	18.2	32.9	33.3	35.0	31.8
35 to 44	28.0	27.0	27.6	25.0	27.3	29.0	39.6	20.0	23.8
45 to 54	14.9	19.7	13.2	32.1	24.2	9.9	10.4	10.0	9.5
55 or over	17.9	19.0	14.5	21.4	27.3	16.8	8.3	30.0	19.0
Not given	1.1	.7	1.3	.....	.....	1.5	4.2	.....	.....
Median =	39.1	40.9	37.1	46.1	45.6	37.2	37.6	40.0	36.0

*Engineering and technical staff: technical manager, chief engineer, engineer.

ersity of Mexico erque, NM | Laird Telemedia Salt Lake City, UT | Coastal Video Productions Norfolk, VA | Valcas Video Production, Inc. River Edge, NJ | VideoAds Kennebunkport, ME | Searle's Video News Service Richmond, MA | Reliance Electric Visual Systems Eastlake, OH | Rochester Ins of Technolo Rochester, I

i Lakes gh School ni, FL | Harris Corporation Palm Bay, FL | WXEL-TV Boynton Beach, FL | Florida News Service Tallahassee, FL | Tampa General Hospital Tampa, FL | WTVT-TV Tampa, FL | WINK-TV Ft. Myers, FL | Paradise Vic Miami, FL

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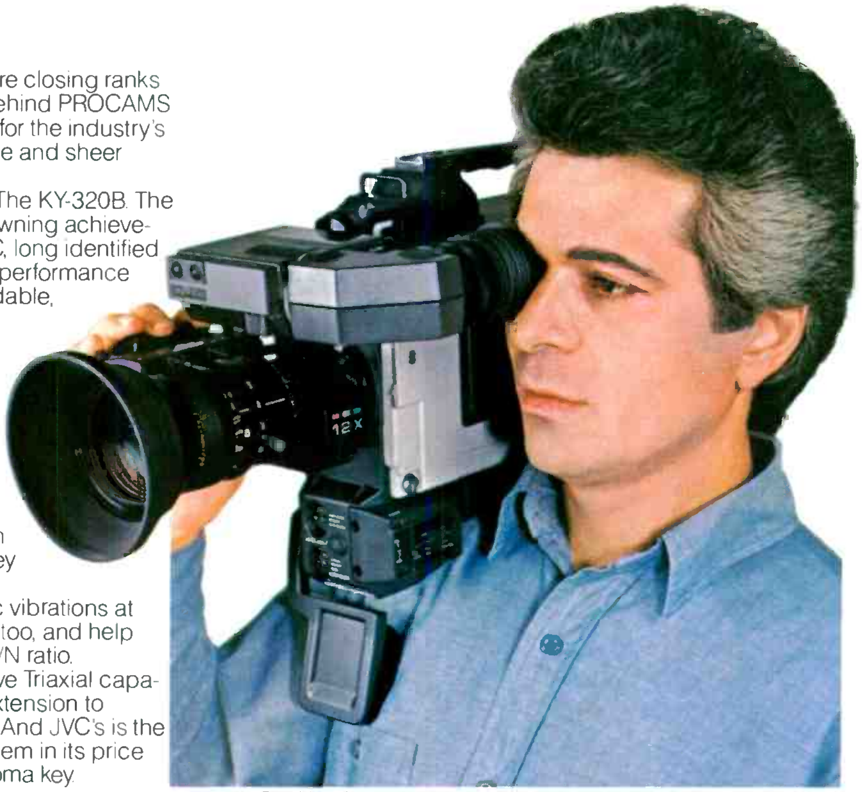

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nroe ty College ster, NY | Dyna-Mark Oklahoma City, OK | United Telecom Inc. Shawnee Mission, KS | Mitre Bedford, MA | Syracuse Fire Department Syracuse, NY | BF Goodrich Cleveland, OH | WNSC-TV Rock Hill, SC | Mark III Miami, FL

TABLE 3.—OPERATIONS STAFF PROFILE*

	ALL MARKETS	TELEVISION							
	Total %	Total TV %	Top 50 %	Top 100 %	Below Top 100 %	Total Radio %	Top 50 %	Top 100 %	Below Top 100 %
Salary Level									
Less than $15,000	15.8	7.5	3.9	3.6	18.5	23.9	11.1	17.6	30.8
$15,000 to $24,999	40.0	34.9	31.4	28.6	48.2	45.0	59.3	29.5	43.0
$25,000 to $34,999	30.2	34.0	35.3	42.8	22.2	26.5	18.5	52.9	23.1
$35,000 to $49,999	9.8	16.0	15.7	21.4	11.1	3.7	7.4	.....	3.1
$50,000 to $74,999	3.3	5.7	9.8	3.6	.....	.9	3.7	.....	.....
$75,000 or more	.9	1.9	3.9	.....	.....	.....	.....	.....	.....
Not given	.....	.....	.....	.....	.....	.....	.....	.....	.....
Median =	$23,500	$27,200	$29,200	$29,200	$21,800	$20,350	$21,550	$25,600	$18,900
Received Salary Increase During Past Year	75.3	87.7	90.1	92.9	77.7	63.3	77.7	82.3	52.3
Percentage of increase									
Less than 5%	15.8	21.7	15.7	21.4	33.3	10.1	11.1	.....	12.3
5% to 9%	35.8	44.3	43.1	53.6	37.0	27.5	25.9	52.9	21.5
10% to 14%	13.0	13.2	19.6	10.7	3.7	12.8	22.2	17.6	10.8
15% or more	7.4	5.7	7.8	3.6	3.7	9.2	18.5	11.8	1.5
Not given	3.3	2.8	3.9	3.6	.....	3.7	.....	.....	6.2
Median =	7.8	7.4	8.2	7.2	5.8	8.6	10.4	8.9	7.5
Fringe Benefits Received (Adds to more than 100% due to multiple answers)									
Medical insurance (paid)	75.3	85.8	86.3	89.3	81.5	65.1	70.4	70.6	61.5
Dental insurance (paid)	43.3	59.4	64.7	64.3	44.4	27.5	40.7	29.4	21.5
Life insurance (paid)	51.6	60.4	66.7	64.3	44.4	43.1	51.9	52.9	36.9
Sick leave	83.7	95.3	98.0	92.9	92.6	72.5	88.9	76.5	64.6
Vacation	93.0	97.2	98.0	92.9	100.0	89.0	92.6	88.2	87.7
Stock purchase plan	10.7	17.9	15.7	39.3	.....	3.7	7.4	.....	3.1
Profit sharing plan	13.0	21.7	23.5	21.4	18.5	4.6	3.7	.....	6.2
Savings plan	12.6	21.7	25.5	21.4	14.8	3.7	3.7	.....	4.6
Pension plan	39.5	56.6	60.8	57.1	48.1	22.9	22.2	29.4	21.5
Bonus	20.5	24.5	15.7	35.7	29.6	16.5	7.4	29.4	16.9
Trade show/convention/ seminar expenses paid	30.7	37.7	39.2	35.7	37.0	23.9	48.1	23.5	13.8
Tuition refund plan	21.4	27.4	37.3	17.9	18.5	15.6	25.9	11.8	12.3
Automobile furnished	8.4	10.4	7.8	10.7	14.8	6.4	3.7	11.8	6.2
Years in Present Job									
1 to 2	38.2	40.6	39.2	39.3	44.4	35.7	48.2	23.5	33.9
3 to 4	27.4	25.5	25.5	32.1	18.6	29.4	33.3	23.5	29.2
5 to 9	18.1	17.0	23.5	14.3	7.4	19.3	14.8	41.2	15.4
10 to 14	7.9	6.6	5.9	7.1	7.4	9.2	3.7	5.9	12.3
15 to 24	5.1	4.7	.....	3.6	14.8	5.5	.....	5.9	7.7
25 or more	2.8	4.7	5.9	.....	7.4	.9	.....	.....	1.5
Not given	.5	.9	.....	3.6	.....	.....	.....	.....	.....
Median =	3.8	3.7	3.8	3.6	3.6	4.0	3.1	5.4	4.1
Years in Broadcast Industry									
Less than 5	8.8	7.6	7.8	3.6	11.1	10.1	18.6	5.9	7.7
5 to 9	28.8	33.0	39.2	35.7	18.5	24.8	22.2	23.5	26.1
10 to 14	21.9	17.0	15.7	17.8	18.5	26.6	22.2	47.1	23.1
15 to 24	29.3	28.2	19.6	35.7	37.1	30.3	33.3	23.5	30.8
25 or more	9.8	12.3	15.7	3.6	14.8	7.3	3.7	.....	10.8
Not given	1.4	1.9	2.0	3.6	.....	.9	.....	.....	1.5
Median =	12.7	12.5	10.7	12.5	15.7	12.8	12.1	12.2	13.4
Do Part-Time or Free-Lance Work	43.7	44.3	45.1	42.9	44.4	43.1	44.4	47.1	41.5
Education									
High school	13.0	7.5	5.9	10.7	7.4	18.3	14.8	11.8	21.5
Two years of college	20.9	14.2	13.7	14.3	14.8	27.5	22.2	23.5	30.8
Four years of college	43.7	50.9	58.8	53.6	33.3	36.7	44.4	47.1	30.8
Post-graduate college	18.1	22.6	15.7	21.4	37.0	13.8	14.8	17.6	12.3
Voc/tech school	14.0	10.4	3.9	14.3	18.5	17.4	25.9	11.8	15.4
Not given	.5	.9	2.0	3.6	.....	.....	.....	.....	.....
Age, Years									
Under 25	10.2	6.6	7.8	3.6	7.4	13.8	14.8	5.9	15.4
25 to 34	45.7	45.3	47.1	50.0	37.1	45.9	51.9	52.9	41.5
35 to 44	28.8	29.2	25.5	35.6	29.6	28.4	22.2	35.3	29.2
45 to 54	8.4	11.3	11.8	3.6	18.5	5.5	3.7	.....	7.7
55 or over	6.0	5.7	7.8	3.6	3.7	6.4	7.4	5.9	6.2
Not given	.9	1.9	.....	3.6	3.7	.....	.....	.....	.....
Median =	33.6	34.4	34.0	33.9	36.3	32.9	31.8	33.3	33.3

*Operations staff: operations manager, station manager, production/program manager.

TABLE 4. — MEDIAN SALARY SUMMARY FOR 1985 AND 1986, TV

	1985 SURVEY				1986 SURVEY			
Category	All Markets	Top 50	Top 100	Below Top 100	All Markets	Top 50	Top 100	Below Top 100
Management	$57,750	$69,750	$59,000	$45,950	$50,750	$58,250	$48,200	$46,700
Engineering	$31,500	$37,550	$28,500	$25,300	$34,900	$42,050	$29,400	$28,700
Operations	$28,800	$31,800	$24,750	$23,500	$27,200	$29,200	$29,200	$21,800

TABLE 5. — MEDIAN SALARY SUMMARY FOR 1985 AND 1986, RADIO

	1985 SURVEY				1986 SURVEY			
Category	All Markets	Top 50	Top 100	Below Top 100	All Markets	Top 50	Top 100	Below Top 100
Management	$34,800	$50,750	$39,500	$28,600	$31,400	$62,500	$42,500	$27,400
Engineering	$23,000	$29,800	$25,000	$18,600	$23,650	$36,050	$24,000	$18,400
Operations	$20,000	$24,600	$20,850	$17,700	$20,350	$21,550	$25,600	$18,900

TABLE 6. — MEDIAN SALARIES ACROSS ALL MARKETS

	TELEVISION				RADIO			
Category	1983	1984	1985	1986	1983	1984	1985	1986
Management	$60,000	$46,250	$57,750	$50,750	$28,600	$28,300	$34,800	$31,400
Engineering	$27,600	$28,900	$31,500	$34,900	$20,850	$23,700	$23,000	$23,650
Operations	$24,750	$25,300	$28,800	$27,200	$17,350	$16,500	$20,000	$20,350

TABLE 7. — MEDIAN VALUE PROFILE OF BROADCASTERS (Radio and TV Combined)

	MANAGEMENT			ENGINEERING			OPERATIONS		
Category	1984	1985	1986	1984	1985	1986	1984	1985	1986
Salary Level	$33,900	$41,000	$39,350	$26,500	$27,800	$29,800	$21,100	$24,700	$23,500
Received Salary Increase	60.6%	58.9%	58.2%	73.0%	75.5%	74.6%	80.5%	77.7%	75.3%
Amount of Increase	8.7%	9.4%	9.2%	8.0%	7.6%	7.1%	8.5%	8.2%	7.8%
Years in Present Job	6.8	7.1	6.6	5.8	6.0	6.7	4.6	4.4	3.8
Years in Broadcasting	21.3	23.1	20.7	15.8	16.1	16.0	11.9	13.5	12.7
Does Free-Lance Work	30.6%	28.3%	26.9%	46.9%	48.4%	41.8%	47.2%	48.0%	43.7%
College >2 years	76.5%	83.2%	80.7%	66.2%	63.5%	71.3%	86.5%	82.8%	82.7%
Age, Years	44.1	44.5	45.8	39.0	39.8	39.1	33.5	33.9	33.6

David Peters, Assistant Engineer KGLT Radio Station, Bozeman, Montana.

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And at every level in between... Dolby SR is not only superior at the extremes of dynamic range—a signal of exceptional purity is obtained at all signal levels. There is no tape modulation noise to be heard and no noise from the system itself. There are no staircase conversion inaccuracies, transient side effects, or phase anomalies due to steep low-pass filters, because Dolby SR does not employ digital conversion.

Listening comparison of line-in to line-out on a simultaneous basis is the ultimate test of any recording process. Dolby SR consistently passes this test.

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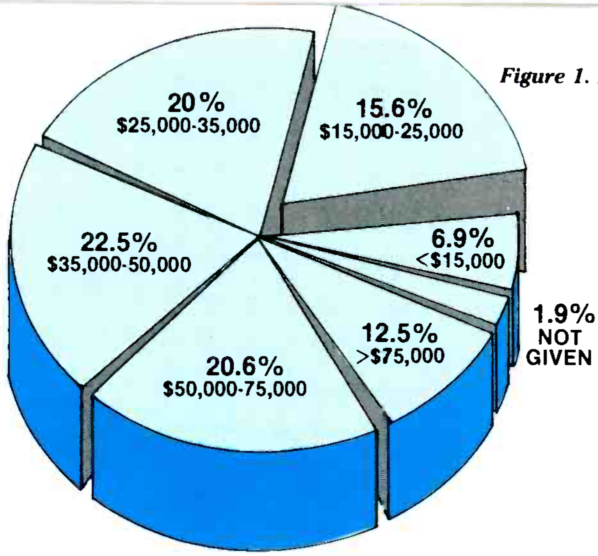


Figure 1. *Median management salaries by salary category.*

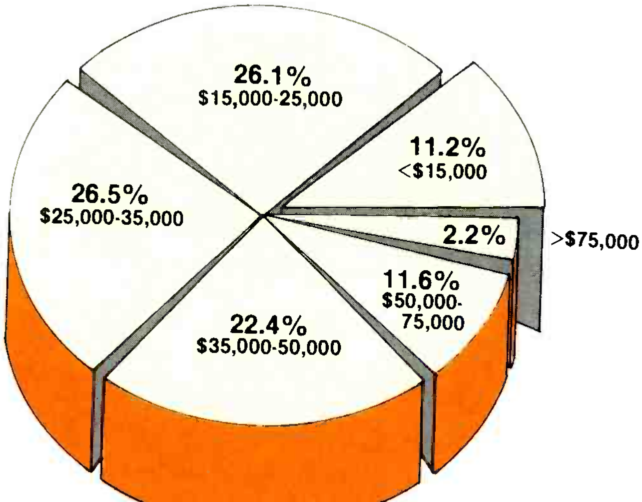
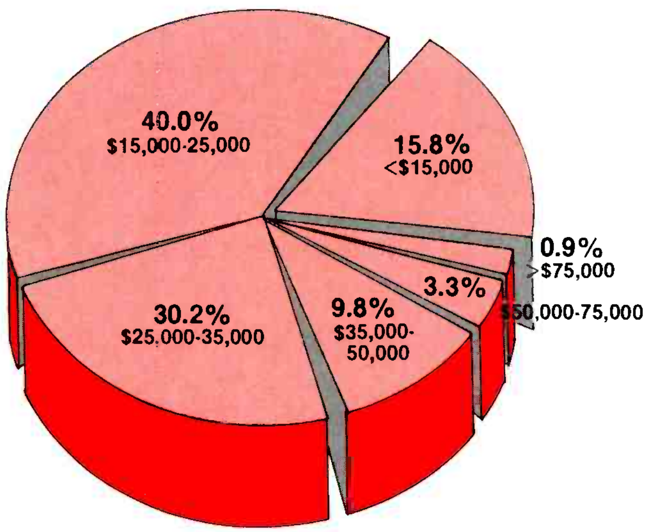


Figure 2. *Median engineering salaries by salary category.*

Figure 3. *Median operations salaries by salary category.*



smallest percentage increase shown.

The bad news

If you think a 2% increase for operators is bad news, look at what happened to the TV manager median salary. This category enjoyed the largest increase in median salary of any group last year, almost 25%. This year, however, any hoped-for trend of continuing increases failed to materialize.

This year's salary survey shows a 12% decrease in the TV manager median salary. The change dropped the salary from $57,750 to $50,750. This decrease parallels the loss experienced in 1984 when these salaries dropped by almost 30%. Based on the last six surveys, there seems to be a lack of consistency in TV manager salaries. Although an upward trend was noted from 1981 to 1983, the large drops in 1984 and 1986 have almost wiped out those early gains.

The radio manager salaries were also on the losing end of the survey. These salaries increased by 23% in 1985. This year, however, they dropped by 10%, from $34,800 to $31,400.

The other category showing a decrease in median salary was that of the TV operators. From a 1985 median salary of $28,800, TV operator salaries dropped to $27,200, reflecting a loss of 6%. This decrease almost wipes out the 9% increase enjoyed by TV operators last year.

As shown last year, the larger markets pay better salaries. Although that is to be expected, a close examination of the data provided a couple of surprises. The radio manager median salary in the *top 50* markets increased by a whopping 23% this year. Matching the radio manager's increase, radio operator median salaries in the *top 100* markets also saw a 23% increase.

Salary trends

From the available data, it appears there is a general upward trend in engineering salaries. This is not to say that every radio and TV engineer is enjoying this salary growth. Yet, the data shows an overall growth in technical salaries over the past six years.

The past three years have produced consistent growth in TV engineer median salaries. In fact, the only setback came in 1983 when TV salaries dropped by 5%. The following years more than made up for that loss.

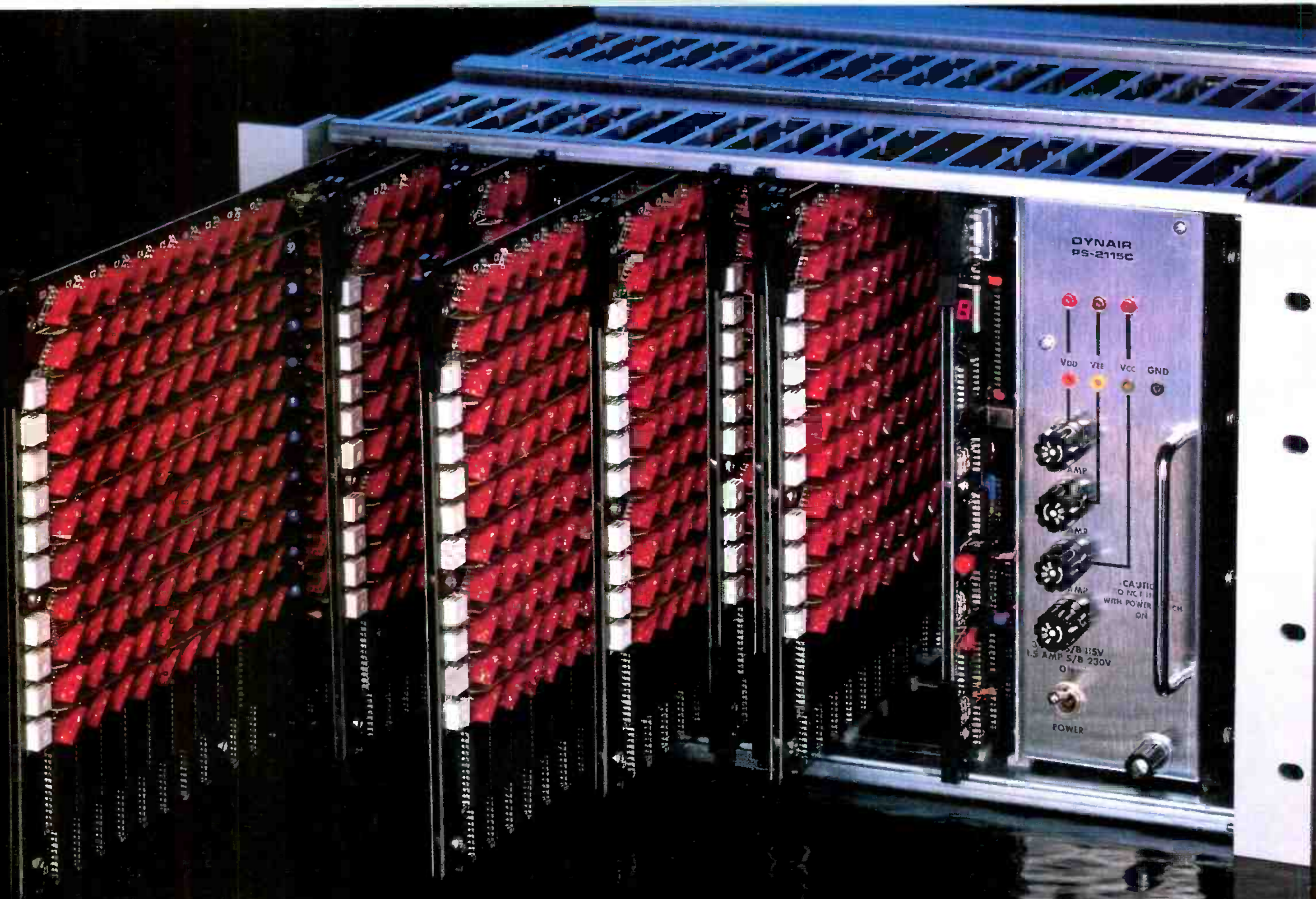
Radio engineers saw a significant increase in median salaries in 1984. Although that rate of increase has not been sustained, it provided a plateau from which salaries are still going up.

Not every category enjoyed the same success. The TV manager median salary for the *top 100* markets decreased by 18%. In fact, the TV manager median salary decreased over all four market categories. These decreases ranged from 7% to 18%. The larger markets showed the larger decreases.

Conversely, the TV engineer median salary, measured by market, increased from last year. The increases ranged from 3% in the *top 100* markets to 13% in the *below top 100* markets.

The radio operators continue to enjoy median salary increases. Over the past two years, this salary category has increased by 23%. Yet, the net change over the last six years is only 7%.

It's sometimes interesting to compare more than just base salary figures. For instance, compare your salary against what the majority of others receive in similar positions. If you find that your salary falls within the majority for that category, it may be competitive. However, if you find that your salary falls in the same category as only 2% of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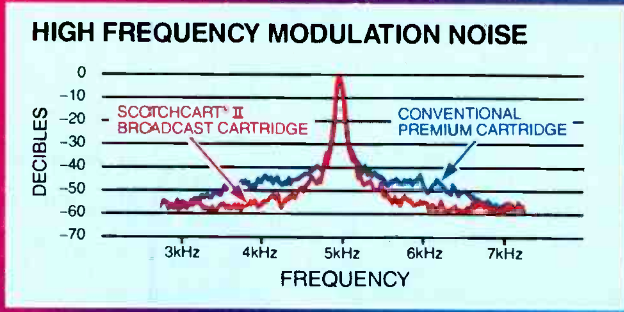
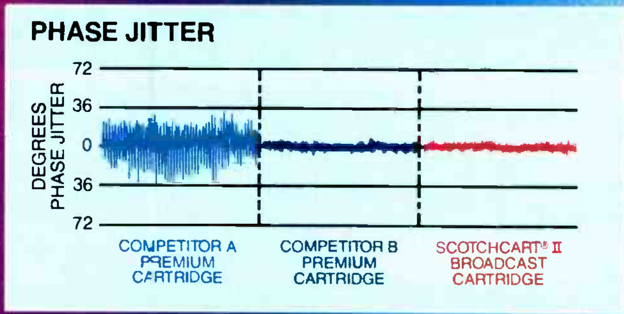
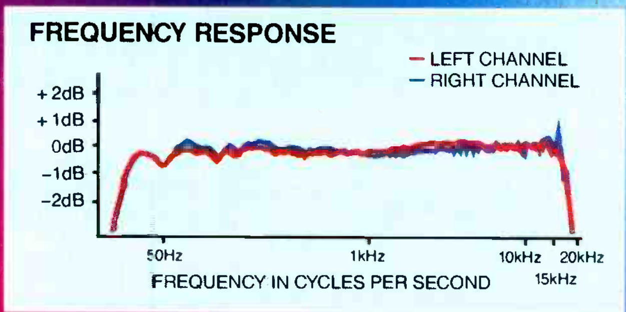


The Revolutionary ScotchCart® II broadcast cartridge design eliminates the excessive audio sideband noise which results from the rubbing effects of pressure pads and the mechanical irregularities of rotating hubs found in conventional cartridge designs.



Some competitive cartridges sound muddy on the air because of excessive phase jitter. ScotchCart® II broadcast cartridges sound crisp and clean.



The new tape was conceived as an integral part of a complete cartridge system. When used with high quality equipment, such as an ITC "99B" cartridge machine, the ScotchCart® II broadcast cartridge is capable of frequency response equalling professional reel-to-reel performance.

were assembled by the engineers into a working *system* that could be operated by less-trained personnel.

To the first simple systems, more devices were added. The original wire antenna was replaced by vertical towers with ground radials. Then, multiple vertical antennas were added to control propagation. Adding a phaser and antenna monitors further increased the system's complexity. Finally, a computer was added to control the station's entire transmission system.

The original studio sound source was probably the carbon microphone. It didn't take long for someone to realize that more sources were desirable. Tape machines, turntables, compact disc players, mixers, equalizers, compressors and audio processors soon became commonplace. Today's audio chain has become so complex that much of it is digitally controlled.

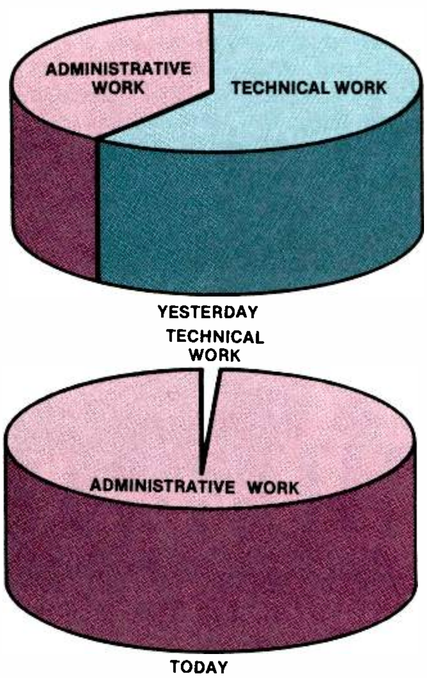


Figure 1. *Today's TV chief engineer spends a much larger portion of time dealing with administrative tasks. Often, little time is left for technical work.*

The first video systems were fairly simple: a source, a mechanical switcher and a transmitter. Then, color video was developed. Along with the inherent complexities of color came cable systems and satellite transmission and a vast array of portable equipment. It is now common for a station to originate programming from locations throughout its viewing and listening area. Today's broadcast systems make all this possible. Today's marketplace makes it necessary.

Although these systems are more complex than ever before, they also are easier to operate and more reliable. It is now possible for a person with only a few weeks of training to relay live TV programming across the United States by satellite.

In broadcast engineering's third generation, the job to be done is not so much *component engineering* as it is *systems engineering.*

Systems constraints

Most of our broadcast systems are constrained by rules, conventions or competition. Technical systems consist of conventional rules we apply to our everyday signals: 600Ω, 0VU, 1VP-P at 75Ω. Other related constraints may be rooted in history, for example: 33⅓ rpm, and 1-inch type C formats. It is no longer possible for any single station to set its own standards. Everyone has to operate according to a number of rules if they want to survive.

Today's engineer must be able to visualize the worst-case scenario.

We apply some system constraints to ourselves by the products and services we purchase. Accounting and logging services, balanced or unbalanced audio, component or composite video recording and sync pulses are examples of system constraints we elect to use by the purchase of devices or services. Equipment manufacturers are the most likely to place system constraints on our broadcast plants.

Even our operators become constraints with which we must live. If the station operation is no longer complex, then we don't need technical staffs. Today it is common for operational people with little technical education to staff and operate high-powered radio and TV stations. Unions, too, have been responsible for placing a number of constraints on broadcasters. Whether or not we agree with them is not the issue. Unions have affected how some stations carry out business.

Broadcasting will neither demand, encourage nor attract the best technically grounded operators.

System engineering

In all cases, the basic act (broadcasting) is built around a system that controls and monitors its function. It is the system that gives the product its intelligence and allows it to meet its goals.

Any system has three components: function, control and feedback. Each system is part of a yet larger system. The effectiveness and efficiency of any system depends on the effectiveness, efficiency and quality of these subsystems. With previous generations, the broadcast engineer's first emphasis was on the component level, then the equipment level, then the systems level. Today's engineers seldom need to be concerned with individual components and equipment is often specified by the system with which it is being used.

In the third generation, we need systems engineers, people who can see the big picture. Systems engineers are only as effective as their ability to see the larger system and its relationship to smaller systems. Given equal resources, the better engineering departments will be those that function on the largest systems level.

Today's engineer

What does this mean for today's engineer? Axioms, such as, "Good decisions require good information and good analysis," and "The broader the approach, the better the odds of success" apply. Engineers who do not understand the basics can never learn the best analytical skills. Engineers who cannot see the big picture will perform poorly.

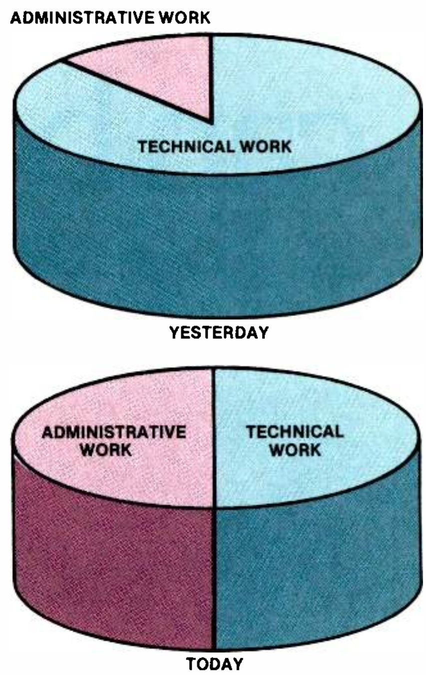


Figure 2. *Today's radio chief engineer spends more time with administrative duties.*

Today's engineer must first think of the end-users, the people on which the system has the most impact. A typical string of users might be the owner, general manager, sales staff, traffic director, operator and maintenance engineer. All of these people use various components within the station's broadcast system.

Today's engineers are rarely equipment chauvinists. They look at all available manufacturers' gear. This doesn't mean that they cannot rule out-of-hand a manufacturer with a poor service record or unsatisfactory support. Although they may love a particular

Continued on page 52

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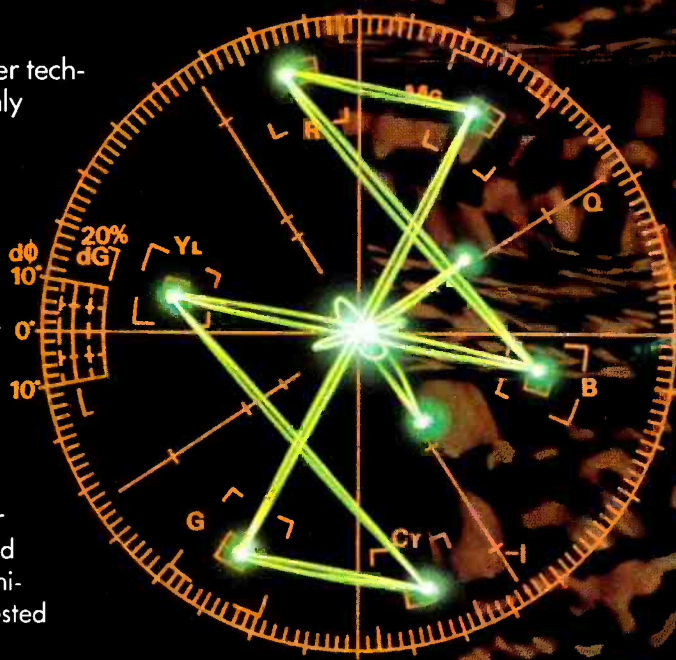

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Continued from page 48
manufacturer's or designer's approach, they are always prepared to jump to a new love when technology or needs dictate a change.

Effective broadcast engineers try to anticipate changes in technology, replacement needs and user responses. They look for secondary benefits and identify potential shortcomings and unknowns. Not everything is logical. Often, success or failure depends not so much on the unknowns, but on what designers call *unk-unks*, the unknown unknowns. Insight into the unk-unks comes from having considerable experience and the ability to carefully analyze situations.

Today's engineer must be able to visualize the worst-case scenario. A systems engineer plans for failure and knows what parts of the system can be

Promotion may attract an audience, but it's the programming that keeps it.

sacrificed for the function of the whole. A systems engineer is conversant with such diverse disciplines as ergonometrics, understands operator traps and develops structures that minimize errors.

Furthermore, a systems engineer can deal with evolution. A plan or design that encourages change in form and function is important. Many broadcast facilities were built in the second-generation period as though they would last forever. Now, these places are more like museums than broadcast stations.

Consider the number of 50kW AM stations operating in their original facilities. The inability to evolve physically and operationally eventually caused some of these more powerful stations to stagnate. Now, some of these stations are being left behind by smaller, newer, more responsive, competitive stations.

The third-generation systems engineer's job is a careful balance of cost-benefits, mean-time between-failure, available resources, operator education, future planning and proper execution. Whether this unique blend of skills is

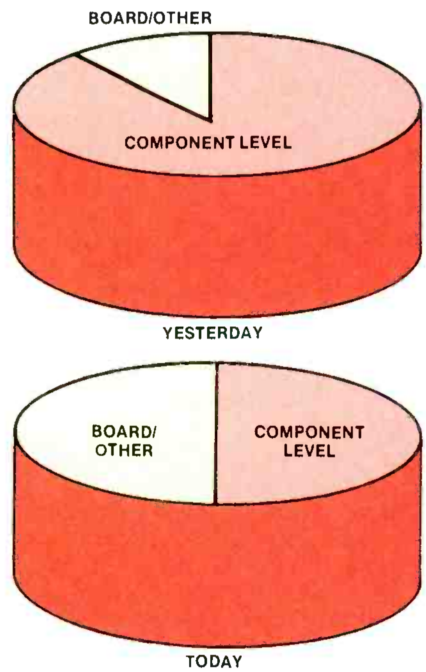

Figure 3. *The early TV equipment relied primarily on component-level servicing techniques. Today, much of the equipment is repaired through circuit board exchange or manufacturer-supplied services.*

readily available is a whole different question.

Today's operators

Equipment operators are also changing. Broadcasting will neither demand, encourage nor attract the best technically grounded operators. The typical broadcast engineer will have a 2-year associate degree in electronics. The station operators may have even less technical education. Both technical and non-technical broadcast engineers/operators will have greater mobility into and out of broadcasting. An extended career in broadcasting will become the exception and not the norm.

Computers and processors will further widen the gap between function and operator. Instruction books will become even less useful and less accurate as the complexity of the gear requires multivolume texts. These texts will increasingly be generated from designers' computer database drawings and parts lists. This means that the documentation will be excellent as construction guides, but will have little application to practical maintenance. The complexity of the equipment and the related complexity of the tools needed will require many repairs to be completed by traveling specialists or centralized service centers. Manufacturers will develop more and more board-serviceable, self-diagnostic equipment.

Source equipment

Broadcast systems have always been limited by the inability to store and retrieve program material. For years, vinyl records and recording tape have been the primary media for storage. However, these technologies place a severe limitation on flexibility. The future holds the possibility for vastly improved quality and flexibility for program source material. A system-design approach will allow optimization of any new technology without handicapping a station's current operation.

Most source and production equipment now performs far better than the transmission systems. The performance of today's consumer equipment, in many cases, exceeds that provided by broadcasters. Seeking an additional 3dB in S/N is fighting a worthless battle. A system constraint exists that currently is not changeable. Striving for improved efficiency, lower cost and utility is where the engineer now wages the battle.

Trends

If you assume that some of this discussion is true, what now? To protect yourselves and your stations, you may want to see if there are any identifiable trends. If there are, then you may be able to use this knowledge to help you adapt

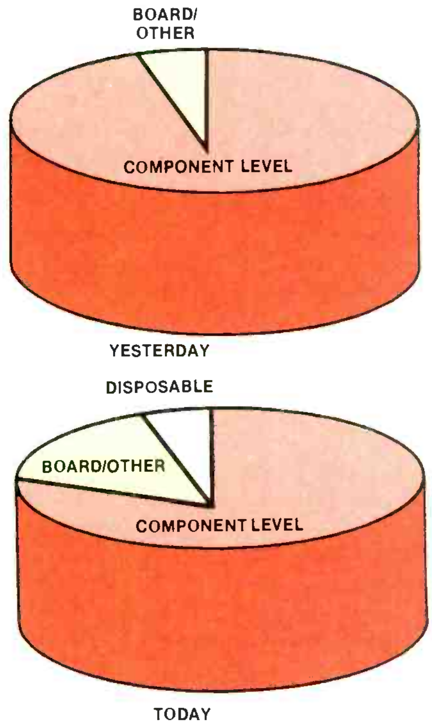

__Figure 4.__ Radio equipment is serviced differently today. In some cases, equipment used in radio stations is not repaired, but simply discarded. Modern technology has developed disposable broadcast equipment.

yourselves, your staffs and facilities to take advantage of these trends.

Broadcasting's third generation is ending. The basic nature of the medium is changing. And, much to the dismay of station managers, the available media *pie* must be continually divided into more pieces. It seems unlikely that the inevitable shakeout will actually take a substantial number of stations off the air. It also seems likely that cable penetration will only increase, as will the number of VCRs and other media sources. These factors will mean additional competition for individual stations.

Programming is becoming more expensive as producers become better marketers and take advantage of the in-

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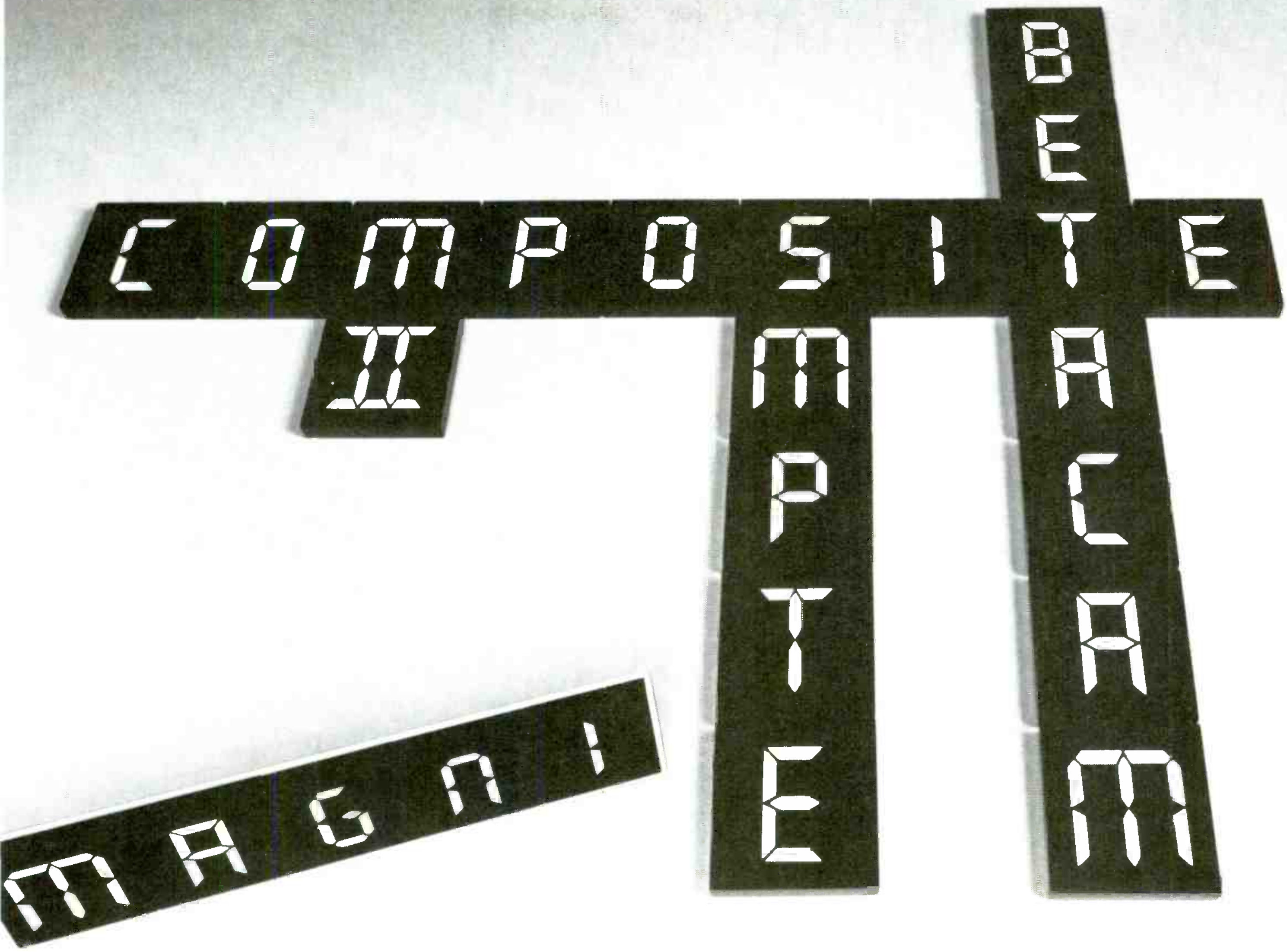

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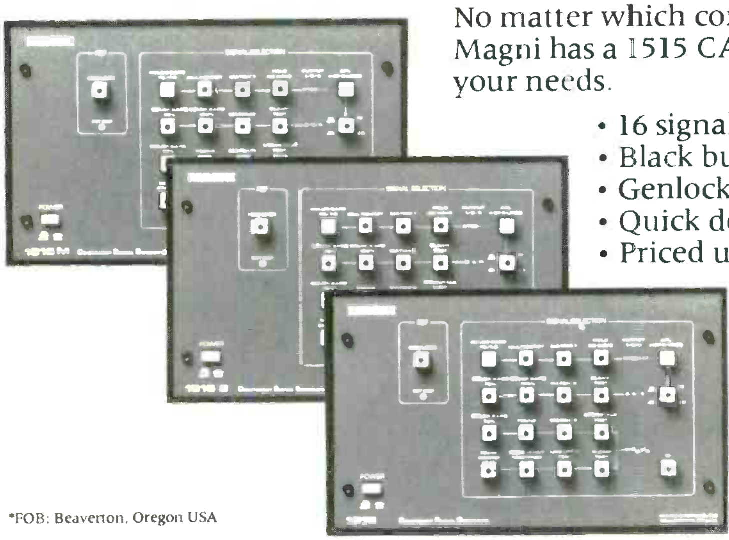

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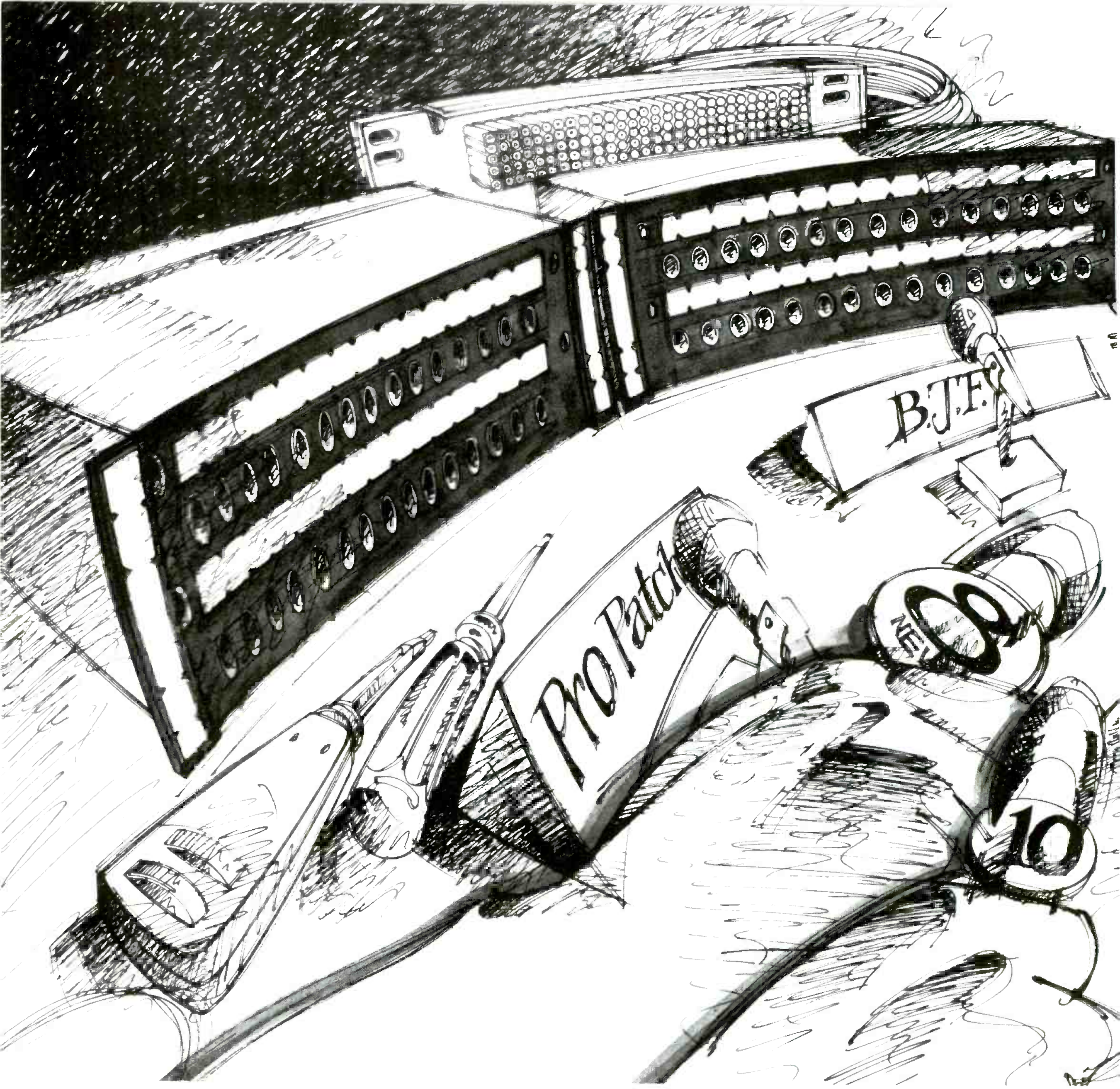
ProPatch
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Continued from page 54
creasing need for product. The consumer is also becoming more sophisticated and demanding better quality. It is no longer possible to attract an audience without quality programming. Promotion may attract an audience, but it's the programming that keeps it.

Perhaps even more critical, broadcast ownership has changed. The early days of entrepreneurs and pioneers putting stations on the air is over. Now, large corporations are buying (or selling) large blocks of stations. These companies view these decisions as nothing more or less than financial transactions. The individual stations must return higher and higher profits or face the consequences.

All this means that financial resources within the station will become increasingly limited and, thus, efficiency will become even more important. Broadcast systems (stations) that cannot respond to this need will be replaced or sold. Engineers who cannot meet the challenge may meet a similar fate.

Broadcast engineer traits

So what's a station to do? How can potential systems engineers be identified? If you're a broadcast engineer, what types of traits will you need to succeed? Although the third-generation engineer is quite different from the first-generation engineer, there are some identifiable characteristics. Here are some of them:

First, they are curious. These people should exhibit the need to be insiders and to know what is going on in each department. The curiosity should not be the kind that seeks destructive gossip, but be a healthy, genuine, innate desire for knowledge. A general curiosity makes it possible to learn lessons from the intricacy of a circuit or dinner with the sales manager. Wanting to learn is worth a lot more than already knowing.

Second, they are excited about the business, still amazed that vibrating electrons can carry sounds and pictures around the world and beyond. Good engineers may be gadget freaks or amateur radio operators, but will know about rating points, ADI and the unnumbered buttons on calculators.

Third, they will be as concerned with station lighting, cleanliness and layout as with technology. Good engineers know when it's more important to replace the carpet than the effects system or audio console.

Fourth, they have a believable view of the future as well as a feeling for the past. They may read Carl Sagan and have Howard Armstrong's biography on their bookshelves. They plan three years ahead and analyze the past as far back as possible.

Fifth, they live, breathe, eat and sleep the technical side of the business. Great engineers know when the proper tool is a pen and not a screwdriver. (Sometimes the screwdriver collects dust for weeks.) Sometimes they are out looking at other stations, reading in the public library or, just as important, gone fishing.

Sixth, they are no strangers to their families and feel a little guilty when they are away from home too long. (A little guilt, however, may be a good thing.) They know where the transmitter on and beeper off switches are located—and when to use each of them.

Seventh, they know that form follows function. Give creative people the technical ability and they will produce impressively. Good engineers see what technical improvements will give the station an advantage, even when the creative people and management do not.

Wanting to learn is worth a lot more than already knowing.

Eighth, they screw up more than occasionally, but have the sense of security and foresight to be the first to say so. Impressive engineers make impressive mistakes.

Ninth, they do not live in a vacuum. While programming and sales departments wage war with the competition, they should be able to slip next door to borrow a piece of gear or replacement part. Every engineer in town should know that they would lend the same or have advice, even at 2 a.m. They should also know when not to talk about programming and sales.

Because of their love of broadcasting, they play an active role in the organizations serving the profession. They speak up at meetings and know when to stand alone for their principles and when to stand united with others.

Tenth, they speak and dress well enough to be welcome and comfortable at a business lunch, but will also have a shop coat and pair of jeans hidden somewhere. Good engineers are equally at home with the custodian and the sales manager.

Impressive engineers make impressive mistakes.

These traits, in the third generation, will make up a great broadcast engineer. To be a great chief engineer, however, requires even more.

Chief engineer traits

Great chief engineers know that humans are far more fragile than equipment. They delegate both work and responsibility and realize there are many solutions to any problem. They are able to live with someone else's solution to a problem, even if they'd have done it differently themselves.

There is a difference between operating engineers and technical engineers. Good chief engineers can talk to, understand and guide both.

Great chief engineers are a comfort and aid to other managers. And yet, they enforce the laws of physics at the department head meetings. They do so when others attempt an impossible technical feat, so others won't be forced to learn by failure. They are not hair shirts, but do look for ways to beat the limits of machinery and cost.

Great chief engineers are risk takers. They will lay out the odds of failure and the rewards of success, then balance them. In the same light, they must be secure and able to accept failure. When the transmitter is down, they should have a Spock-like analytical calm, moving at the correct time with the correct answer at the correct speed.

The first law of physics is entropy. All devices will eventually decay and fail. This is expressed as mean-time between-failure (MTBF). Chief engineers need to remember that this law is just as important as Ohm's law. They ask for spares, build in redundancy, throw out the useless and keep the old but useful. Some old gear is junk; other old gear represents security.

Good chief engineers fight for a quality signal but identify esoteric quality and avoid its great expense. They know what a cost-benefits analysis is and how to apply it to improvement projects.

The proper approach

These are the traits to look for in the third-generation engineers and chief engineers. Don't expect to find them very often. Be cautious of any good trait carried to extreme. Ultimately, all vices are good traits overemphasized. If your station is fortunate enough to have more than one engineer on staff, try to balance their individual traits.

If I were an engineer, I hope I'd realize the meter stick to which I was measured was taller than I. I'd also hope that the scales marked on it included more than technical or operating skills.

In a way, it's ironic that in the third generation of broadcast engineering, the technology that was predicted would isolate and mechanize now realizes abstract analytical skills and people skills.

Broadcast engineering is not going to go the way of the dodo bird. There will always be a need for knowledgeable broadcast engineers. However, the skills needed to become a top-rate broadcast engineer are different than they used to be. What worked then will not work today. What works today will not work tomorrow. It's true that times are changing. So, too, must the broadcast engineer.

Developing an FM processing strategy

By Dennis Ciapura

Don't let the adjustment of your FM audio processing equipment become a 3-ring circus. Step back and plan your approach to this important task.

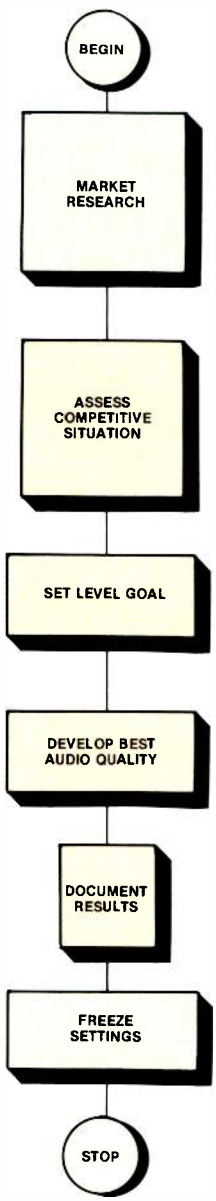

Figure 1. *Developing a successful FM audio processing strategy requires a logical progression from one planning stage to another.*

At most stations, the approach to audio processing system design and implementation is a manifestation of compound craziness. It often involves a set of adjustments that is the result of the program director and the chief engineer alternately tweaking various components of processing armament and running out to listen to the results on their favorite auto receivers. Sometimes the general manager also participates, guaranteeing further compounding.

Oh, there's usually lots of rhetoric about what the competition is doing in the marketplace, and occasionally somebody tries to duplicate the equipment and adjustments that have proved successful at some other station. For the most part, however, the whole operation is born of a non-strategy.

Developing the best possible air product is similar to developing any other successful product, or at least it should be. A radio station's product has three key components: *program content, promotion* and *technical quality.* Each of these elements has a major impact on the product's success in the marketplace. Although broadcasters have become fairly astute at developing programming and promotional strategies, the technical part of this critical triad is more often the result of personalities and station politics than of solid market research and targeted response.

Ciapura, BE's consultant on radio technology, is president of Teknimax, a San Diego-based telecommunications consulting company.

The *Golden Ears* fantasy

The least successful, and most dangerous, approach is to allow the station's technical sound to become the product of anyone's *subjective* influence. The *Golden Ears* phenomenon is a fantasy. More often than not, the bearer of that ubiquitous title is a person who is extremely opinionated about *tailoring* the station's sound, and has been lucky enough to be at one or more stations with great programming and/or promotion. The *Golden Ears* may even have been the architect of the great programming or promotion. If so, no one knows how much better the results could have been if the sound wasn't colored.

This is not to say that there aren't some people who are unusually talented at hearing audio defects, for there certainly are. These people can be invaluable in spotting problems at an early stage before most listeners are affected. However, what we're talking about here are the folks who seek to use the station's audio to paint a personal signature on the air product. Broadcasting breeds strong personalities with a keen sense of product differentiation, and nothing about a station is easier to change than its technical sound. The question is whether altering the *technical* sound of the program material is a valid approach from a business perspective.

Standing out among the 20 to 30 stations that can be heard in most larger radio markets is certainly a difficult proposition. There are only so many programming variations (that the listener could perceive) available to the broadcaster to differentiate that station's air product from the competition's.

Unique promotional activities can help, but that's usually an expensive undertaking and, in the end, the air prod-

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uct itself must provide the appeal. Isn't it logical then, that a unique technical sound might also help define a well-differentiated air product?

The listening environment

For an air product to have maximum appeal it must sound good to most of the listeners most of the time. This seemingly simple axiom has some profound implications. The universe of radio listening environments contains everything from mono portables to equalized auto systems to component systems rivaling professional studio monitors. The key to providing the best possible performance for such a diverse audience lies in providing a technical presentation that is *statistically* compatible with this entity. To understand what that universe looks like, you must first look at the characteristics of the three major FM radio listening environments.

The portable receiver environment is generally characterized by declining low- and high-frequency response, limited undistorted acoustic power and high ambient noise levels. For a typical headphone receiver, however, it's a whole different ball game. Frequency response is practically flat over the audio range, undistorted acoustic power exceeds a human ear's endurance capability and most ambient noise is blocked out.

The auto environment ranges from standard receivers with no low bass, mid-bass peaks and declining high-frequency response, to amplified and equalized systems with tremendous bass boost and screaming highs. The available acoustic power ranges from limited to unlimited, and ambient noise runs anywhere from low to barely tolerable. Another factor is that in all moving vehicles, some form of low-frequency masking occurs due to road noise.

The home listening environment, even with moderately good equipment by today's standards, is generally fairly flat, except for the bass boost from the loudness compensation that most non-audiophiles leave on. Acoustic power capability is unlimited given that typical listening levels and ambient noise levels are low. In the audiophile's home system, which is usually adjusted for flat response, the total environment is more affected by room acoustics than by equipment anomalies.

Can there be an optimum sound?

What happens, then, if you optimize your audio for the small, mono portable radio? To do so means boosting the lows and highs and applying heavy compression so you can make the most of the limited acoustic power and high ambient noise levels. Unfortunately, when monitored on headphone portables, your audio will be awful. If you attempt similar corrections for the standard car radio, the amplified and equalized radios will produce a tubby, raspy sound. Any processing at all will probably have an adverse effect on the sound produced by better home receivers.

How can any tailored sound effectively address such a diverse set of requirements? Clearly, the old notion of optimizing the sound for auto reception in drive time is way off base for many other modern listening situations. In fact, this approach is even wrong for many of today's auto systems.

Statistically, the universe of these listening environments looks like the average of all of them, which is flat. Also bear in mind that the listeners who care the most about their sound usually have equipment that lets them tailor the audio to their own preferences. If so, they probably make those adjustments with a flat and uncompressed tape or CD. For these cases, any station coloration is a

negative factor. Station processing may indeed provide some product differentiation, but unfortunately, the wrong kind.

The best processing, therefore, is no processing. Obviously, that's impossible in the real world because of transmission system limitation, and the higher average level required for competitive reasons. However, a properly developed processing strategy can yield the best level-vs.-quality compromise for any given station and market. This approach helps achieve the objective of delivering the best sound to the most listeners.

Market research pays off

If you accept the premise that the optimum sound is a *neutral* one, and that higher level means more coloration, then it is critically important that you know how high the levels have to be. Unless the station has a unique format and sufficient coverage to go along with it, as many fine arts stations do, the required audio level is largely driven by the marketplace. As a matter of fact, an accurate record of the average levels produced by all of the major competitors in the market is required information. This information will be used in developing a processing strategy, and it's too important to be relegated to the auto radio punch-up test alone.

A simple and effective measurement method is to connect VU meters to the outputs of a good stereo receiver and compare each station's average output to some arbitrary reference level. Two convenient ways to do this are with a receiver feeding the production console, or with the VU meters of a tape deck connected to a home receiver. A 400Hz tone at 50% total modulation from an RF generator is a good reference level because it corresponds to the maximum left and right channel average output achieved by contemporary processing systems. Most stations in the market will probably fall within 1dB to 2dB of the 0VU setting.

All of the stations you're interested in should be resampled at least a couple of times, preferably at different times of the day. This will allow for changes from different board operators and help ensure that the data is accurate. The data should then be circulated to the program director and general manager and a meeting scheduled to discuss the results. This is the first step in developing the processing strategy.

In the end, everyone must agree on the processing objectives and results, so it's important that everyone really understands what's happening in the marketplace. The tests often yield some surprising results. Stations with terrible processing artifacts are often gaining little in average level. Densely modulated FM stereo signals also crash much more audibly in high-multipath situations.

Developing the strategy

The management team (and it's important that this be a team effort) must decide what level the station needs to achieve in order to avoid sounding noticeably softer on the air than its competitors. The engineering department will then have a specific average target level to play against the various quality compromises that every processing system produces. This is where the team's creativity comes into play.

If at all possible, the entire processing system should be taken out of the program chain and moved to a studio. This will permit music samples to be fed into the system over and over again while various combinations of adjustments are tried so that the best fidelity, consistent with the average target level, can be derived.

If the audio processing system incorporates an integral stereo generator, an FM signal generator or spare exciter can be used to generate a ministation. If the FM receiver has a composite output jack, a scope can be connected to view the peak-to-peak levels of the competition and the ministation. This setup will help ensure that the maximum modulation levels are all the same. Multipath must be negligible if the peak-modulation samples are to be accurate.

The best place to conduct these tests is in the production studio, where there are cart, phono and CD sources to match the ones normally employed in the air studio. With this setup, it's easy to compare the receiver output to the program source and the other stations in the market. The most important comparison is to the source. The objective is to give up as little fidelity as possible while still reaching the loudness target level. Remember that it is extremely important that monitor levels be matched exactly during any A/B comparisons with the source. Otherwise, you may be fooled in comparing the various sources.

Because FM is a pre-emphasized system, modern FM audio processors invariably employ frequency-dependent limiting. Therefore, the system's response at higher input levels is likely to sound a little duller than the source. If the system uses a multiband AGC ahead of the limiter, and a little highband boost is used in an attempt to offset the loss, be sure that the high-frequency distortion, low-level response and noise are not adversely affected. Remember the guy in the car who has already boosted his equalizer 10dB at 12.5kHz.

Any inclination to similarly adjust the low-frequency response should be approached with the same caution. If multiple high-pass filtering is affecting the low-frequency response, it's far better to remove all but the first filters in line than to boost the whole lowband in an effort to compensate for the loss.

This sort of experimentation quickly reveals the most sobering aspect of aggressive audio processing: that one quickly reaches a point of diminishing returns. Beyond a certain level, every decibel of average level gained takes a significant toll in sonic purity. Conversely, backing off on the processing usually opens up the sound quality without much difference in loudness.

These relationships can never be adequately explored with the processing system on the air due to the necessity of playing the same test cuts over and over at different levels. Even then, you still have to compare the processed audio to the source audio while checking levels against the competition.

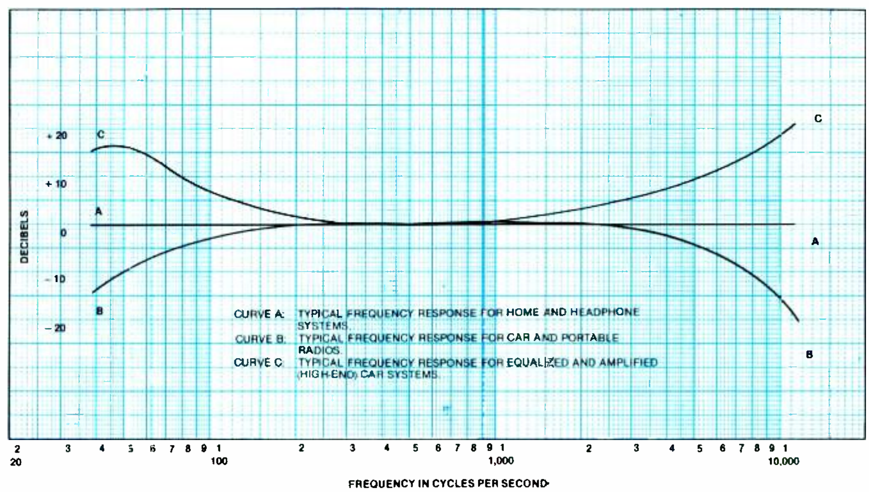


Figure 2. *In general, there are three FM radio listening environments. Although broadcast equalization might make one category sound better, it would adversely affect the others.*

Document the results

When the management team is satisfied that it has engineered the best possible fidelity at the audio target level, it's time to document the results. To the greatest extent possible, the documentation should be done in terms of control-voltage measurements for specified input signals rather than knob positions. The record of these input signals and the resulting meter readings will be invaluable if the equipment is suspected later of misadjustment or drifting.

Obviously, any seat-of-the-pants tweaking after the system is reinstalled in the program chain subverts the whole processing strategy and invalidates the documentation. You should allow at least two days to listen to the A/B comparisons with the source, and level comparisons with the competition while the processing is still feeding the ministation in the production studio. The team should take as much time as it requires to feel confident in the final adjustments and then commit to them. Playing with the processing after it's on the air will only create instability and uncertainty about the many interrelated processing parameters.

Stabilize the sound

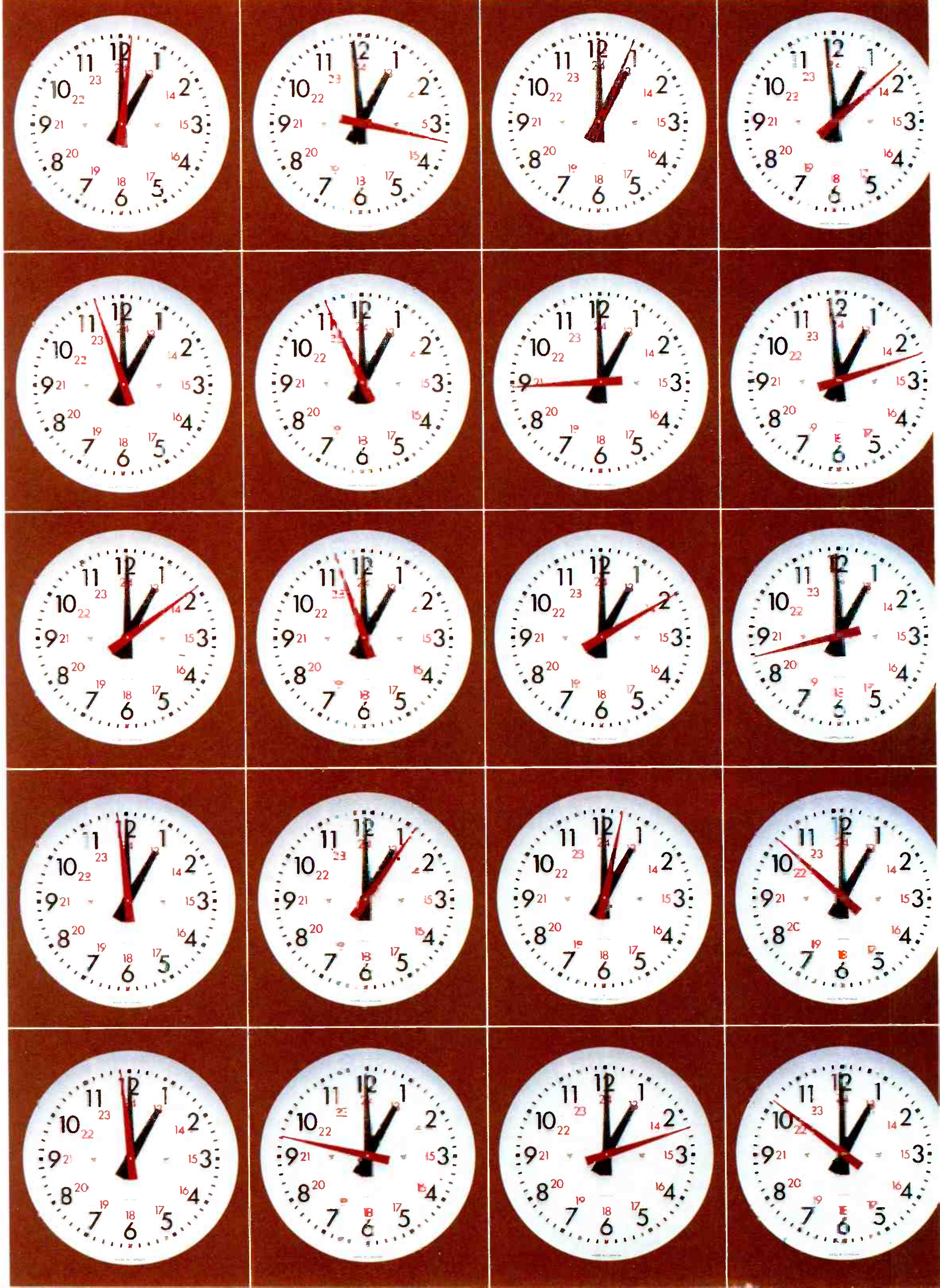
Don't be tempted to try further optimization based on what somebody hears on some receiver or another. There is no such thing as a *standard* receiver. An acoustically and electrically neutral monitoring room (recording studio or control room) can be useful, but few broadcasters have access to such facilities.

Developing an effective FM processing strategy involves a logical, step-by-step approach. It starts with a little market research, followed by an assessment of the competitive situation and the establishment of a level goal. Next comes the research to develop the best audio quality and documentation of the final settings. The final, and probably the most important, step is freezing the processing settings to stabilize the station's technical sound.

The overall business objective is to provide a technical sound that won't reduce the effectiveness of the other components of the air-product triad: program content and promotion.

Most of the radio audience listens to a station for the programming. They tune in either because the promotion sent them there, or they liked what they heard when tuning by. In either case, the listening experience must be as pleasant as possible and the audio quality must not be an irritant.

The real challenge in FM processing today is not the loudness barrier. Any station with the current generation of audio processing gear can be loud. Finding that elusive optimum balance between competitive levels and appealing fidelity takes real audio artistry. With consumer audio equipment improving at an incredible rate, there is a growing incentive to move to more elegant processing approaches. These approaches should, however, be based on a well-defined and scientifically developed strategy.



Managing a community tower site

By Donald E. Lincoln

Managing a community tower site requires the knowledge of an engineer—and the finesse of a diplomat.

In today's political and economic climate, putting up a tower is no small feat. Even if a station can find an appropriate piece of real estate, secure the necessary funding and obtain the seemingly endless permits (beyond those from the FAA and FCC), the advantages of owning a tower are sometimes limited.

The initial costs are quite high. Maintenance can become a major expense and insurance costs continue to skyrocket. In many communities, towers are viewed with such distaste it's almost impossible to obtain permission to locate them in areas that provide the desired coverage area.

Despite the drawbacks, broadcasters must have towers. With the implementation of Docket 80-90, FM stations are finding it necessary to reach the minimum height and power requirements for their licensee class if they want continued protection. Many TV stations are in a similar situation. Increased competition makes it necessary to maximize the station's coverage. If the station is not operating with as much height as possible, its market share may be jeopardized.

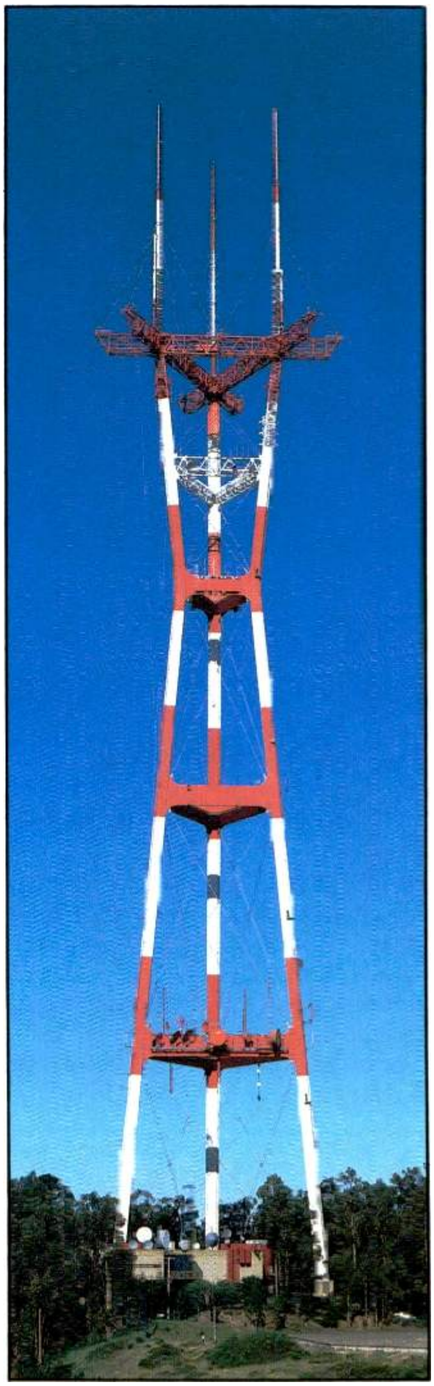
However, not all broadcasters can—or want to—build their own towers. In fact, the FCC, FAA and some communities encourage stations to cooperate in locating broadcast facilities. In some instances, a community tower site may be the only acceptable solution.

Benefits

There are a number of benefits to locating on a single large tower. From the community's standpoint, a single tower site requires only one "ugly" structure, instead of several. The number of antennas mounted on the tower is seldom an objection. It's the number of towers at a site that presents the problem. The fact that only one tower is needed to support the antennas of several stations benefits the builder.

The FAA is one federal agency that favors community antenna sites. In recent years, the FAA has erected numerous roadblocks to the construction of new towers. From the standpoint of aviation traffic, the fewer tall towers, the better. Instead of spreading out the tall broadcast towers across large areas (and, hence, near airports) the FAA tends to favor single locations where several towers can be constructed. This fact may make it easier for a broadcaster to gain the needed height. In other words, you may be able to trade location for height. Similarly, a single tower for multiple stations may gain the FAA's favor if it represents a reduction in the number of broadcast towers.

Lincoln is director of engineering for Sutro Tower, San Francisco.



Sutro Tower is a landmark in San Francisco and is familiar to broadcast engineers throughout the country.

The broadcaster is often the one who benefits most from a community tower site. Although the initial erection costs are far greater than would be encountered with a single smaller tower, the additional costs can be shared among several users. Maintenance, a significant expense for a big tower, can also be shared by the users.

Tall towers are attractive to land mobile, cellular and other private communication users. Owners of large towers usually find it possible to offset many of the tower's ongoing costs by charging these other users for tower space. These companies can often afford to pay reasonably high rates because of the additional height and coverage provided by the tower. A community tower may be able to offset the entire cost of tower maintenance from the fees paid by 2-way radio users.

Tower management

It's not easy to build a community tower. The political realities are difficult to overcome. There is often considerable reservation by various stations in the initial planning stages. Each station wants to be sure that its interests are protected.

To overcome any potential objections and ensure sound management, a formal structure or organization must be developed. In many instances, the stations that begin the project form a separate corporation to direct the tower's construction and management. In this case, the legal jurisdiction is clear, yet controllable. Each of the tower's owners has a clearly defined say in what

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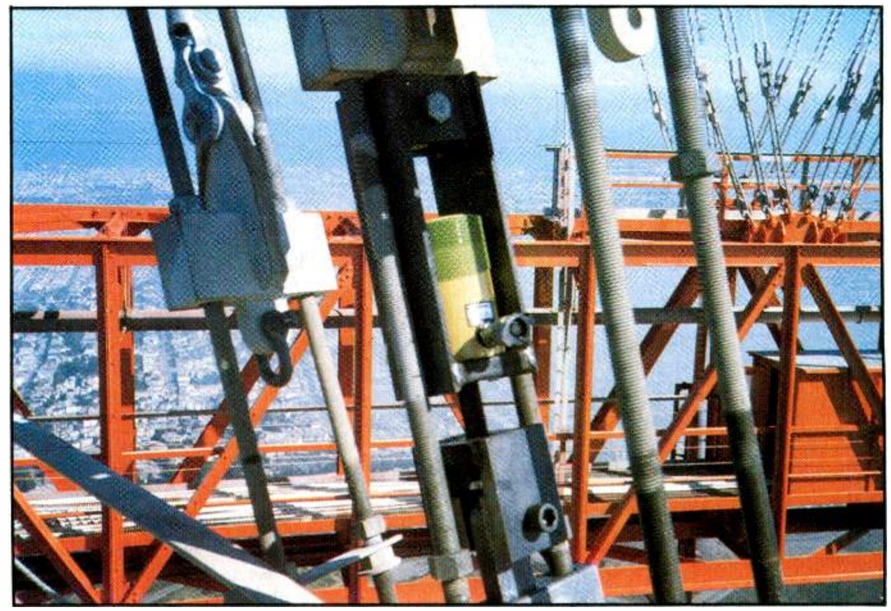
happens as the tower is constructed. Even more important, the formal structure protects the owners' rights after the tower is completed.

Whether daily on-site management is required depends on a number of factors. The first is the tower location. If it's a populated area, then it may be necessary to protect both the tower site and local residents from unauthorized access.

Second, if there are a number of users on the tower, then on-site management is important. As the number of smaller users (2-way, cellular and private carriers) increases, so too does the traffic. Someone must be available on site just to ensure that all of the tenants' installations and equipment are protected.

Finally, the recent FCC rulings on RF radiation (ANSI C95.1-1982), may require that someone be available to coordinate access to the areas of the tower that may contain a high level of RF radiation. In this case, it may be necessary to arrange for some of the stations to switch to auxiliary antennas or reduce power during the needed maintenance period. As the number of high-power stations located on the tower increases, this aspect becomes even more important.



Guy tension for the antenna stacks. Note the hydraulic ram in the center. The RF-protected sixth-level riggers' shack can be seen at the far right.

Community relations

Assuming you are successful in constructing a community tower site, what then? Is the task completed? Hardly. Anytime you have several broadcasters using a common resource, there are bound to be problems. Sometimes the problems don't come from the broadcasters, but from the many non-broadcast tenants on the tower. A carefully developed management organization and well-structured leases can go a long way in preventing squabbles among the tenants.

The location of the tower is critical in terms of community relations. If the tower is located 20 miles outside of town, you may not have any neighbors, and the cows probably won't care if you paint the tower in a wind. However, if the tower is located on or near residential or business property, then you must consider your neighbors' needs. The last thing any broadcaster wants is an

Continued on page 74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Continued from page 70
unhappy neighbor.

It's not difficult to be a pleasant neighbor. Even though the tower property is quite different from the houses or businesses that may surround it, you all have some common interests.

One of today's most likely concerns will be RF radiation. Let's face it: the topic of radiation causes fear in people. In most cases, the fear can be eliminated by open, honest discussion. The FCC has adopted RF standards that—depending on your point of view—may help or hurt your particular situation. Broadcasters now have an accepted *standard* upon which to rely when answering questions on RF radiation.

Answering questions

One of the most important aspects of dealing with the public is honesty. Answer all questions in a forthright and open manner. Don't attempt to hide information. When a specific question is asked, answer it. This doesn't mean you have to give away priority information. It does, however, mean that you must respond with accurate information. Don't make broad statements that can come back to haunt you. Don't be dogmatic, and never state anything as fact if there is any other possible interpretation.

View of the upper section of Sutro Tower. Downtown San Francisco, Oakland and Alameda can be seen in the background.

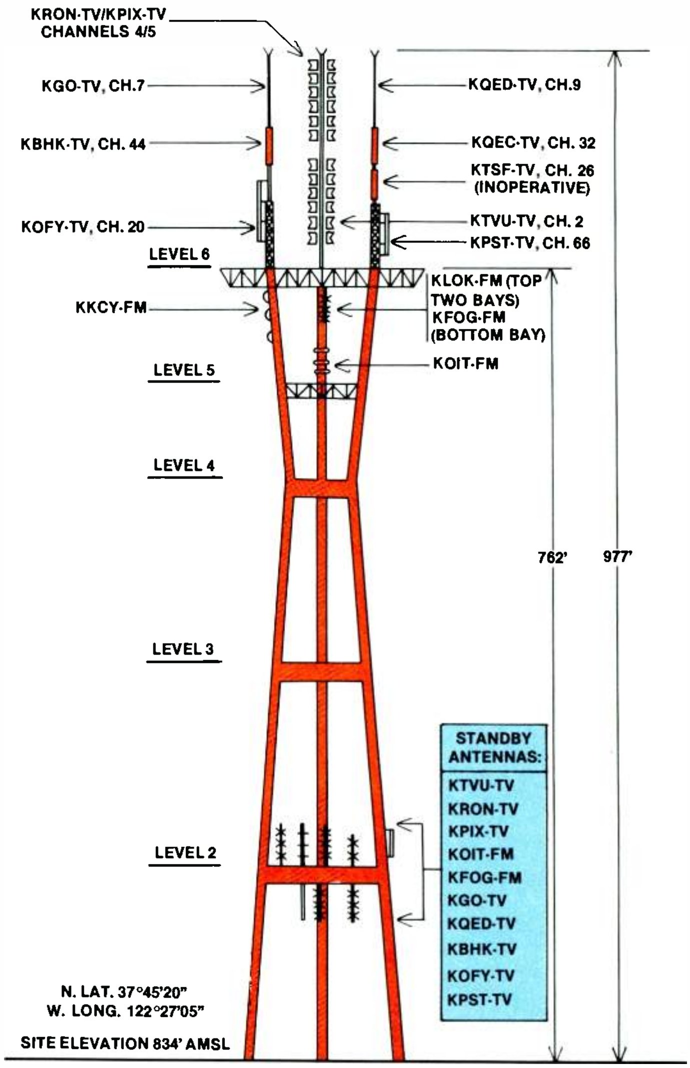

Figure 1. *An elevation drawing showing the location of the various antennas.*

Never talk over the heads of the audience. Let your answers be complete without being so complex that only experts would understand what you're saying. Remember, if a question is asked, the only answer is information—accurate information. Evasion or misdirection will almost always be counterproductive.

Treat any complaint with courtesy, even if you know it's groundless. The most obnoxious complainer can become an ally if handled in a friendly and open manner.

Try to establish good rapport with the local citizens' groups. Attend their meetings and suggest their officers tour your facility. Most often, it is the fear of the unknown that is your greatest enemy. If you can dispel that fear, you've gone a long way toward effective communication.

Be visible and show the community that you have its interests at heart. For example, if you share a road, fix the pothole before being asked. When major work is going to be undertaken, let the neighbors know well in advance. Don't surprise them with sounds of giant cranes at 8 a.m. When possible, show that you've initiated actions to correct or prevent problems. These positive kinds of action can play a big part in maintaining good relationships with the neighbors.

A case history

Sutro Tower was constructed in 1973. At that time, it was one of the largest tower projects ever undertaken in the United States. The tower is owned by four large broadcast companies, all of which have TV antennas on the tower. The original consortium of owners was formed in 1968. Each owner has two representatives on the board of directors, and officers are elected annually. The positions are rotated among the owner companies so that each station has a turn at each elected office.

The tower, illustrated in Figure 1, is 977 feet high and contains three covered levels that are used for radio equipment

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and microwave installations. The top two levels are open areas with catwalks that allow the workers access to the antennas and other equipment.

A riggers' shack located on the east face of the sixth level provides storage for rigging equipment and shelter for the workers. The shack offers RF protection because of a special coating of conductive copper paint. The paint attenuates RF by about 40dB for frequencies between 1MHz and 1GHz. Because of the new FCC RF standards, access to the top two levels of the tower is restricted. Protective clothing is also available for workers.

The original tower provided operational space for six TV and four FM stations. It wasn't long before other broadcasters and RF users wanted space on the tower. In 1976 a large number of ENG receivers were added as broadcasters ventured into the area of live news remotes. Requests from others for tower space continued to be made. To facilitate maintenance on the tower exterior and to help in the installation of these new requests, a maintenance scaffold was added in 1978. This allowed workers to reach places that were previously inaccessible.

The original plan called for microwave antennas and reflectors to be located on the second level. However, this level was basically unused and the activity was concentrated on the fourth level. Most of the ENG equipment, both program and communication, is located on this level.

About the same time, it became obvious that the tower power needs were no longer being met. Consequently, power feeds were added from the main building switchboard. The site now has triple redundant power feeds. Two different electric power feeds enter the building, each from a different substation. To back up these two feeds, the site also has an emergency generator. Switching between the various feeds is automatic. Although both substation feeds seldom fail at the same time, it has happened and the generator has proved its worth.

Maintenance

Sutro Tower, which is located in the geographic center of San Francisco, is often shrouded in fog even when other areas of the city are enjoying sunshine. The fog contains salt spray from the ocean and is a primary cause of constant rusting.

Maintenance on the tower never ends. Because of the amount of maintenance required, Sutro Tower now employs its own riggers and painters. All mechanical work on the antennas, coax lines or waveguides is handled by these crews. When special projects come up, contract workers are hired if needed.

The tower was repainted in 1982. The work required a crew of up to eight painters working full time for almost two months. Because the tower structure is unique, most of the steelwork and mounts for new installations must be custom-designed and fabricated. This work is typically handled by the Sutro engineering department. When necessary, the final designs are checked by an outside structural engineering firm.

LOCATION	PEAK VALUE (mW/cm^2)	MEAN VALUE (mW/cm^2)
PARKING LOT (NORMAL OPERATIONS)	0.013	0.004
ROOFTOP (NORMAL OPERATIONS)	0.53	0.016
SECOND LEVEL (NORMAL OPERATIONS)	0.009	0.003
THIRD LEVEL	0.053	0.007
FOURTH LEVEL	0.27	0.061
ELEVATOR	0.27	0.003
PROPERTY PERIMETER	0.027	0.008

Figure 2. *Typical power-density readings obtained during a recent field-intensity study.*

Management

An engineering committee, consisting of the chief engineers from the four owner stations, reviews each major request for space or modification. The committee examines these requests and determines the impact on the entire complex. Although the requests are usually granted, some may be modified or denied altogether.

Most of the requests are for new or different radio facilities, remote-control systems or ENG changes. The committee enforces a strict policy of protection for the current users. All leases carry a noninterference clause, which requires the new tenant to protect all current tenants.

With the spectrum becoming increasingly crowded, the work of finding channels for microwave and communications has fallen to the Northern California Frequency Coordinating Committee (NCFCC). This organization consists of representatives from all over northern California. Other interested parties are also represented. The FCC usually sends a representative to the meetings.

The frequency coordinating committee has no legal right to grant or deny anyone a specific frequency. However, the element of peer persuasion can usually avert any problem. The NCFCC believes that cooperation, not confrontation, is the key to success.

Rental income

In the 13 years since the tower became operational, nearly 100 antennas of various types have been installed. One effect of this increased usage has been to keep broadcasters' rents low. The average broadcaster's rent has gone up only 13% from the original 1973 rate. During this same period, the cost of maintenance and operations has increased by a far greater amount. Sutro Tower management's goal is to keep the rental costs as low as possible for the tenant broadcasters, while keeping the tower complex up to date.

Radiation study

Because the tower is located in a residential neighborhood, a close relationship has developed with the local neighborhood association. The policy is to maintain a good relationship and Sutro Tower management goes to great lengths to see that nothing happens at the tower site that might cause distress in the surrounding area.

As an example, in late summer of 1985, after two more UHF TV stations had been added to the tower, management undertook a new radiation study of the site and surrounding streets. They believed it was important to determine if the additional facilities had changed the power-density patterns obtained in a 1981 study.

Although Sutro personnel were competent to conduct the study, they wanted the results to have a stamp of impartiality. An outside firm conducted the study, which was completed in a short time. The results showed that there was no RF problem at the ground level. In most cases, the RF level was less than $0.001mW/cm^2$. This level is far below that mandated by the FCC.

Having the results of a current study allows Sutro Tower engineers to discuss with greater certainty any questions on RF radiation. Because the topic is so controversial, any station would be well advised to adopt a similar approach.

Community towers are not the answer to every situation. However, if your station is considering additional tower height or a new tower, give the idea of a community tower careful thought. If you can overcome the initial political roadblocks, it may be one of the most profitable decisions you've ever made.

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Understanding tower loading

By Jeffrey H. Steinkamp, P.E.

Understanding the basics of structural loading helps to avoid undue stress on your tower and antenna.

As a broadcast engineer, you are concerned primarily with the electronic and electrical aspects of signal generation and transmission. You don't have time to worry about structural engineering, too, right? Wrong. Some knowledge of structural design can provide you a better understanding of the tower and antenna and help you to avoid tower failures, lost air time and liability suits.

Radio and TV engineers are seldom required to design a tower or to analyze the tower maintenance needs. The station engineer should be able to communicate with tower and antenna manufacturers and maintenance services in regard to the structure. This review of the basics of stress analysis and structural loading may help to narrow the gap between the two engineering disciplines.

Structural loading

In any broadcast tower, self-supported or guyed, the structural members in the design experience one or more different types of loading. Tension, compression, shear, bending and torsion exist singly or in combination upon every part of the structure. Proper application of information on the strengths of various materials can produce a tower capable of withstanding almost any stressful loading condition.

Tension loading is a stretching force. (See Figure 1.) Tower legs, diagonal bracing and guy cables undergo tension loading, which is similar to the stress placed on a rope used for towing, under various wind conditions.

Compression loading is in the opposite direction of tension. (See Figure 2.) Just as the legs of a chair must support the weight of the person sitting on it, tower legs must handle large amounts of compression loading caused by the dead weight of the tower, antenna and vertical force components of the guy cables. Wind conditions often cause additional compression forces on tower members that can result in failures known as buckling.

Shear loading is best compared to a cutting action, similar to scissors cutting through paper. (See Figure 3.) Tower legs and bolted connections experience

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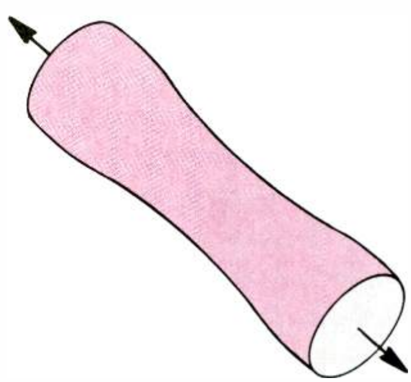

Figure 1. *The effect of tension loading on a cylindrical solid.*

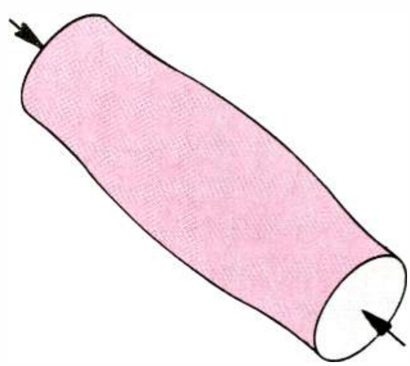

Figure 2. *The effect of compression loading on a cylindrical solid.*

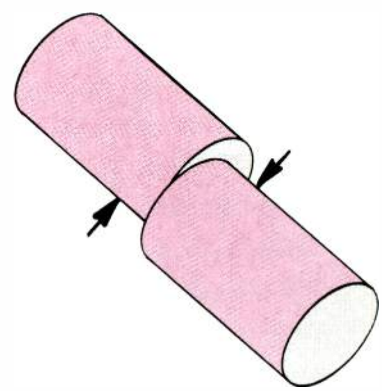

Figure 3. *The effect of shear loading on a cylindrical solid.*

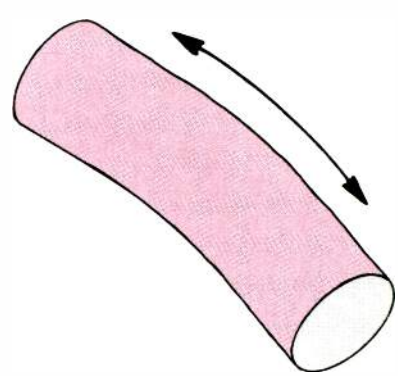

Figure 4. *The effect of bending on a cylindrical solid.*

Steinkamp is manager of mechanical engineering for Broadcast Electronics, Quincy, IL. Illustrations prepared by Mike Mountain.

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Continued from page 78
shear loading from horizontal wind forces.

Bending loads, similar to the stress placed on a vaulting pole during a jump, are prevalent in towers. (See Figure 4.) Top-mounted antennas need to overcome large amounts of bending because of their cantilever-type positioning.

Torsion loading is a twisting force and can be compared to the torques present in rotating machinery, such as the drive shaft of an automobile. (See Figure 5.) Side-mounted antennas are a primary cause of torsion in the tower structure when winds blow from certain directions.

These five types of loading are the basic load conditions found in any antenna tower structure. Determining location and magnitude of these loads in the tower is the mathematical accumulation of all known outside forces balanced with the internal forces until an equilibrium is achieved. Dynamic loading, the forces placed on the structure by changing external conditions, is also a critical element of tower design. Because of the complexity, however, dynamic stresses are not included in this discussion.

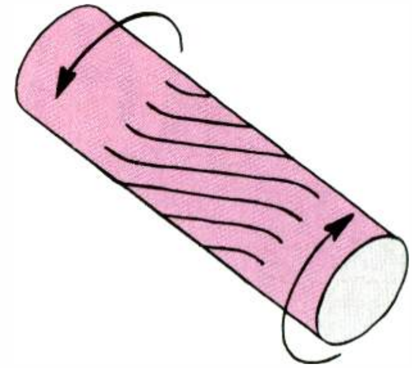

Figure 5. *The effect of torsion on a cylindrical solid.*

Stress analysis

The process of stress analysis consists of concepts and methods for relating the loads acting on structures with the physical displacements and stresses at all points in the structure. *Stress* is defined as load per area or pounds per square inch (psi).

Every material used in construction, including steel and aluminum, has two stress levels of importance to the tower designer. The first and lower level is the *yield stress*, or the force that causes permanent deformation, but not failure, of that particular material. The second, higher-level force is *ultimate stress*. If this level is exceeded, the result is catastrophic failure of the material.

In the design of towers and antenna support structures, another level, the *allowable stress*, is used. The ratio between the yield stress and the allowable stress is called the *factor of safety*. A large factor of safety indicates that the structure will withstand the forces applied to it without resulting damage.

The structural engineer, by knowing the magnitude of forces in any given tower member and the allowable stress of the material being used, can select the correct size and shape for that load-carrying element. Although the procedure is complicated and time-consuming, computers with structural design software can accomplish much of the design procedure relatively fast.

Windloads

The dominant force presented to a tower structure is from wind. Although the force of wind is seldom a non-varying static value, from a design standpoint it can be represented as a horizontal static load upon the tower. The magnitude of the load is proportional to the square of the wind velocity and the projected area

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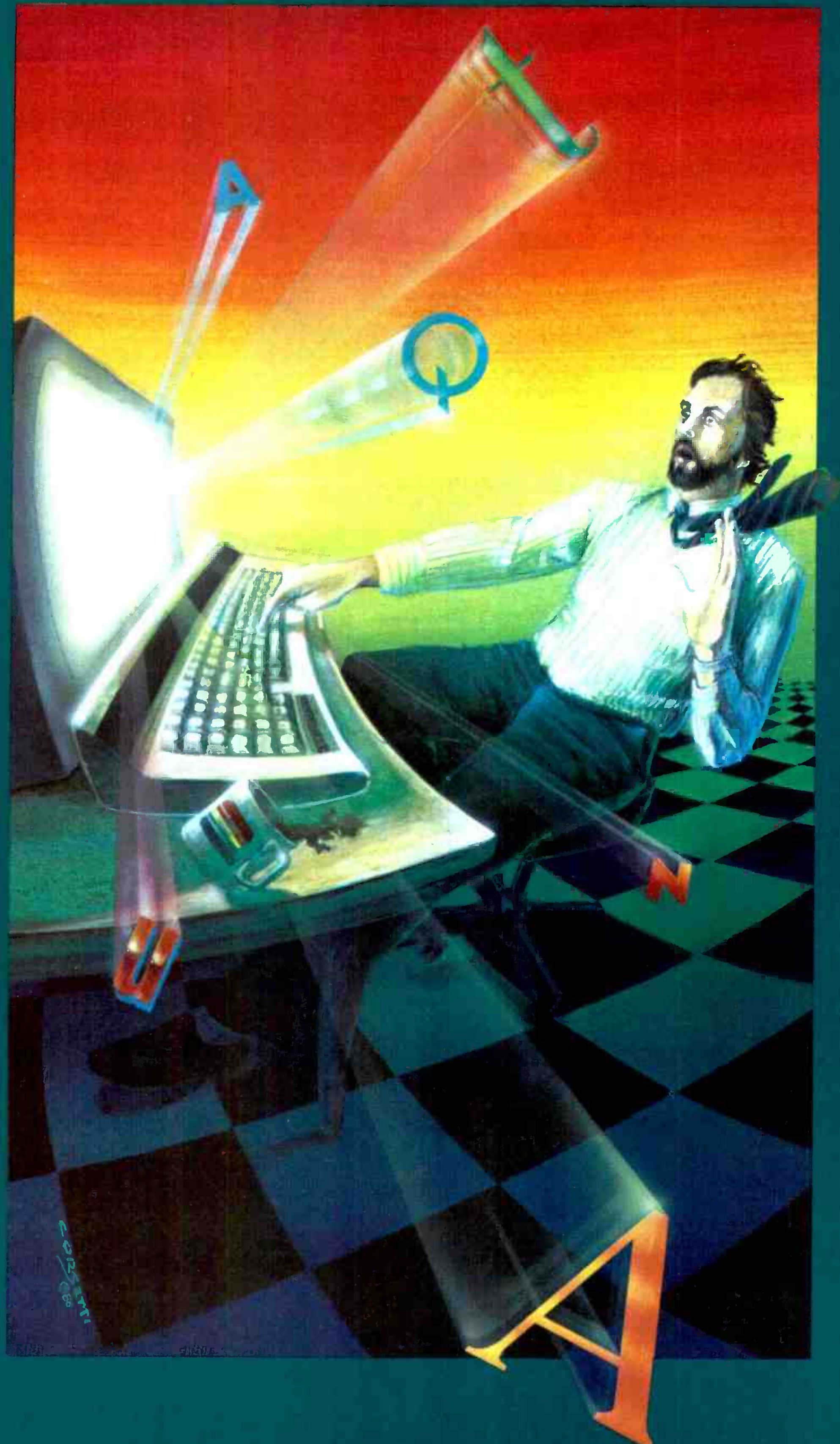

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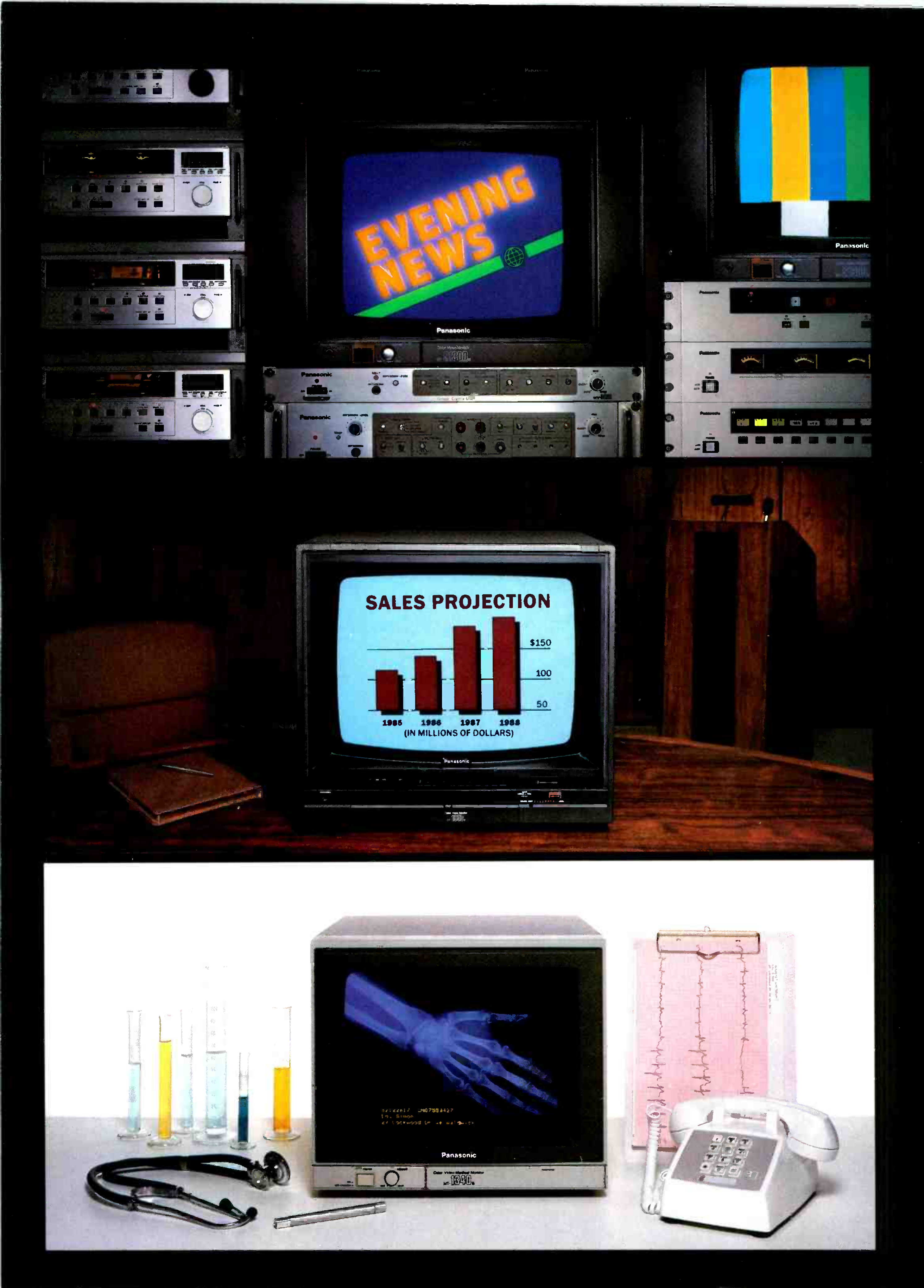
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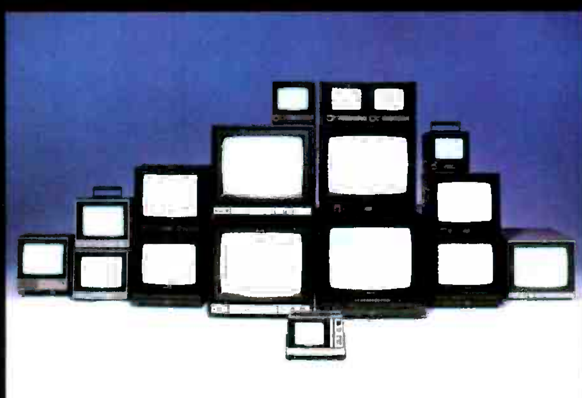

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Continued from page 82
of the structure.

The relationship between wind velocity and wind pressure is expressed by the formula $P = KV^2$, according to EIA standard RS-222-C. (See the related article, "Loads and Codes," at right.) P is the wind pressure, stated in pounds per square foot. V is the actual wind velocity expressed in miles per hour. K is a constant (0.0040) and is called the wind conversion factor. K includes a gust factor and drag coefficient for flat surfaces. The streamlining effect of rounded or cylindrical surfaces allows the factor to be reduced, that is, $K \times \frac{2}{3} = 0.0026$. (See Figure 6.)

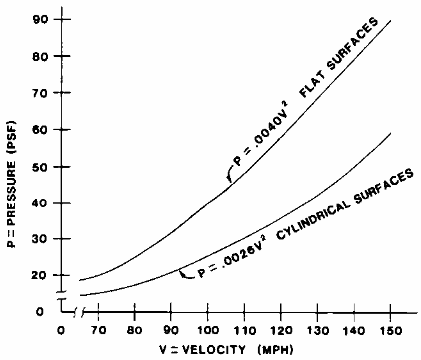


Figure 6. *A comparison of flat and cylindrical tower members with respect to wind velocity and pressure.*

Load ranges

How does the broadcaster know what magnitude of windload the tower must withstand? The EIA standard document answers this question by assigning windloading and height zones for each particular tower structure design. The windloading zone is determined by the geographic location of the structure within the United States. The standard includes a map and list of counties with the corresponding ratings. The height zone dictates what windloading is to be used, relative to the overall height of the tower above ground level. As tower height increases, so does windloading.

From a table in EIA RS-222-C, the station engineer determines the wind pressure specification from the tower location and height. The possible range of loading is from 30 pounds to 85 pounds per square foot (psf), or the equivalent wind velocity from 87 to 145 miles per hour.

Adding it up

When the tower designer knows the wind pressure that the structure must tolerate, the loading on each tower section can be determined. This load is calculated by multiplying the wind pressure in psf and the projected area in square feet. The wind angle of attack, aerodynamic shielding and geometric relationships of the system must be taken into consideration.

For open face (latticed) structures of square cross section, the wind pressure shall be applied to 1.75 times more than the normal projected area of all members in one face. On similar open face towers of triangular cross section, the wind pressure shall be 1.5 times greater than the projected area of all members of one face.

For closed face (solid) structures, the pressure is equal to the normal projected area. Similar calculations for projected area and wind pressure must be made for all other tower accessories, such as guy cables, transmission line, ladders, rest platforms and conduit.

With these calculations performed, the tower designer proceeds to resolve all windloads and corresponding stress levels of the structure.

Effects of ice

Under certain atmospheric and environmental conditions, icing can occur on the tower and antenna structure. The formation of ice on tower members has two distinct effects. First, it increases the dead weight load (compression stress). Second, it increases the structure's total projected area, and consequently, the load produced by the wind.

Ice accumulation is expressed in terms of radial icing. To understand this concept, consider spraying a tower member with a heavy coat of paint. (See Figure 7.) This thickness of the covering is expressed in radial inches and weighs 56 pounds per cubic foot.

Iceloading is discussed in RS-222-C, but no specific accumulation or correspond-

Continued on page 90

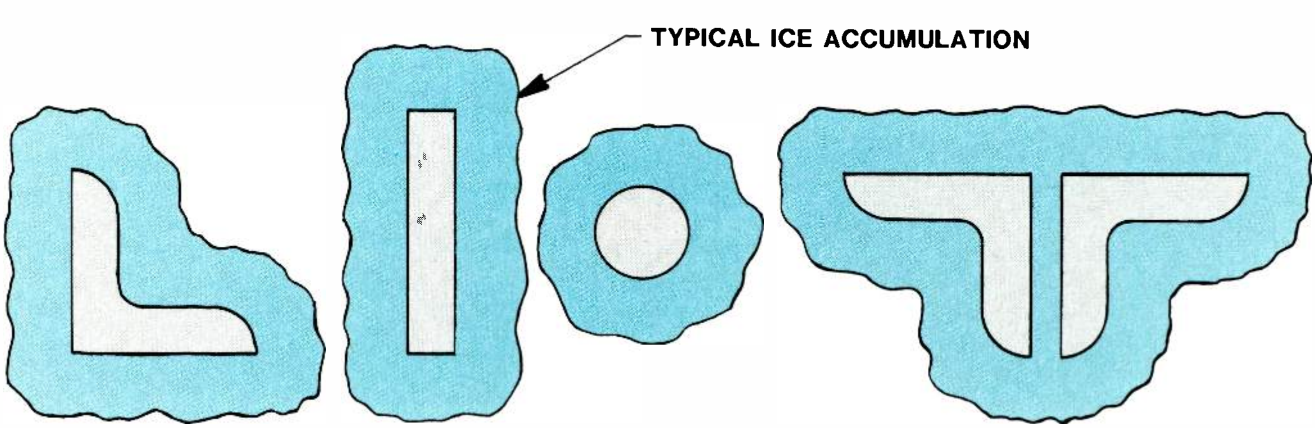
Loads and codes

There are numerous statutory codes that regulate the design of structures with regard to windloads. The most common of these specifications are the Building Officials and Code Administrators International (BOCA) basic building code, the International Conference of Building Officials (ICBO) uniform building code and the Southern Building Code Congress (SBC) standard building code. Although these codes are well written and thorough, they pertain primarily to conventional structures (buildings and bridges) and do not address some of the peculiarities of broadcasting towers.

The standard that covers criteria specifically for tower design is the Electronic Industries Association (EIA) RS-222-C, "Structural Standards for Steel Antenna Towers and Antenna Supporting Structures." This document brings together all necessary minimum requirements for the structural engineer. Most towers in the United States are designed in accordance with the document.

The broadcaster should determine the applicable statutory requirements for a specific tower site. Such information should be made a part of the specification for the tower.

Figure 7. *How ice might form on different tower member shapes.*



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Continued from page 86
ing windload is specified or recommended. Assistance from local architectural engineering firms or the tower designer is advisable to determine if iceloading should be considered. If icing does occur, precautions should be made to protect transmission line, microwave antennas, obstruction lights and the transmitter building from falling ice.

Antenna loads

The sole purpose of the FM, TV or microwave tower is to provide a stable support for an antenna at the proper height and orientation. Top-mounted antennas introduce three loads to the main tower structure. (See Figure 8.) The weight of the antenna (and ice) must be supported by the tower.

The shear load is a horizontal force that results from the windload of the antenna's projected area. The shear component can be represented by a single force located at a specified distance (the shear center) from the top of the tower.

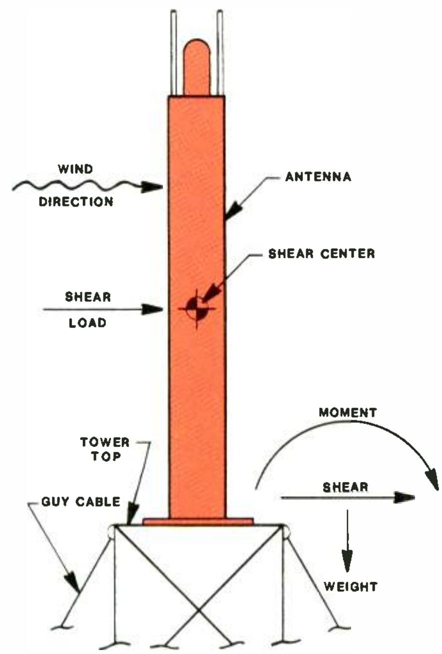


Figure 8. *Force placed on a tower by a top-mounted antenna.*

The product of multiplying the shear load and the shear center distance is the *overturning moment* that the tower must withstand.

The shear, moment and weight loads can be obtained from the antenna manufacturer and are usually expressed under certain windload and/or iceload conditions. The given load conditions for the antenna and tower should be the same. Any conversion of load conditions should be calculated by the antenna supplier and verified by the manufacturer of the tower.

For support of UHF and microwave antennas, structural integrity is not the only consideration. Mechanical stability is crucial to proper performance with such high-frequency antennas. As a result, the antenna manufacturer should specify the amount of rigidity necessary under certain windloads. Allowances should be made by the tower designer. In most cases, a tower designed for rigidity will also have adequate strength. However, a tower designed for strength alone may be too flexible for the designated application.

Before the last analysis

The procedures of designing a tower for a specific application are much more complex than this rudimentary outline. Any knowledge you can obtain on the subject, however, helps to close the communication gap between you and antenna structural designers. When the requirements of the tower are more fully understood by both parties, the result will be a safer and more cost-effective antenna tower structure.

Controlling ice build-up on towers

By Karl Renwanz

When ice forms on the tower, your station becomes liable for everything from dented cars to real tragedy. The search for effective de-icing methods continues.

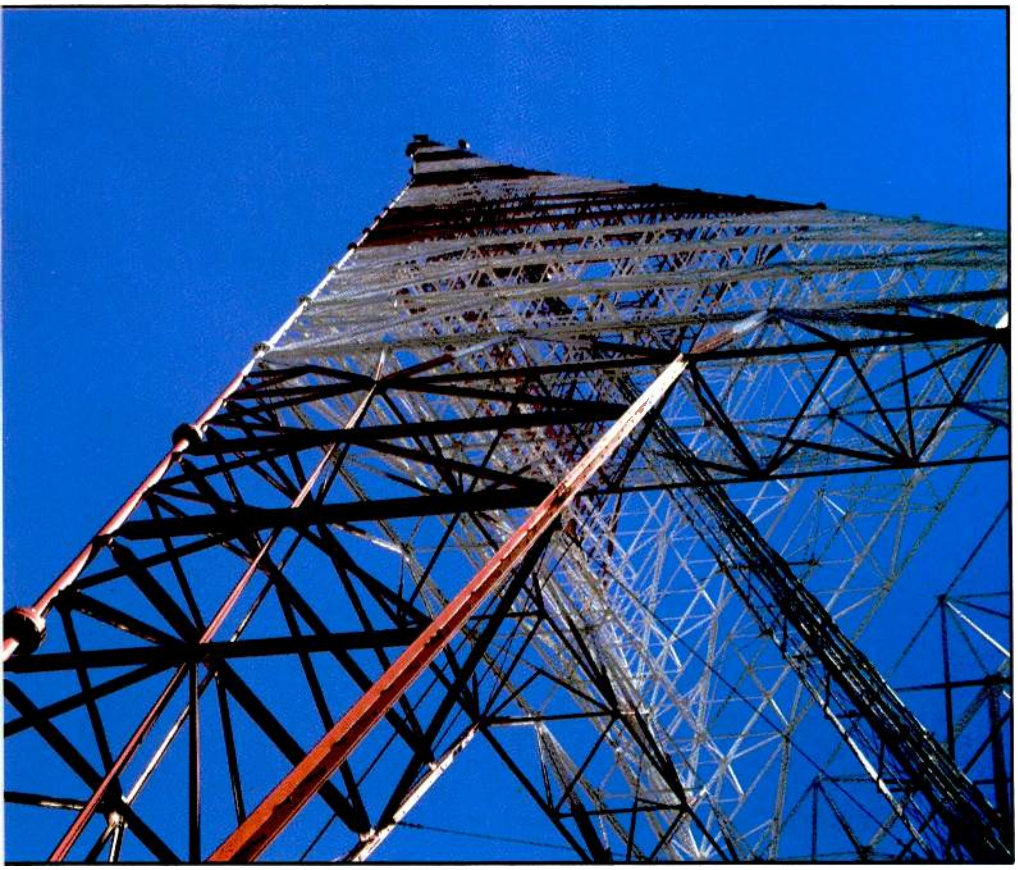
Ice and towers, unfortunately, go together for a large number of radio and TV broadcast stations around the world. The problem exists with both guyed and self-supported towers, occasionally causing the structure to be stressed to failure. The potential for personal injury and liability problems due to falling ice grows daily, as residential and commercial construction approaches and surrounds the transmitting tower sites.

Are there answers to the problems of tower icing? At WNEV-TV, which has a 1,067-foot structure that presents 120,000 square feet of steel surface for the formation of ice, the engineering staff felt obliged to find out after severe icing occurred in 1984.

First steps

Broadcast stations located in areas where icing may occur from late autumn to early spring have a potentially dangerous problem on their hands. It seemed logical, then, that others had sought answers to ice build-up. However, contacts with numerous individuals and organizations involved in ice research brought little in the way of solutions.

The search turned to the U.S. Army Cold Regions Research Laboratory (CRREL), Lebanon, NH. The CRREL, a research facility devoted to studying cold weather phenomena, could offer no answers. Within government policy restrictions, CRREL representatives assisted in designing an elaborate monitoring system to study icing phenomena on the WNEV tower at Newton, MA. These representatives would also work with the station in data analysis and in software support areas, in the hope that the CRREL might also benefit from the findings.



The 1,067-foot WNEV-TV tower, Newton, MA, is a prime candidate for heavy winter icing.

Preparations

The monitoring system involves three solid-state meteorological test probes at the 400-, 690- and 850-foot levels of the tower. Each monitors wind speed and direction, humidity, temperature and barometric pressure, passing the parameter measurements through optical fiber cables to the transmitter facility for constant monitoring and data recording.

Data are recorded every half hour, unless ice detectors, co-located with the monitoring probes, register three ice detections within a single half-hour period. Whenever this happens, data recording increases to 15-minute intervals until 30 minutes pass without further ice detection. (See Figure 1.)

Data sampling actually occurs every three seconds, but the samples are averaged over the longer periods before any information is recorded. The data, analyzed by CRREL engineers, will be correlated with current and past data from nearby Logan Airport in an effort to determine the frequency of severe icing conditions in the area.

To visually supplement meteorological data, five monochrome cameras are in-

Renwanz is vice president of engineering and operations, WNEV-TV, Boston.

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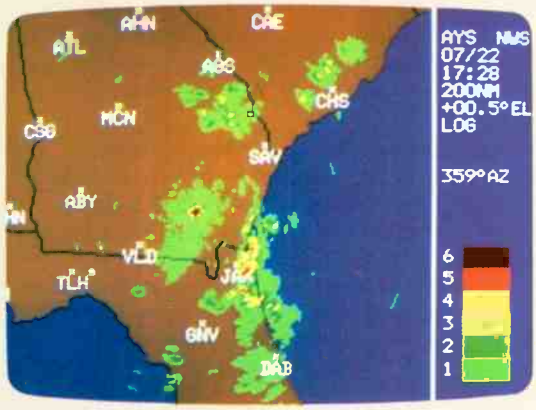
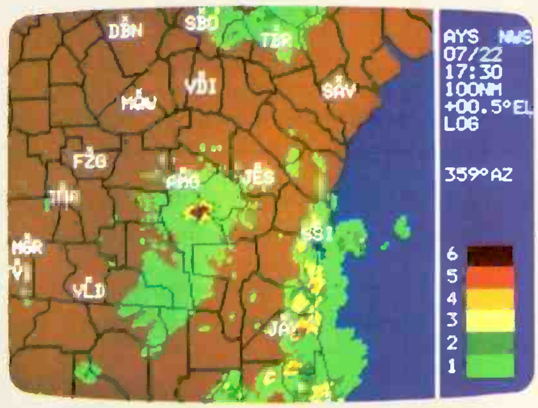
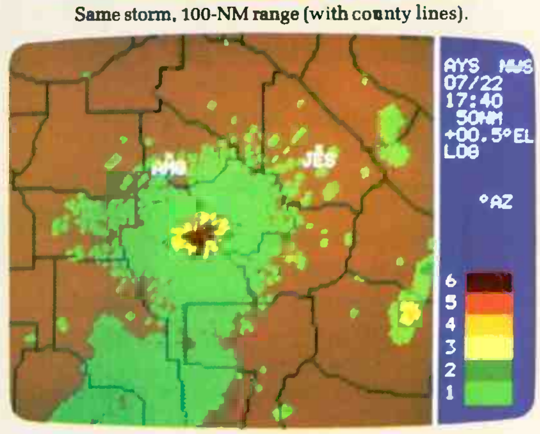


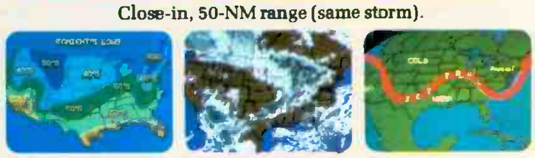
Waycross, GA: 200-nautical mile range.



Same storm, 100-NM range (with county lines).



Close-in, 50-NM range (same storm).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cluded in the tests. Three are mounted with the monitoring probes on the tower. Another is stationed on the ground looking upward at the tower, while the fifth camera is positioned 200 yards from the tower base to view ice departures from the structure.

The cameras, responding to infrared light and operable at 0.1fc, feed time-lapse video recorders. Supplemental lighting assists on dark, non-overcast nights. Pan, tilt, zoom and focus controls, operated remotely from the transmitter facility, allow close analysis of various members of the tower during icing.

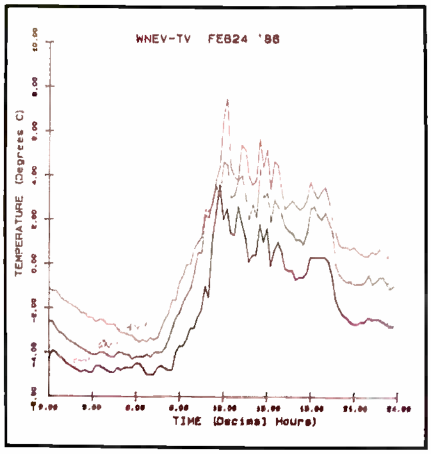

Figure 1. Temperature and time of day play an important part in icing control.

Superhydrophobia

Numerous options are to be studied during the tests that will occur over several years. One of those options is the use of a superhydrophobic coating material. More than a repellent or water-resistant coating, Vellox 140 is said to produce a surface effect that keeps water droplets away from the actual metal. The result is a visible air layer between the surface and the water that causes the droplets to roll freely and rapidly off the surface.

Users of the material have reported a success rate of approximately 50%. Perhaps part of that figure can be attributed to the critical application process that must be followed. The coating requires a 2-step process. First, a base coat is applied as a heavy brush coat primer. It can be tinted somewhat to maintain FAA tower paint colors. Steel temperature, humidity and wind speed factors must be considered when the application is made. An electrostatic application method has been developed to reduce waste and improve coverage around hardware in flange areas.

Although the base coat temperature requirement is approximately 45°F, the second step, application of the top coat, can be completed at lower temperatures. The top coat is a solution of low viscosity with a low particle concentration. Repeated overspraying is necessary to build a satisfactory coating depth and to achieve good bonding. Typically, seven to eight top coats are required.

Too many applications of the top coat can leave unbonded particles that cling to the surface and reduce the hydrophobic effect. The loose particles tend to coat droplets of water, causing them to adhere to the tower. Brushing the oversprayed areas with a soft cloth or brush will allow only the particles to stick, increasing the hydrophobicity.

The longevity of the Vellox coating is being studied. Some experiments show the material is worn away by rain, requiring reapplication after a few years. Tower crews report that the coating tends to be somewhat slippery, which brings up questions in regard to safety. However, the material is abraded when crews work on the tower, which diminishes the effectiveness.

This chemical coating is somewhat expensive. The base coat is priced at $84 per gallon, while the top coat costs $66 per gallon. The suggested rule of thumb is 90 cents per square foot for exterior applications. It must be noted, however, that the tower paint must be in good condition for proper bonding of the Vellox base coat. If the paint is in poor condition, a complete paint job may be required before the Vellox can be applied.

Vibration

Another experiment, using low-frequency, high-magnitude vibration,

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has also met with some success. In theory, the vibration prevents ice build-up by shedding water from the tower before freezing occurs and/or by fracturing the ice bond of successive accretions, causing the newly forming layers to fall away in small, relatively harmless increments.

The prototype vibrator involves the concept of an unbalanced automotive tire. The applied force of the eccentric

The icing control research package includes meteorological probe readouts, tabular data printer, chart recorder and video recorders.

rotating weight increases with the rotational speed. The prototype, operating at 1,800rpm, generates 800 pounds of force applied 30 times per second.

Cold room tests resulted in an 80% removal of a ¾-inch ice cover from an 8-foot span of 10"x2.6" channel iron in a single 20-second cycle. Most of the de-icing occurred during resonant vibration with beam displacements of about ⅝-inch. It is predicted that the effec-

Continued on page 100

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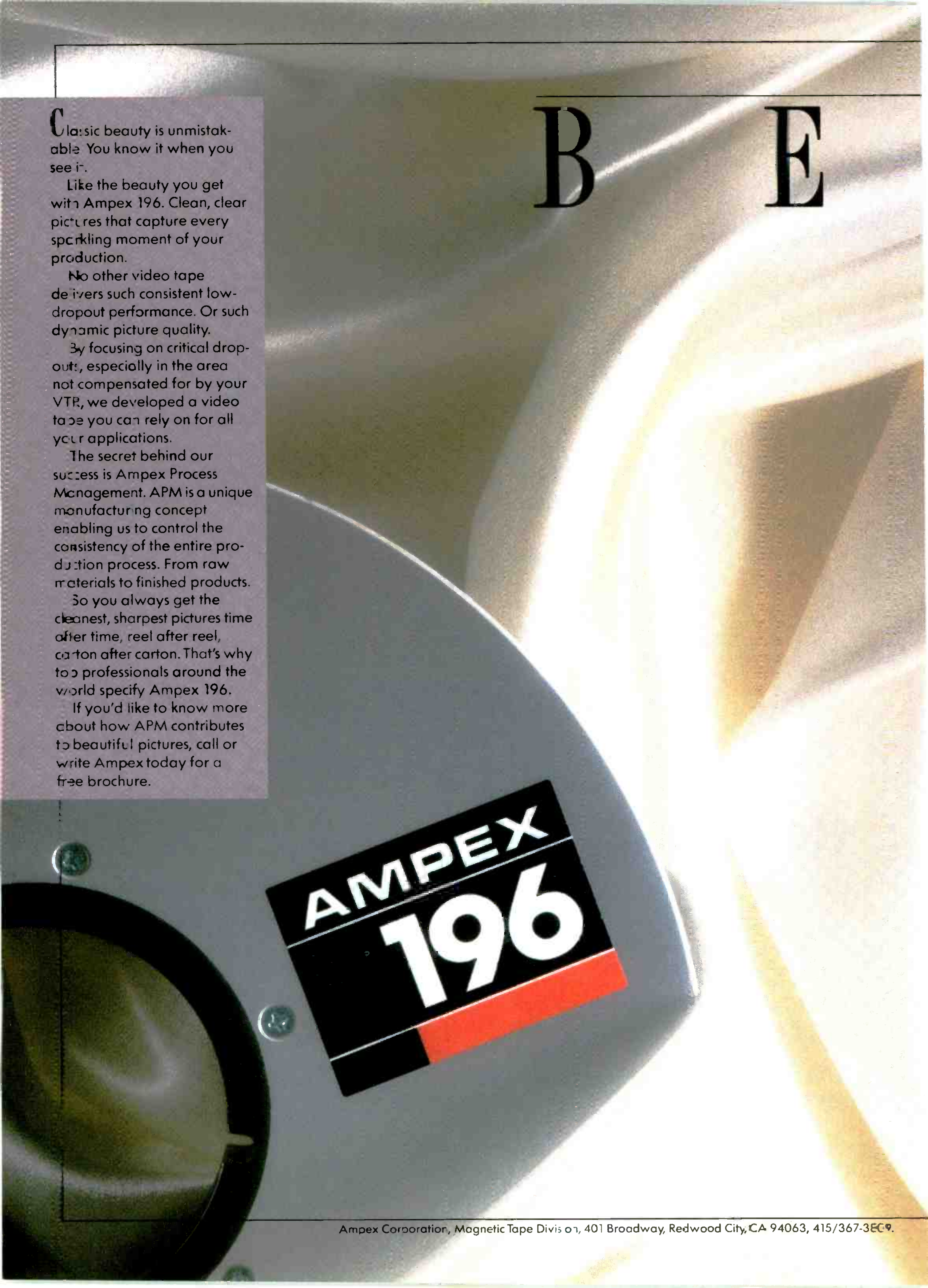

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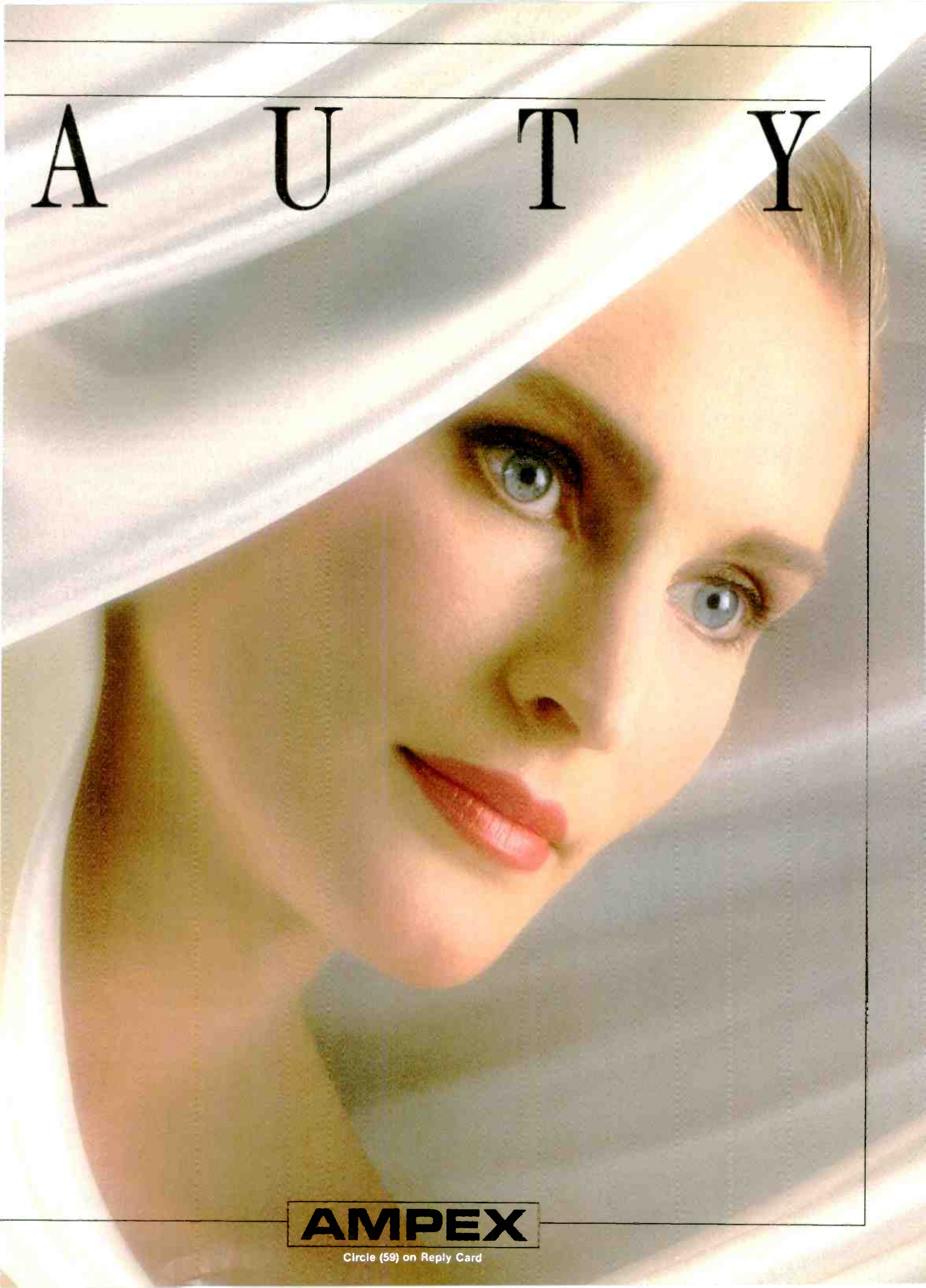
A U T Y
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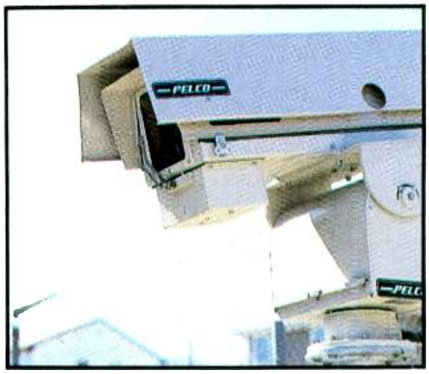
Continued from page 96
tiveness would be greater if the tower coating material reduced the bond strength of ice to the test surface.

Mounted at the 860-foot level of the tower, the prototype vibrator produced visible vibration over a 60-foot section of the tower. Vibration of magnitudes on the order of the cold room tests did not propagate over that distance, causing the experiment to be inconclusive. The massiveness of the tower, no doubt, accounted for the damping of the vibration, although modifications to the vibrator may make significant improvements. CRREL personnel continue to investigate the effectiveness of vibration.



One of five infrared cameras, mounted on the tower and at the transmitter site, monitors ice falls on a 24-hour basis.

Mesh

Following an experiment at WHDH-AM, Boston, another approach is to install plastic-coated wire mesh around tower joints. The purpose of the material is to contain snow and ice, preventing it from falling when melting occurs. In one test, the mesh remained in good condition after 20 years.

Because the mesh would create some additional surface area, tower loading characteristics might be questioned. Loading caused by this method should remain minimal, if not insignificant.

Thermal methods

The only proven effective icing control method, the use of electrothermal heaters, is not feasible economically or practically. Consisting of fine, high-resistance filaments wrapped around or taped to the structural members, electrothermal heaters are highly susceptible to damage from falling ice and probably from any tower maintenance activity.

Tests performed on a 100-meter guyed tower in Finland indicated that 300kW of power would be required continuously for an 8-hour cycle to remove ice from the structure. At 6 cents per kilowatt hour, electrothermal de-icing would cost approximately $15,000 per day.

Current plans

Tower icing is no laughing matter. To aid in finding solutions, approximately 10 broadcast stations will be working with WNEV-TV and CRREL. As ice formation or ice fall conditions occur, each station will report the time of the occurrence to CRREL. From that time, the research scientists can ascertain from the regional weather services the exact conditions that were present.

Other broadcasters may participate in this research project as additional reporting stations. Interested engineers should contact Karl Renwanz at 617-725-0810 for information.

Interim suggestions

To date, no hard and fast single solution exists to alleviate tower icing problems faced by the broadcaster. Liabilities resulting from tower failure and collapse can be kept down if human habitation of the area surrounding the tower can be controlled. Ideally, a circular area of radius equal to the tower height should suffice. Complaints about falling ice also would be kept at a minimum.

For those tower sites that have residential or commercial development at the guy points or even at the tower footings, additional experimentation is necessary.

Editor's note: This material was adapted from Renwanz's presentation at NAB '86, "New techniques in controlling and documenting ice build-up on tall towers."

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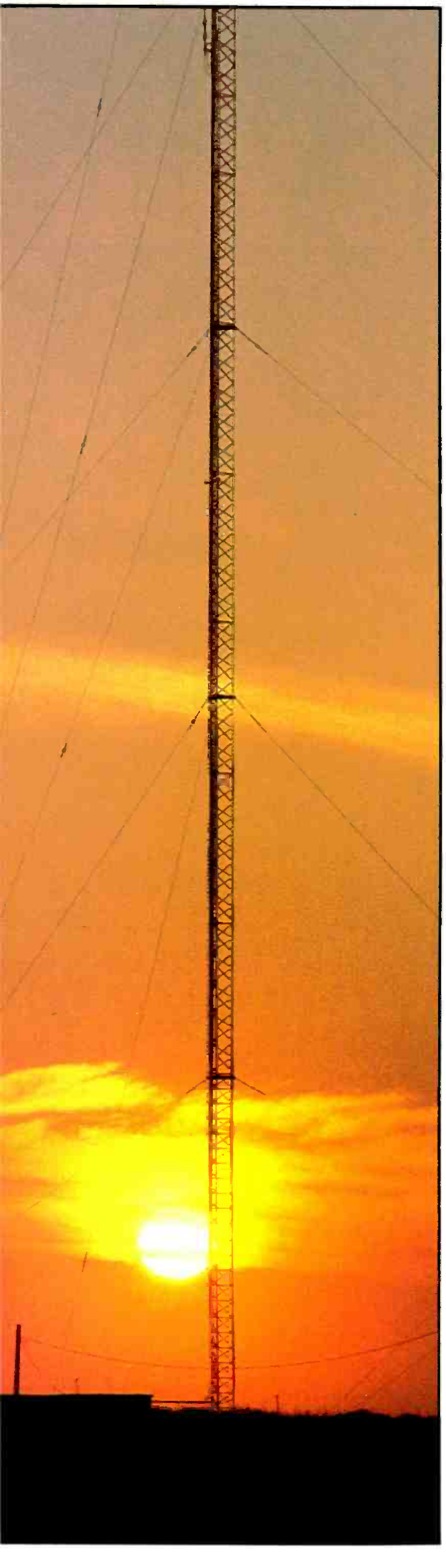


Maintaining an antenna ground system

By Bud Stuart

Just because your station's ground system is out of sight, don't let it be out of mind.

Grounding: what you do to your children when they've been bad.

That's one definition of grounding, but in the world of broadcasting, it means something quite different. For an AM station, grounding is a crucial element in the effort to gain effective coverage. For FM and TV stations, grounding systems often mean the difference between lightning protection and lightning damage. If you haven't inspected your station's grounding system in the past few years, it may be time to do so.

Effects

How can you tell if your ground system needs some attention? Although deteriorating ground systems can affect an AM station's pattern in unique ways, there are usually a few telltale signs. These changes are normally more apparent with directional antenna systems. However, even non-directional antenna sites exhibit changes caused by a deteriorating ground system.

The most obvious effect will be a reduced AM field intensity. In directional systems, antenna ratios and phase relationships may also change. Unfortunately, these changes are seldom drastic, and usually occur over a long period of time. These two aspects tend to make the detection of a deteriorating ground system more complicated.

Sometimes engineers are inclined to dismiss reduced field-intensity measurements as being caused by changes in ground conductivity. Although this may occasionally be the cause of some slight discrepancies, a properly installed and maintained antenna system should never show more than minor variations in both field strength and operating parameters. Typically, the changing parameters are attributed to weather or other temporary conditions. It's only when the array can't be brought back into tolerance that any thought is given to the grounding system.

System inspection

If your ground system has been buried for 15 years or more, it is due for a complete inspection. If the system has been in place longer, then the odds are that it is due for more than an inspection. It's probably time to replace it.

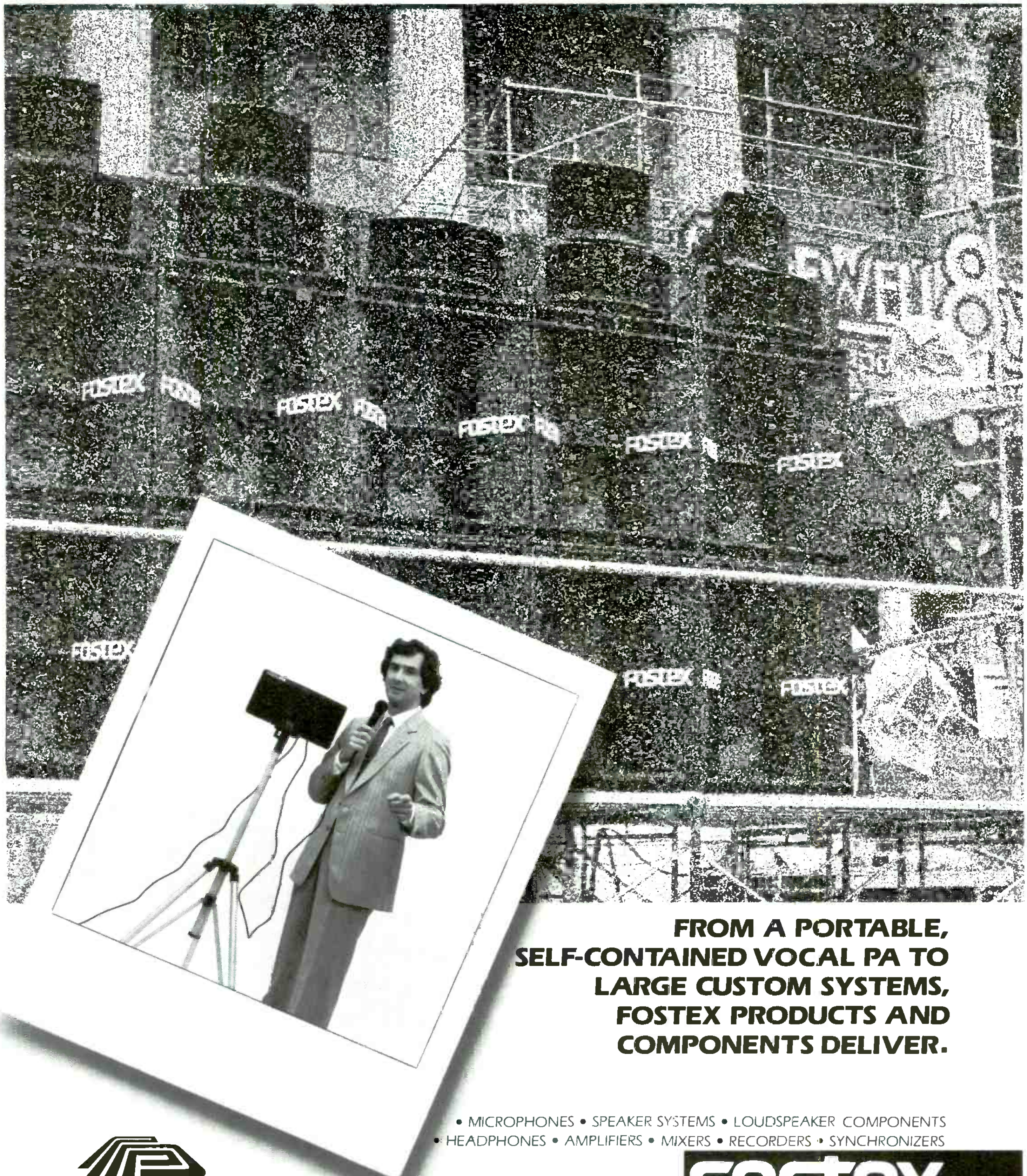
The top photo on page 106 shows what years of burial in the soil can do to an AM tower ground screen. The screen shows severe damage caused by the soil's acidity. Large patches of the screen are completely missing.

Soil conditions vary greatly across the country, but few areas have soil that permits a ground system to last more than 15 years. In some places, a ground system can deteriorate much faster because of soil acidity or severe weather.

Also, if you were not involved in the original installation, you may not be aware of factors other than soil content that may be contributing to rapid deterioration. For instance, your ground system may have been installed with rivets connecting the ground radials to the copper strap. These rivets can quickly break down when exposed to soil conditions. If left unsoldered, the connection is practically useless.

Continued on page 106

Stuart is an independent broadcast engineer in Susanville, CA.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The AU-400 Camera Recorder. This lightweight, compact camera recorder provides ENG users with more than 20 minutes of recording, and a picture quality that rivals that of 1" VTRs. The AU-400 also features B/W video confidence playback through the camera's viewfinder, a chroma confidence indicator and audio confidence output through a speaker. There's even an automatic backspace editing function and warning indicators. And the AU-400's rugged construction provides excellent resistance to dust and moisture.

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Continued from page 102

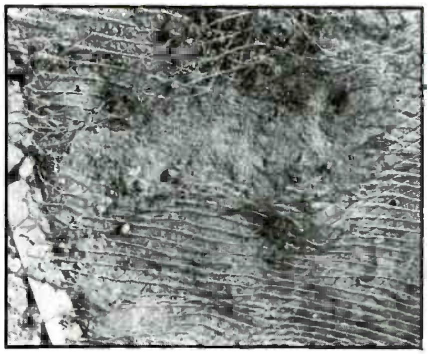
It's also not uncommon for untrained installers to use soft solder to connect the rivets and other grounding elements. A ground system constructed with soft solder is doomed from the start. These types of connections cannot stand up to the acid and mechanical stress imposed by the soil.

Another condition that can diminish a station's coverage and give false power readings is sometimes called the *rusty bolt syndrome*. In these cases, metal-oxide-metal connections develop between the bolts and the tower sections. Although the bolts and nuts may look good, they actually may be severely deteriorated.

The only way to check for this problem is to carefully remove several bolts and inspect their condition. If a bolt is severely oxidized, it may actually twist off as it

These two radials were connected to the ground screen with rivets. After a few years, they failed to provide an adequate connection.

Small pieces of copper strap were used to attach the radials. It is far better to use a solid piece of strap around the perimeter of the ground screen for these connections.



The holes in the ground screen were produced by acid developed in the soil.

is removed. This is a certain sign that the tower needs immediate maintenance. It is not unusual for a ½-inch bolt to be eroded to perhaps a ⅜-inch diameter. Not only does this process affect the conductivity of the tower; it also diminishes the tower's strength.

Although many of today's towers use welded sections, old towers are often constructed of single beams, bolted together. If you have a bolted tower, a thorough inspection is suggested.

Even if your tower is composed of welded tower sections, the individual sections are bolted together. Again, the bolts and nuts can rust away, affecting both the tower's strength and conductivity. Today, the individual sections on AM towers are sometimes welded together. Although this may solve the conductivity problem, it does nothing to bolster the strength of the tower.

Lightning protection

FM and TV engineers sometimes don't share the same concern for proper tower grounding systems that AM broadcast engineers do. AM signals depend on having a solid ground system for effective radiation and for developing the proper patterns. The nature of FM and TV antennas make tower grounding less important in terms of signal coverage.

Even so, proper grounding for FM and TV towers is important for lightning protection. There are probably as many different methods of grounding FM and TV towers as there are FM and TV towers. Some towers rely on a single ground rod at the base of the tower. In these cases, the ground rod may simply be bolted to a tower brace. Other installations may rely on several ground rods spaced around the tower base. An effective FM/TV tower ground system involves much more than a couple of ground rods driven into the soil.

If the tower is to be properly protected from lightning damage, the ground system must be carefully planned and installed. The first step is usually the installation of ground rods.

Some towers rely on the standard 10-foot ground rod. The actual depth to which the ground rods must reach depends on the soil conditions. Although it may be preferable to reach the water table, it's not always necessary. A depth of 40 feet is usually sufficient, and 15 feet might be considered an average depth. The required rod depth also depends on the number and spacing of ground rods.

Just as important as the length and number of grounding rods is the interconnecting wire. Most soil conditions will permit the use of No. 10 gauge or larger bare copper wire. However, if the soil has low conductivity, then solid copper strap must be used. The strap may be as thin as 0.016 of an inch. Thicker strap is not necessary as the skin effect limits the current to a 0.006-inch depth. One authority recommends that the strap be at least as wide as 1% of its length.

Even though the copper strap may appear undamaged, give it a strong pull. This strap came apart with little strain.

This romex cable was buried without conduit protection.

Connecting the components

Some broadcast engineers do a good job of planning the ground system. They may even install enough copper strap and ground rods. Where they often fail is in the interconnection of the various pieces of the ground system.

A new approach to the ground rod

A new form of ground rod is being used in some communication systems. Instead of relying on concrete-encased Ufer grounds or copper-clad steel rods driven into the ground, an electrolytic root system is established.

This new type of ground rod contains chemicals which, when combined with moisture, form an electrolytic solution. When it is installed, atmospheric pressure pumps air into the tube through the breather holes, which always remain above grade. The chemicals inside the rod pull moisture from the air, forming condensation. The condensation combines with the chemicals to produce the electrolytic solution.

As time passes, the solution accumulates and gradually seeps out through the bottom weep holes, at a rate of seven or eight drops a day. The electrolyte's bleeding action creates a network of roots into the surrounding area, allowing energy to dissipate. According to the manufacturer, the resistance generally drops from 5Ω to between .5Ω and 2Ω within four months of installation.

These rods are not driven into the ground like other ground rods. Instead, a 6- to 10-inch-diameter hole is made with an auger or water drill. The rods are available in 8- to 20-foot lengths. If soil conditions prohibit such depths, a trench can be dug and the rods installed horizontally.

Soft solder is not adequate for ground systems. It deteriorates quickly when in contact with the soil and provides little strength in the connection. There are two much better methods of connecting metal components.

The most common method of connecting copper ground rods to copper strap is with silver solder. The process requires the use of brazing equipment, which may be unfamiliar to the average broadcast engineer. The process uses a higher-temperature, higher-conductivity solder to complete the bonding process.

An even more permanent process involves the use of molten copper to melt

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together the connectors, forming a permanent connection. The process, commonly called Cadwelding, is well suited for tower grounding needs. The connection process is particularly useful in joining dissimilar metals. In fact, if you must join copper and galvanized cable, Cadwelding is the only acceptable process. The completed connection will not loosen or corrode and will carry as much current as the cable connected to it. See the related story, "A New Approach to the Ground Rod," page 108.

Examples

Tower ground systems may fail sooner than expected if not properly maintained. Following are several examples of how age can affect a typical AM grounding system.

The bottom left photo on page 106 shows how not to connect ground radials to the grounding screen. It shows how small pieces of copper strap were joined to the screen and radial wires. A much better method uses a continuous copper strap running along the entire perimeter of the ground screen. The radials are then connected to the copper strap. Near the tower, the ground screen should be connected to the tower with copper strap at 90° intervals.

Over a long period of time, even the best installations suffer damage. The top right photo shows a broken 4-inch copper strap. Although the strap appeared to be acceptable upon visual inspection, it easily broke into pieces when pulled.

Electrical cables

In some old installations, the power for tower lights was often carried on cables buried in the ground. The cable, usually romex, was often simply laid in a trench without the benefit of conduit or other protection. The cable failed after several years in the ground. If you suspect your station used a similar installation process, don't wait for the cable to fail. Arrange to have the wiring replaced immediately.

An inexpensive method to protect the cables relies on 3- or 4-inch PVC pipe buried at a depth of eight to 12 inches below the ground radials. All of the lighting, communications and sampling lines can then be installed in the conduit. Be sure to use a pull rope that is more than twice as long as the conduit run. Also seal both ends of the PVC pipe to keep out insects and rodents.

Inspection

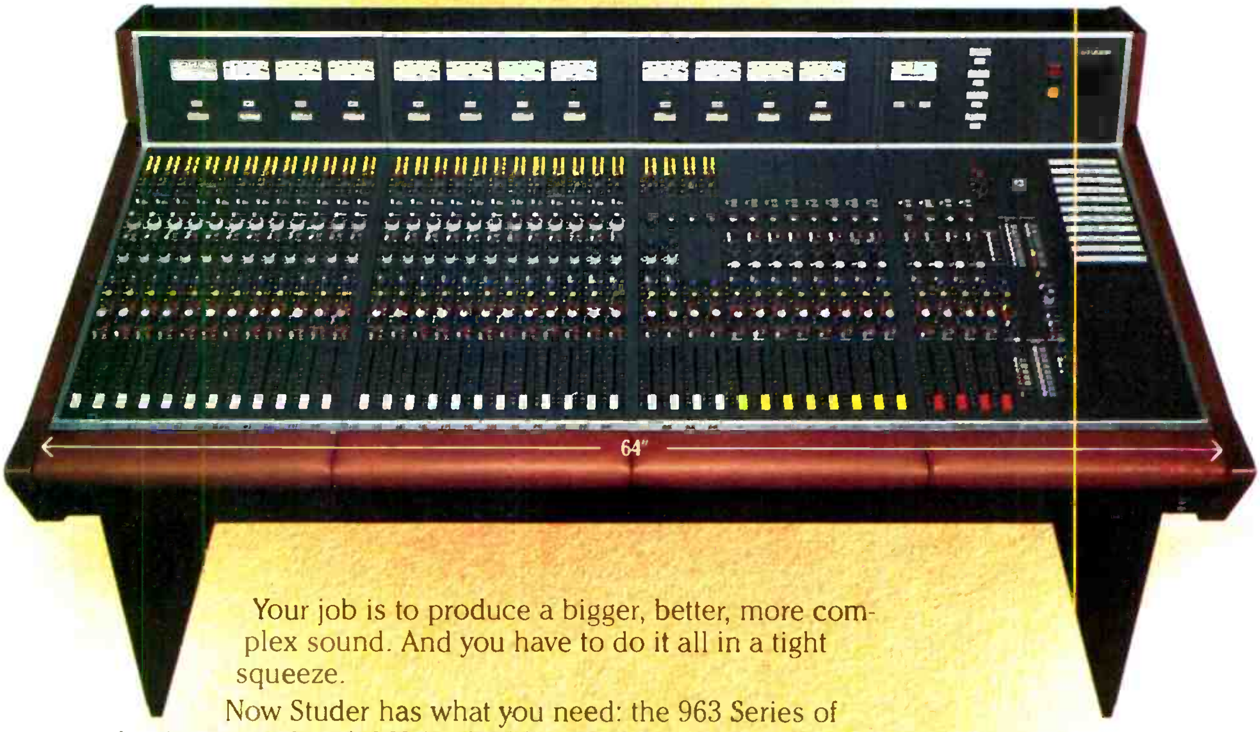
When was your station's ground system last inspected? Checking a ground system is not really a major project (unless it's under a parking lot). It is a relatively simple matter to uncover a sufficient number of radials for a distance of three or four feet. Repeat the process every 10 or 15 feet along a number of the radials. Likewise, inspect the copper strap and any connections made to it. Look for evidence of oxidation, loose connections or metal fatigue.

In some cases, a good metal detector will help you identify portions of the grounding system. It won't, however, tell you if you have any breaks in the system. You still will have to uncover portions of the ground system to complete the inspection.

The loss of signal strength, for whatever reason, is a loss of coverage and a loss of potential audience. As the station engineer, you are responsible for maximizing the performance of the station's equipment. That equipment includes the ground system.

Not-So-Big News

The news is out. Studer's new 963 is big on features, performance and reliability. And not-so-big on size.



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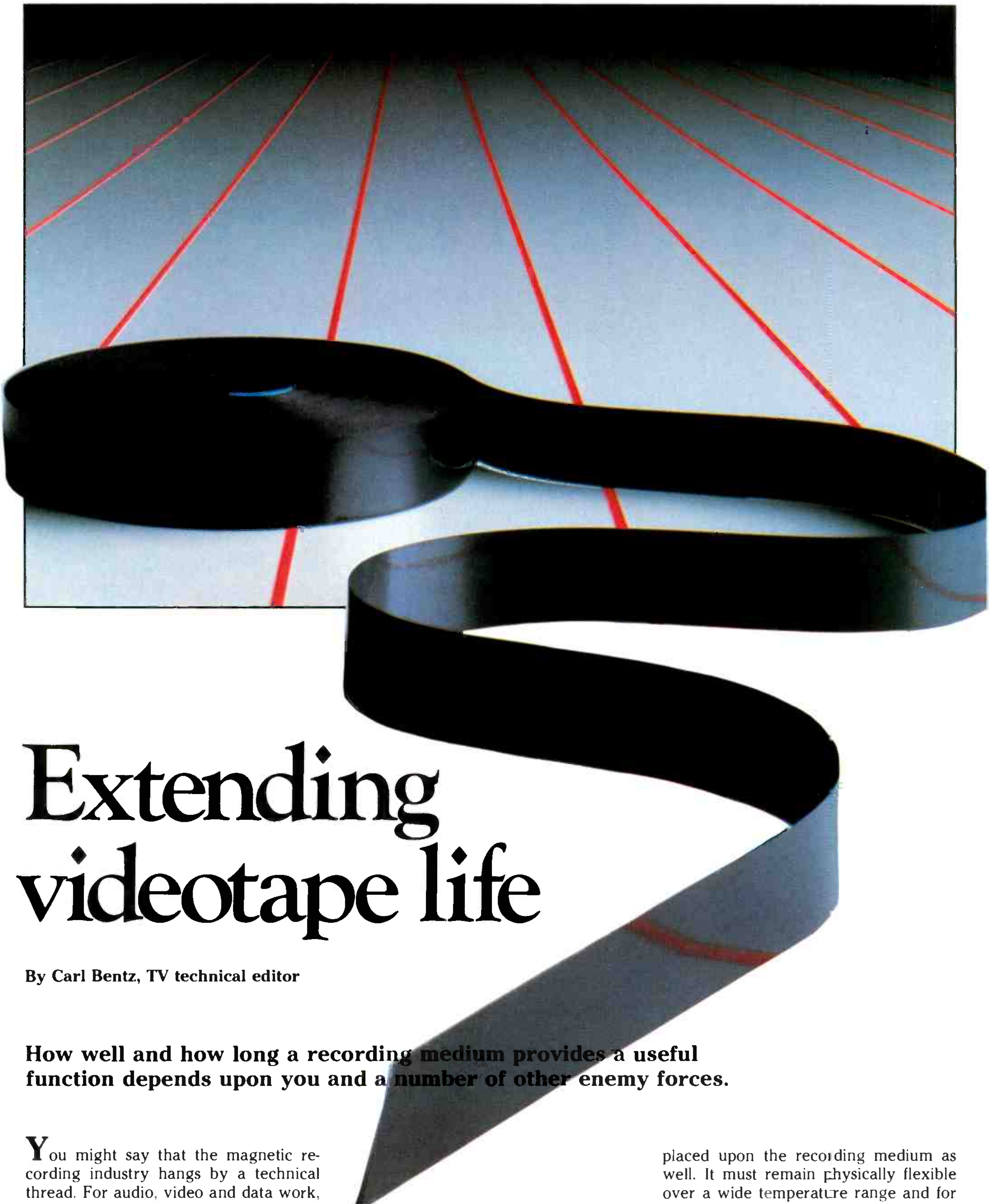


Extending videotape life

By Carl Bentz, TV technical editor

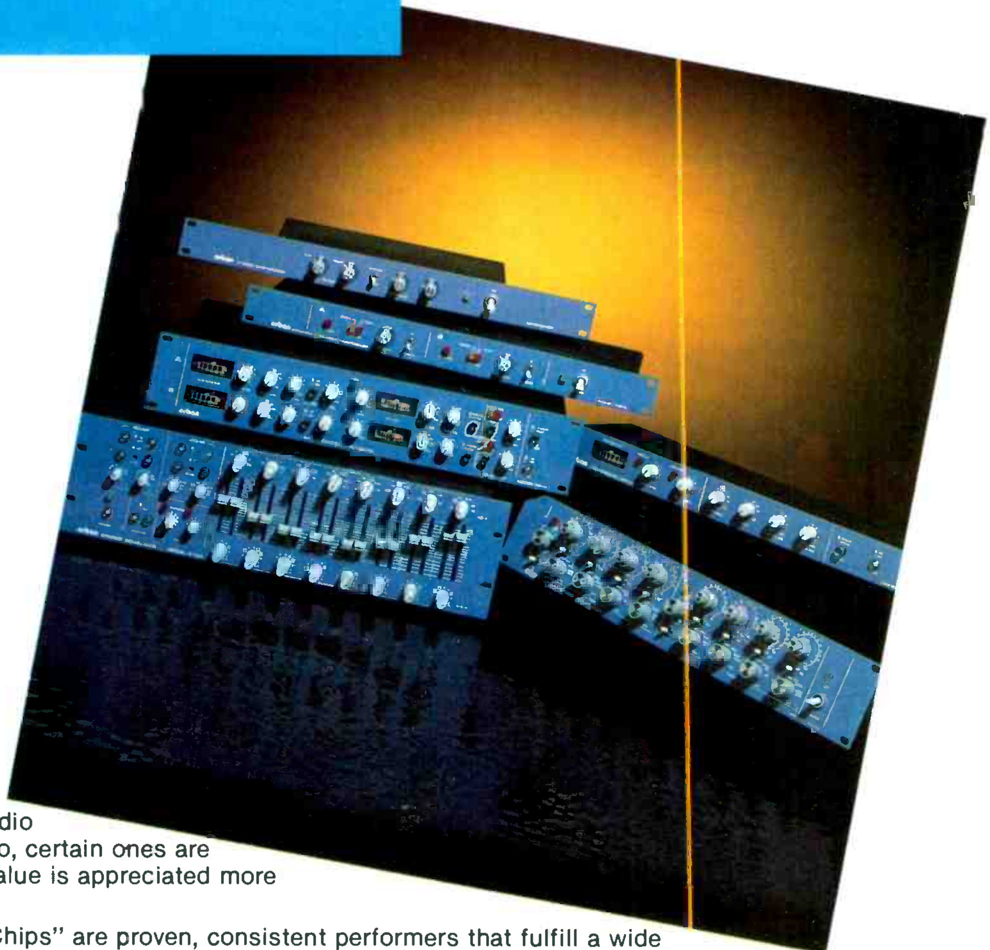
How well and how long a recording medium provides a useful function depends upon you and a number of other enemy forces.

You might say that the magnetic recording industry hangs by a technical thread. For audio, video and data work, the success of the recording process demands a great deal from an ultrathin (measured in mils) piece of plastic and its microscopic layer of ferromagnetically active material.

The medium must respond magnetically to an electronic stream of information and retain that information for an indefinite period of time. The tape must allow the information to be recovered in a form that resembles the original as closely as possible. It must also be possible to replace previously stored information with new data.

Recording media in general

A number of physical requirements are placed upon the recording medium as well. It must remain physically flexible over a wide temperature range and for an indefinite time in order to pass through the recording mechanism without damage. It must withstand reasonable variations in temperature and humidity with minimal changes in dimensional stability. Its thickness must allow a reasonable length of recording time per convenient package, yet the thickness must be sufficient to avoid ten-



sion deformation in longitudinal, transverse and perpendicular directions. Surface smoothness must remain constant through all the abuses of normal applications.

Chemically, the tape material is stably inert and will not decompose under normal conditions of temperature and humidity. It should not react to normal cleaning solvents prescribed for tape path cleaning. (Note that, normally, such solvents would not be applied directly to the tape, but may exist as residue after the system is cleaned.)

For electronic purposes, the medium must be capable of faithful storage and recovery of a wide range of frequencies. That range varies with the application of audio, video or data. Specifications will describe reasonable values for a number of key magnetic characteristics. These include coercivity, a measure of energy necessary for recording, and retentivity, a measure of magnetic energy available for signal reproduction during playback. A signal-to-noise ratio will indicate the purity and homogeneity of the magnetic coating mixture, any dimensional thickness variation and the number of non-aligned magnetic domains of the material.

The medium and the environment

Consider that recording tape is probably the least expensive item in a production technical inventory. Consider, also, that this fragile piece of plastic will be the sole record of the production that may have cost thousands or millions of dollars. Obviously, precautions should be taken to preserve the tape and its stored information. Unfortunately, the tape must exist in a hostile environment.

Ideally, recording media would be used only in an area with a tightly controlled environment. The tape should be kept free of dust and other foreign particles. Factors of temperature and humidity should be controlled within a narrow range. The area should be free of all extraneous magnetic forces.

Video dropout occurs with tape-head gap of	0.4μm
Magnetic coating on tape is approximately	4.2μm
Smoke particles	6μm
Fingerprints	15μm
Typical dust particles	37μm
Human hair	62μm

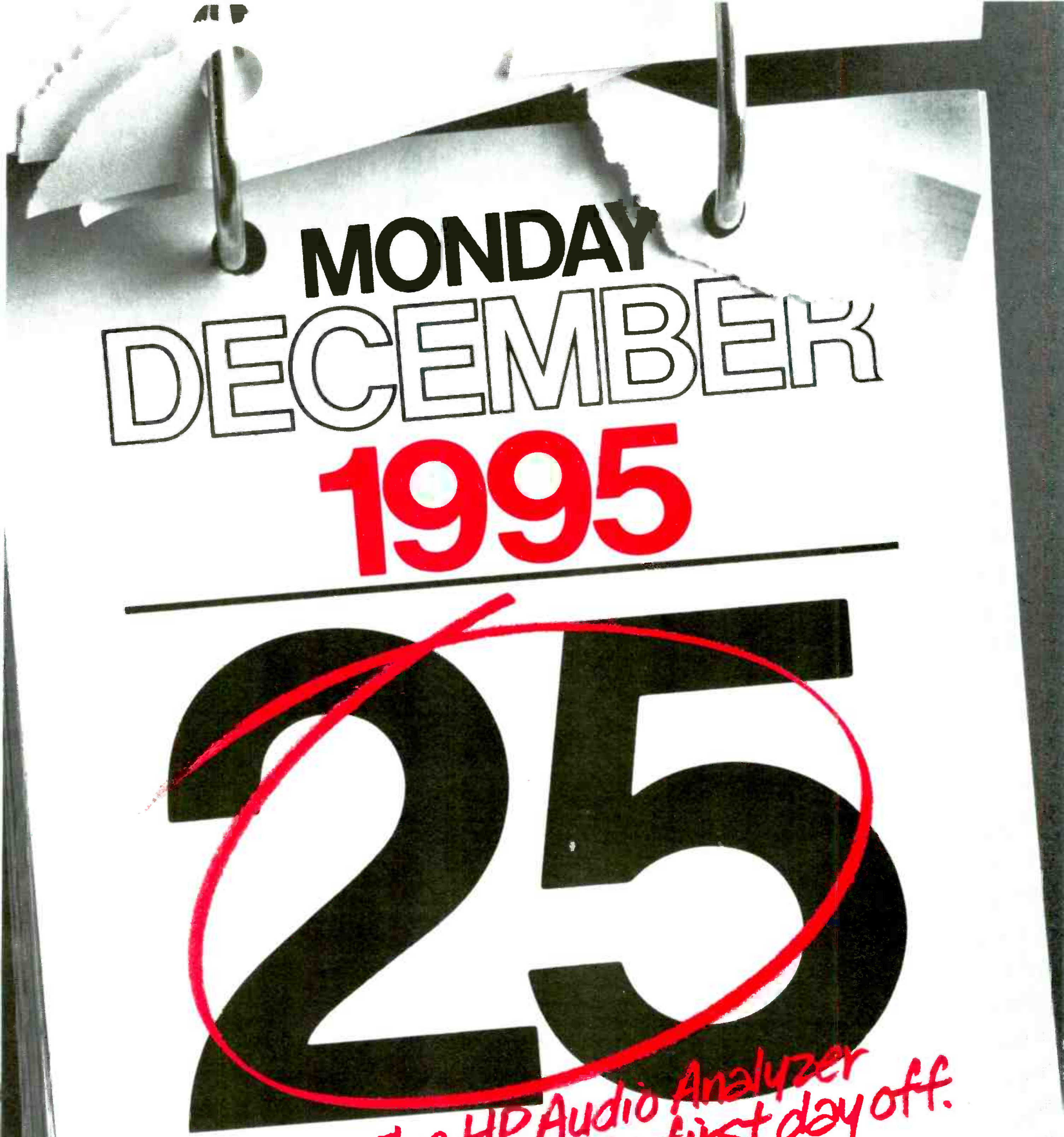
Table 1. *The dimensions of various tape contaminants.*

Dynamics of static

When different materials move against one another in close proximity, the result may be the literal tearing of electrons from the molecular structures of one material by those of the other. This is demonstrated in the age-old science experiment of rubbing various types of fur against a hard rubber rod or a silk fabric against a glass rod. The presence of static electricity is evident when the rod may be used to pick up small fragments of paper.

When a polyester recording medium moves in close contact past a recording head, the same effect is found. Tape often assumes an electrostatic charge that is highly attractive to dust and other foreign particles. The charge can develop into many volts of static potential unless removed. Tape in protective cassette housings is particularly prone to the development of high-static potential conditions and becomes attractive to dirt. The problem is less critical with reel-to-reel formats, in that air molecules (and water molecules in the air) can help to remove the static conditions.

Ingredients in the tape formula may be used to reduce the static build-up. In cassette formats, that reduction may be further enhanced through anti-static materials as a coating within the cassette housing.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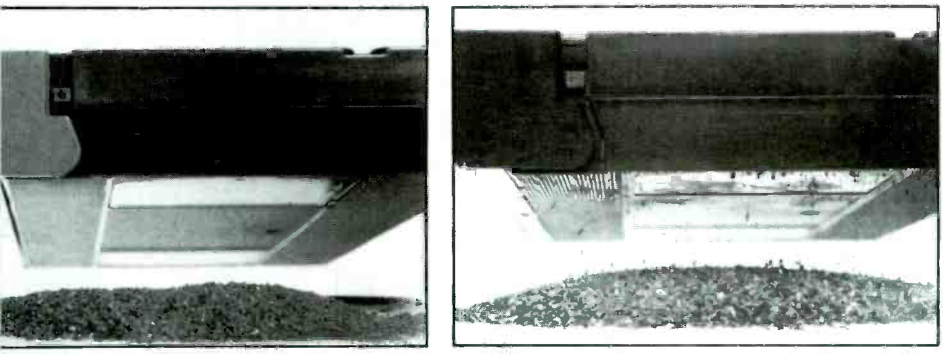


One way to provide preventive maintenance for cassettes is to apply an anti-static treatment. Static charge on an untreated videocassette (right) attracts dry ash and other airborne debris. However, a treated videocassette (left) repels the debris.

Practically, because such conditions are impossible to achieve, relatively safe surroundings can be created for the delicate recording material. Avoid temperatures so hot that deformation of the medium results. Excessive cold may cause binder failure, as can excessive variations in humidity during storage.

Foreign contaminants are probably the greatest enemies of recording tape during its use. Many of those contaminants are typical airborne material, such as dust, dirt, smoke and ash particles and even disintegration products from ceilings and wall coverings. Additional material may include metal particles, a product of frictional forces within a recording system.

A well-organized cleanup program in the technical area is one method of reducing the level of possible contaminants. Any number of cleaning products are available to aid in collecting dirt from floors and from non-tape path surfaces of equipment. Smoking should be avoided in or near tape operation areas. An electrostatic air-cleaning unit, in conjunction with air-conditioning systems, is one way to reduce airborne particles.

Media vs. machines

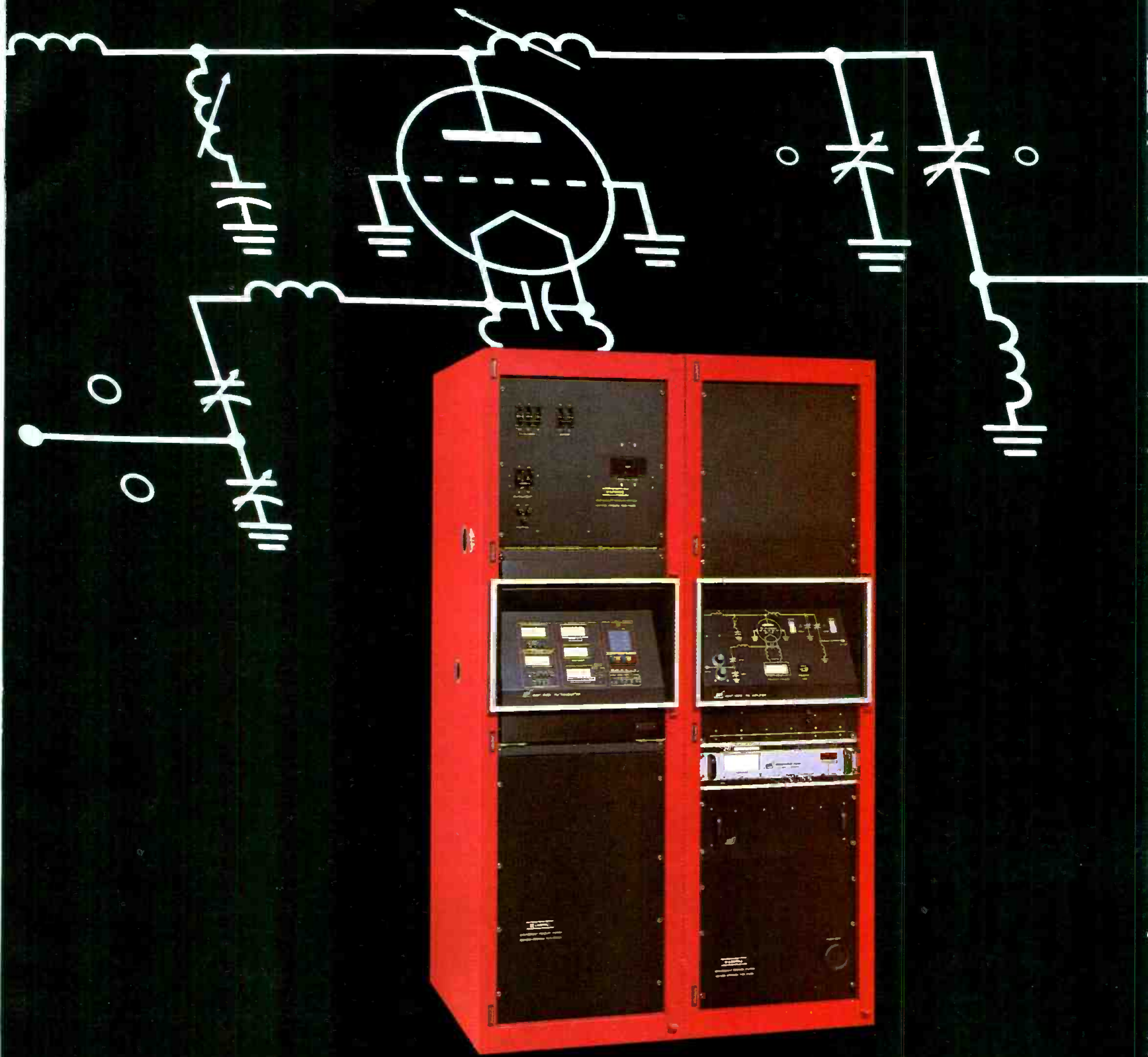
The difficulties caused by foreign matter have the greatest effect when tape or floppy disks are used. In operation, dirty tape causes excess wear on the recorder deck and on the tape. The abrasion caused to metal parts in the system may result in metallic particles being added to the system. Not only are the machine surfaces degraded, the tape surfaces may be damaged.

The machine/tape interface becomes a double-edged sword. Contaminants of the recording material can cause wear on the machine. Dirt in the machine produces wear on the tape. Both may increase the tendency of natural oxide sloughing, which commonly builds up on tape path surfaces. This often causes clogged heads and stickiness, resulting in poor machine performance, uneven tape motion and varying tensions within the system. If the build-up of oxide becomes excessive, tape may be forced out of its normal path, which can result in wrinkling and tearing.

Moisture in the tape path may also produce irregular motion of the tape across the guides. In many video recording systems, where a large amount of headdrum/tape surface contact is possible, moisture sensors may be installed to disable operation in the presence of excessive moisture. Under normal circumstances, a minute layer of air separates the tape from the drum and only the video head protrudes against the tape. The presence of moisture upsets the air layer *bearing effect* and creates the potential for damage to both the tape and the mechanism.

Tension within the medium/machine

Main story continues on page 120



Cassette cautions

Cleanliness is only part of the picture when you're dealing with a machine. Particularly with cassette-based equipment, tape tension is a major source of difficulties. As long as braking, holdback and tape pulling forces are correct, these machines work well. Tensions that fall beyond a certain tolerance can result in tape failure.

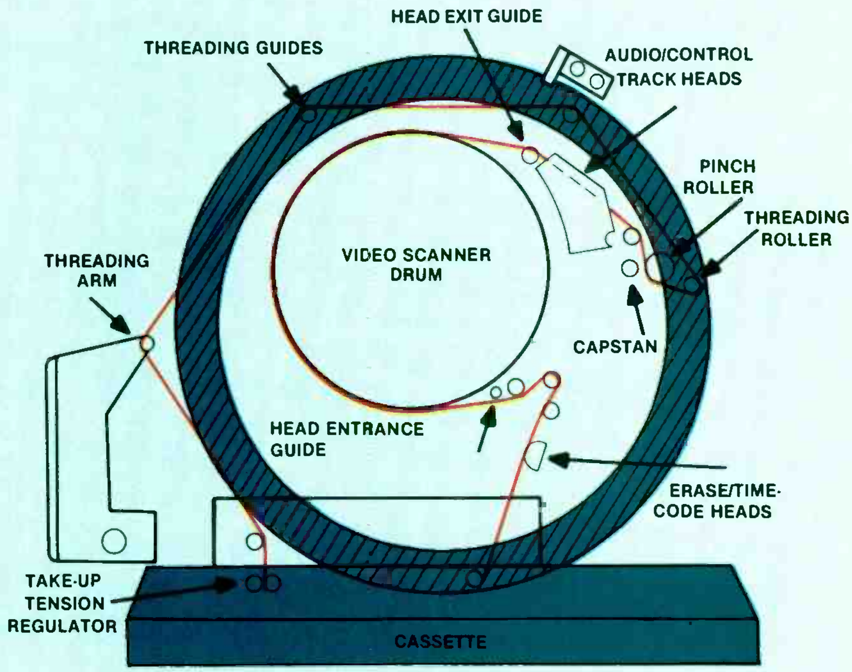
When tape moves through the machine, a certain amount of static builds up. Additives to the tape formula can reduce the level of static, but there remains enough electrical charge to attract dirt. As the tape is wound onto a spool in the cassette, the static accumulates and can produce a large force to attract contaminants.

Tape should be pulled at a steady force as it is wound onto the spool. Under a constant winding tension, the result is a smooth packing of the tape. However, any time the mechanism is stopped, a change in tension of the tape pack will occur.

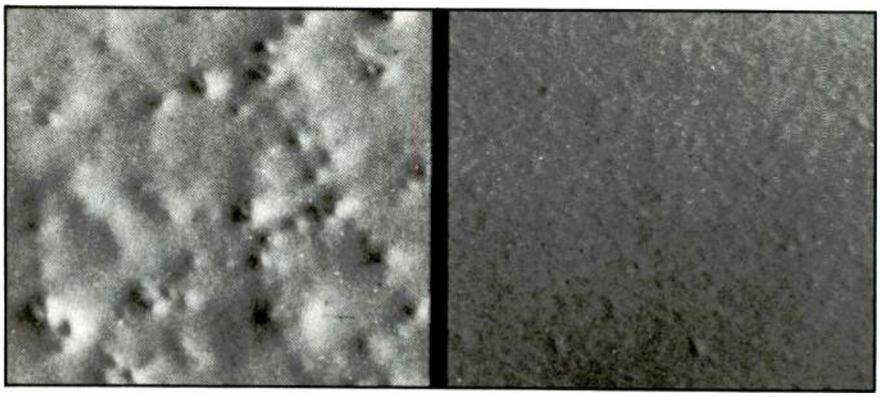
As long as tape motion continues generally in a forward direction, the variation in tension will be tolerable. However, with excessive jogging, as in an editing session, the differences may fall well outside the tolerable range. In such cases, poor editing accuracy may result. A solution is to run the cassette fast forward to the end, then rewind and finally return to the desired point in the tape in the forward direction.

System tension also depends upon the tape transport. Improper tensions may cause devastating results in thread and unthread modes of some VCRs. Early U-format systems were notorious for eating tape without warning.

Later U-format systems incorporate a number of special tension regulators and controls. Optical sensors and improved guides help to reduce any unnecessary slack in unsupported tape spans. The use of more rigid material avoids some of the bending of guides that could occur and reduces the threat of tape destruction.



This drawing of the helical scan tape path shows points at which tape damage could occur.



Courtesy of DuPont

This photo compares the typical base material (left) to newly formulated material (right) through interference contrast surface topography magnified 100 times.

Continued from page 116

system is critical for proper recording and playback. If tape tension becomes too great, the tape may be stretched beyond a point of dimensional recovery. Some tension is required for proper head/medium contact, but the amount is carefully designed into the system. On the other hand, insufficient tension results in poor head/medium contact and poor system performance.

A specified coefficient of friction is designed into the system. That value is a force that must be overcome for the tape to move over the recorder surfaces. The tape-handling characteristics of the machine allow for some operating tension variation. However, any stickiness, which causes increased friction, or oiliness (from human body oils), which produces reduced friction, may create a condition of widely varying tensions that may exceed the capabilities of tension servos. Variations in head/medium contacts under such conditions produce less-than-satisfactory results.

Tape vs. reels

As tape is wrapped onto a reel, tension also plays a part. A constant tension produces a smooth wrap that stores or ships well. Varying tension in the tape wrap can allow the pack to shift upon itself. The result might be a cinching of the tape, if one part of the pack rotates relative to another. Large horizontal offsets between two portions of a reel of tape could produce transverse or edge damages during long periods of storage or during shipment.

Whenever the medium is not actively being used (as on a machine in standby), it should be properly stored. For disc media, that means the disc is housed in a protective jacket and in a disc container. For tape, proper storage means the loose end of the tape is *tacked* to the remainder of the pack with a small piece of adhesive tape.

Ideally, the small strip of plastic that adheres to the tape through a weak molecular adhesive force will be retained. Throughout the life of a reel of tape, however, that force decreases and an actual adhesive material is put into service. As you select a hold-down material, avoid those that leave a sticky residue when removed. Obviously, make certain the hold-down is removed completely before the tape is threaded on a deck.

For long-term storage or shipping, use approved containers. High-impact plastic, protective containers are available for all types of recording tape for shipping purposes. They afford little protection against external magnetic fields, but they do provide a high degree of isolation from dirt and moisture. Such cases also offer greater security for the tape when it is stored on the library shelf. Reels in the library should stand on edge, not on the flat side.

To ship floppy disk material, enclose

Format and formula factors

A variety of requirements must be met by any recording medium. Some of these have already been noted in the main story. It must also be noted that the tape material and recording formats have an interactive relationship.

A case in point is the frequency response of a recording system. The frequency range over which tape is useful is a function of the size of iron or chromium oxides or metallic particles embedded in the magnetic coating. As particle dimensions are reduced, magnetic domain packing density is increased. This can be used to advantage in two ways. At the same linear tape speed through the audio transport or writing speed on the video deck, frequency response can become wider. If the tape or writing speeds are reduced, an increased data-packing density can be realized. At the present time, a practical minimum of ½-wavelength appears to be the limit for coated-type recording material with today's linear recording technology.

The width of a recorded track plays a major role in the signal-to-noise ratio of the record/playback system. If you assume that for a track width of Nμm there are 100 magnetic domains to retain the magnetic polarities for signal recovery, then a 2Nμm track width will contain approximately 200 domains. The greater the number of available domains for playback sensing, obviously, the larger the sensed signal will be, and the less system preamplification will be required.

Track width plays another part that is related to the mechanical design of the recording deck. Head-positioning servo systems continue to provide more precise control in today's recording equipment, particularly in moving-head products, such as video and disc recorders. If, ideally, the playback head were as wide as the recording head, then all domains affected by the recording would provide part of the pickup signal. A head that is perfectly aligned with the track would sense the optimum amount of signal. With any transverse mistracking, the reproduce head senses non-aligned domains, a situation that increases the noise level.

One solution is to write a track that is wider than the read-head width. Some tolerance is thus provided for mistracking. A reduction in track width, then, requires even more precise head tracking in order to keep the playback head within the relatively noise-free area. The trade-off for a narrow track, and presumably a narrow read head, is an inherent increase in the noise pickup or a decrease in the S/N.

Also included with the S/N and signal strength is the thickness of the magnetic layer. Domains closest to the recording/playback head will be affected more by the recording signal and will produce most of the reproduction response during playback. As with light, sound and RF energy, magnetic energy varies inversely with the distance. A variation in the thickness of the coating, which might move the magnetic domains farther from the head gap at any instant, will also play a role in the reproduction in terms of response and noise.

Improvements can be made through the use of magnetic materials with increased retentivity figures, and consequently higher coercivity values. A major advantage is provided by the use of metal particle tape. The difference in coercivity and retentivity of a metal particle formula over one of metal oxide is approximately 7dB. You can either continue to use a specified track width and appreciate a 7dB gain in the relative S/N value or you can reduce the track width with an attendant reduction in S/N for an increase in packing density.

This trade-off is one of the major concerns now under discussion in the ½-inch recording camps. The same argument has led several major manufacturers to predict that 8mm video recording systems for broadcast use are probable, but their timetable for implementation is indefinite.

The physical dimensional stability of tape is highly dependent upon the polyester film material used as a backing. As tape widths decrease, the capability of the backing to resist deformation becomes a project for chemical research. As systems decrease in size, so does tape thickness, again requiring greater physical stability.

In 1985, magnetic media manufacturers consumed some 250 million pounds of base film products—approximately one-third of all polyester film produced during that year. Over this decade, the use of film material for recording media is expected to quadruple, from 100 million to 400 million pounds. That prediction is based on an expected reduction in home video and data media requirements in the second half of the decade. Another factor that will contribute to the reduction of tonnage will be the continued demand for thinner media.

the disk in a rigid container made for the purpose. For storage, the disk should be in the paper sleeve that probably came with it originally. In addition, the disk should be inside some type of storage box that allows it to stand vertically without a great deal of pressure exerted on it from either side.

Evaluating tape

When does a reel of tape become unusable? Edge and end damage, scratches, wrinkles and dropout are accumulative and unavoidable factors with any tape, either reel or cassette, that sees active duty. By following careful handling suggestions, you can avoid creating defects, but eventually, the time arrives for evaluating the tape.

Tape cleaning and evaluation systems are available. For reel-to-reel tape, wiping attachments exist that allow the transport to be used for either wet or dry cleaning of excessive sloughed oxide and other foreign material. Special transports, which include cleaning knife edges and a vacuum residue-removal facility, may also include a fabric-wiping station along the path. Such systems may include an edge damage detector and counter. Thin areas in the tape may also be sensed through photo-optical methods. When a complete pass has been made, options provide a printed report of the condition of the reel.

A cleaning system is usable with any reel of tape, whether or not it contains information to be retained. For evaluating tape that will be reused, some evaluators may write to the tape, obviously disrupting any prerecorded material. In this way, these systems can provide a complete description of the tape condition. Before using an evaluator product, ascertain whether any such disruption will occur. Don't leave yourself open for a surprise.

Another obvious procedure that aids in recorded program maintenance is proper labeling. Your production procedures undoubtedly include a method of identifying the program material for your system. Adhering to that procedure also provides future tape operators with some background on the material.

Common sense

For anyone in the broadcast station who works with the various recording media, it is important that proper handling procedures be used. There are no exotic guidelines to follow to prolong the useful life of the media, just some good common logic.

Tape may be the most inexpensive part of the production, technically, but once the production is finished, that reel, cassette, cartridge or floppy diskette represents the combined efforts of a number of people. It has taken on a value that should not be jeopardized by carelessness.

Editor's note: For more information on the nature of tape and the art of recording, readers are invited to refer to **Broadcast Engineering**, May 1985; the **Television Engineering Handbook**, B. Benson, McGraw-Hill, 1985; and the **NAB Engineering Handbook**, 7th edition, E. B. Crutchfield, NAB, 1985.

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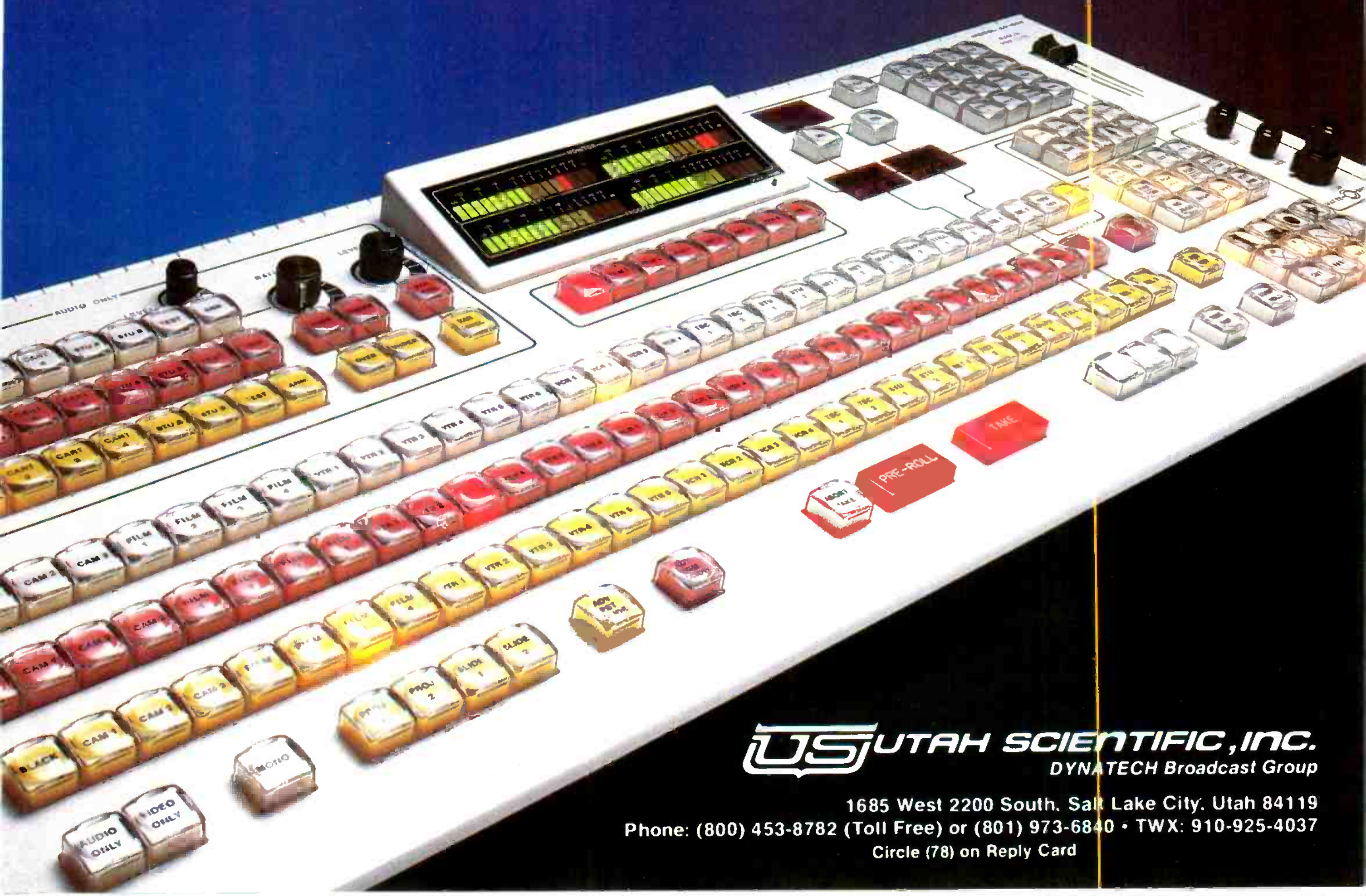

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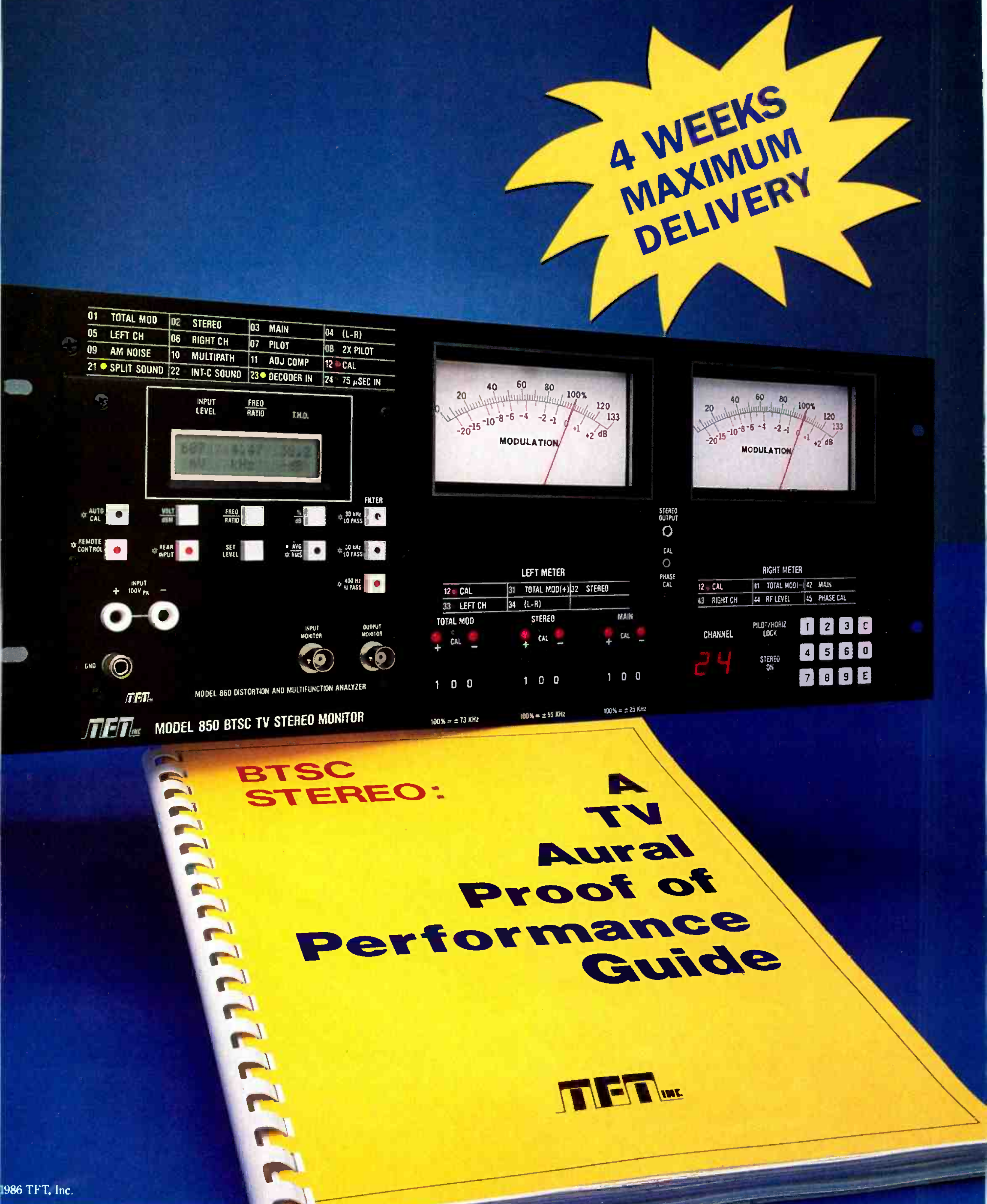

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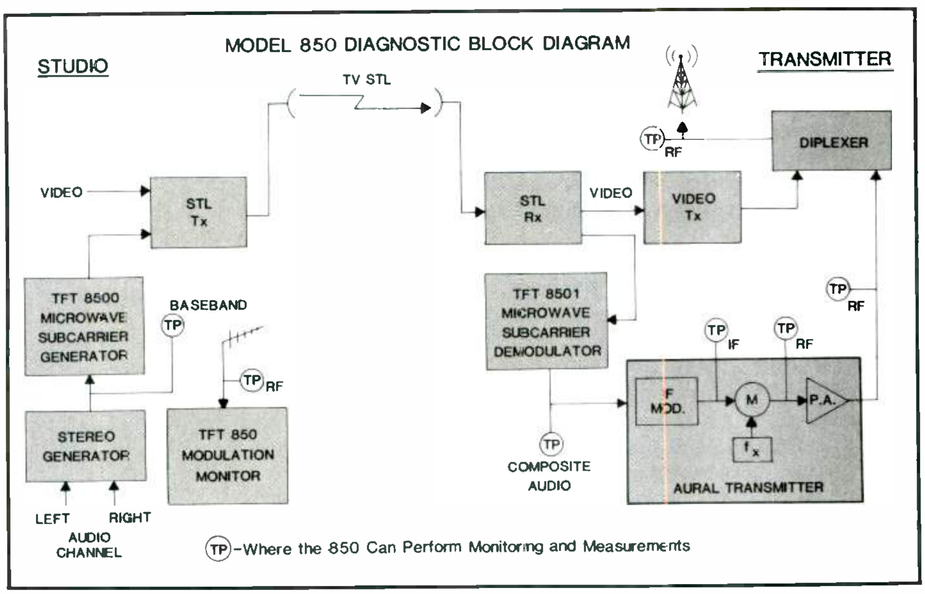

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Using audio patchbays

By Lonnie Pastor

Even in today's world of electronic switching, there is still a place for patchbays.

In this age of microprocessor and digital technology, it may seem out of place to discuss the applicability of electromechanical patchbays in the audio industry. In many applications, however, this technology is as viable today as it was in the past.

Patchbay theory

There are two schools of thought concerning patchbays. You can design a system without patchbays, in which the interconnections between the components are made directly. On the other hand, you can design a system with patchbays, in which the component's inputs and outputs are connected through the jacks in a patchbay.

Without patchbays, the interconnections between the devices in a system are fixed, permanent and difficult to access. If troubleshooting or setup adjustments are required, it is usually necessary to access the connections onto the equipment itself. This means working from the back side of the equipment rack. If signal rerouting is required for new equipment or to bypass an existing device, most engineers do not relish the thought of breaking open a neatly dressed bundle to pull new cables and install connectors.

Pastor is broadcast marketing manager for ADC Telecommunications, Minneapolis.

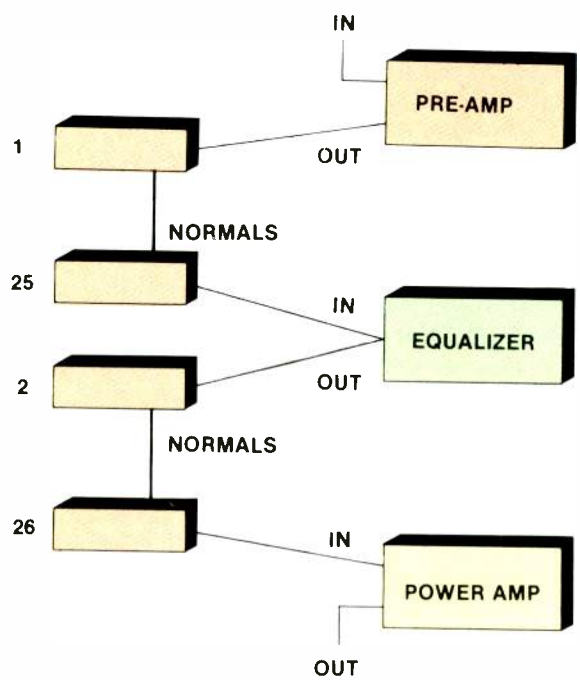

Figure 1. *Two sets of normaled jacks in a 2 x 24 patchbay in a simple audio system.*

With patchbays, if access to the equipment inputs or outputs is required, that access is readily available through the patchbay. This easy access accelerates the troubleshooting or fault location and bypass process, thereby reducing downtime and its associated costs.

Interconnections

Most patchbays are configured with two horizontal rows of vertically aligned 3-conductor tip, ring, sleeve (TRS) jacks. The jacks on the top row are connected to the equipment outputs or sources. The bottom row of jacks is connected to the inputs or loads. (See Figure 1.)

If the signal path changes frequently, patchcords are used to complete the circuit between the desired jacks in the patchbay. This signal routing is the most basic function served by a patchbay. With this design (see Figures 2 and 3), the jacks provide no switching functions.

When the system's circuit path is relatively permanent, switching jacks are used. (See Figure 4.) These jacks incorporate TRS terminals that are an integral part of the contacts that mate with the corresponding contacts on the patchcord plug. These terminals are connected through normally closed contacts to the

Figure 2. A non-normaled 3-conductor jack.

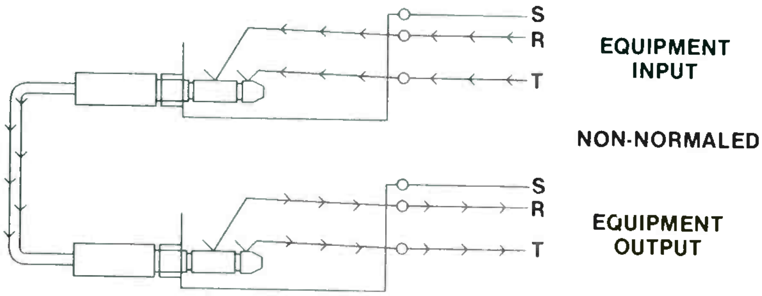

Figure 3. Two non-normaled jacks with a patchcord inserted in both.

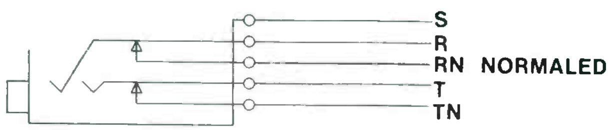

Figure 4. An interconnecting or switching jack.

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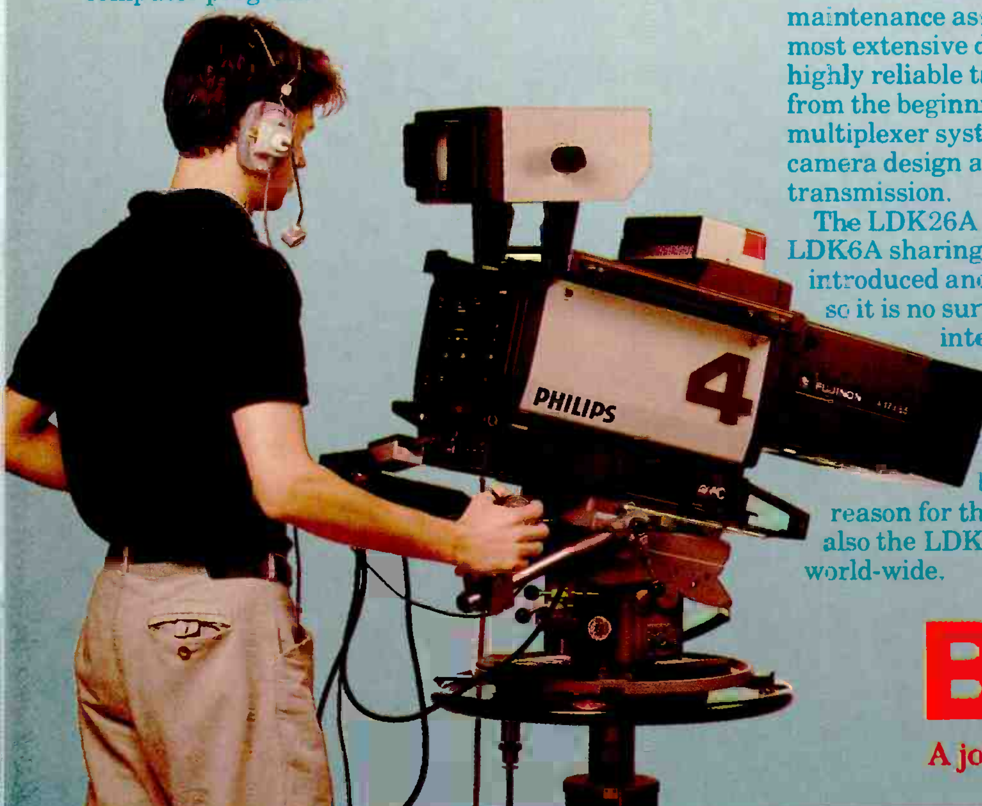

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normal (tip normal and ring normal—the sleeve usually floats) terminals on the back of the jack. When a pair of jacks is normaled to each other, the normal terminals on one jack are connected to the normal terminals on another jack. If a patchcord is not inserted on either jack, the circuit path is from the TRS on one jack to the TRS on its opposite jack.

When a patchcord is inserted in either of the two normaled jacks, the circuit path is broken and the signal is routed into the patchcord. The plug on the free end of that patchcord can then be inserted into another jack in the patchbay, where the normal circuit path to that jack is broken and the reconfiguration is complete. (See Figures 5 and 6.)

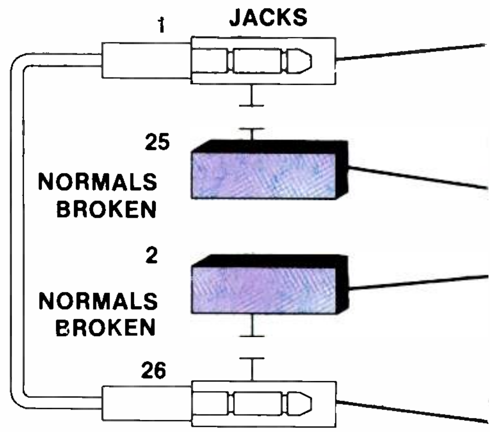


Figure 5. *A circuit reconfigured with a patchcord in a 2 x 24 jackfield.*

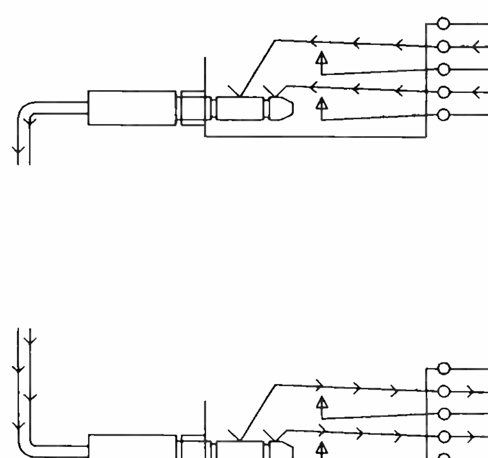


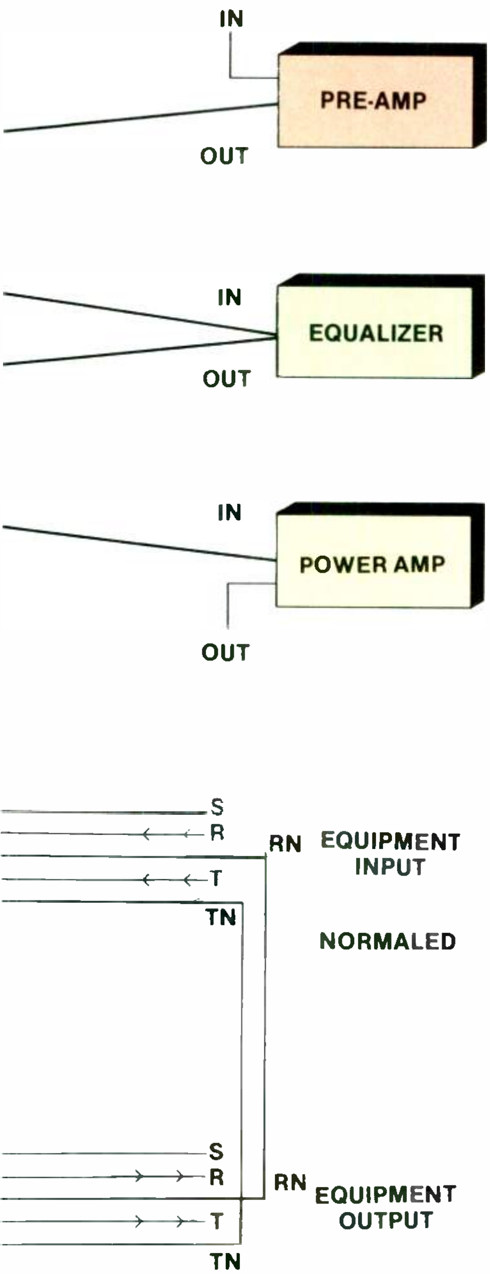
Figure 6. *Two jacks normaled together. The normal circuit is broken by the insertion of a patchcord.*

This reconfiguration function is especially valuable in four situations:

- initially setting up a system;
- troubleshooting and measurements (see Figure 7);
- reconfiguration when the trouble has been isolated (this is useful if redundant or alternate equipment is incorporated into the system and connected to the patchbay); and
- incorporating new or ancillary equipment into an existing system without reworking cable bundles or adding loose wire to a rack.

Equipment types

Patchbays are invariably 19-inch rack-mount devices with panels that occupy



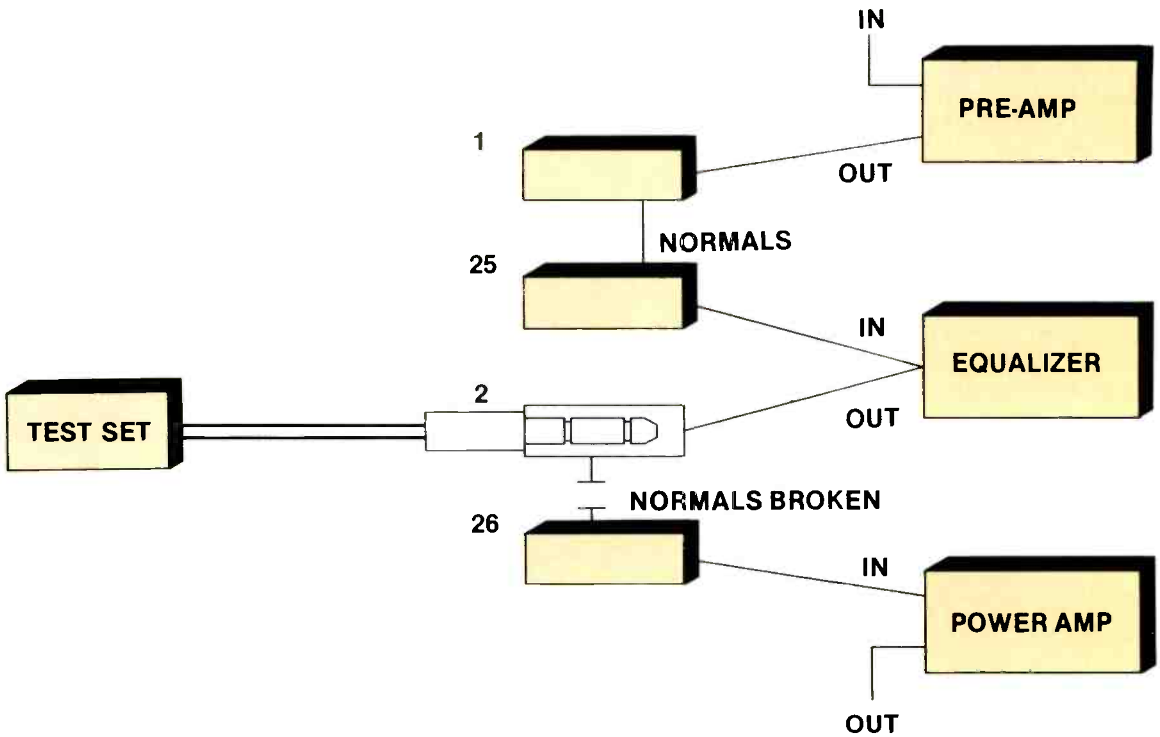
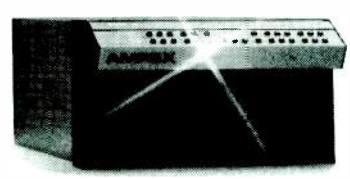


Figure 7. *The typical application of a patchbay with normal jacks used to test a circuit.*

one or two rack spaces (1¾ or 3½ inches high). The jacks incorporated into these panels come in two sizes: 0.173 inches in diameter (bantam) and 0.250 inches in diameter (long frame). The patchbays using long frame jacks are usually arrayed in two rows of 24 or 26 across, with a panel height of one or two rack units.

The smaller diameter of the bantam jacks allows them to be arrayed in twice the density of their long frame counterparts. This results in a panel of 48 to 52 jacks in each horizontal row. This high density is valuable when rack space is at



Two virtuoso performers who won Emmys this year.

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Winners of the television industry's coveted Emmy Awards for technical excellence.

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a premium. It should be noted that the long frame patchbays are larger because they were developed for the telephone industry, which specifies a 30-year equipment life span.

The switching contacts in these jacks are usually gold crossbars, which introduce negligible resistance into a circuit. Designation strips are usually incorporated into the panel for identification purposes. Patchcords are available in various lengths.

Connecting patchbays

Because the terminals on the jacks are not easily accessible when rack-mounted, equipment input and output lines are usually not connected directly to the jacks in a patchbay. Instead, the jacks are connected to an intermediate termination device that is mounted in a convenient location. *Christmas tree*-type terminal blocks and insulation displacement or punchdown blocks or panels are commonly used.

Bringing the TRS connections out to a remotely mounted termination panel greatly simplifies system wiring. With this design, it's also much easier to reconfigure the system as your needs change.

Lately, there has been a proliferation of enclosed patchbays with the circuit terminations mounted on the enclosure's back panel. This configuration affords protection for the jacks and offers an easily accessible area for circuit termination. This configuration eliminates the need to install a wiring harness between the termination point and the patchbay.

Time and money

Until recently, the only way a station could incorporate patching into a system was to purchase the necessary components (panels, jacks and terminal blocks) and build them in-house. However, in the past few years, prewired patchbays have supplanted individual components. Wiring a patchbay is a labor-intensive and tedious job.

The increasing sophistication in electronic systems also has major implications in the use of patchbays. Today's sophisticated and complex broadcast facilities require extensive tests, calibration and maintenance. These procedures are more efficient and simplified when patchbays are incorporated into the system.

Even with the proliferation of modern electronic switching systems, patchbays still have their place in the broadcast facility. They are economical and reliable. For those of us who grew up with patchbays, there is also something reassuring about being able to see how a signal is routed by simply looking at the patchcords.

The key to the effective use of patchbays lies in planning. When designing a new studio or control room, think about how the signals need to be routed. Most of your routing needs may be met with electronic routing switchers. For large and complex facilities, that is typically the case.

However, the use of patchbays in addition to the routers offers many advantages. If patchbays are properly incorporated into a broadcast facility, equipment failure can be quickly diagnosed and rerouted as needed. This process can help you avoid off-air time—as well as frayed nerves.

Schematics courtesy of Peter Adams, ADC Telecommunications.

Editor's note: The term patchbay, jackfield, patch panel and several others are used interchangeably in the industry. In this article, the term patchbay is used to refer to any panel fitted with a group of jacks used for patching purposes.

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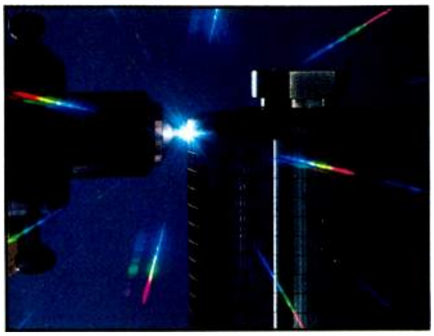


Improved CCDs mean better picture quality

By Larry Thorpe

Camera tubes based on lead oxide or selenium, arsenic and tellurium materials are moving targets when it comes to picture quality. Steady improvements continue to be made in the parameters that contribute to total picture quality—resolution, sensitivity and lag, for example—particularly for the 2/3-inch-format tube on which current international developments are primarily focused. Until recently, these pickup tube technologies have enjoyed little competition in studio, ENG and EFP cameras.

Charge-coupled device (CCD) imaging systems, first introduced in 1975, have been touted for their many advantages over tubes. Seemingly well suited to ENG because of their light weight, ruggedness and ease of operation, CCD cameras have left much to be desired in areas of sensitivity and resolution. In addition, they presented new problems of *smearing, blooming* and fixed pattern noise.

Refinements in CCD imaging have resulted in picture quality improvement. Trials with various configurations of the photosensor array, placement of the array on the optical block and different methods of internally transferring the image have steadily contributed to CCD improvements.

Thorpe is director of studio product management, Sony Broadcast Company, Teaneck, NJ.

CCD cameras are limited in resolution, compared to the best 2/3-inch pickup tubes, but their unique benefits more than compensate for this shortfall in ENG applications. High sensitivity, no lag, no comet tailing and no registration adjustment all add up to definite advantages for a rugged camera capable of operation at low-light levels.

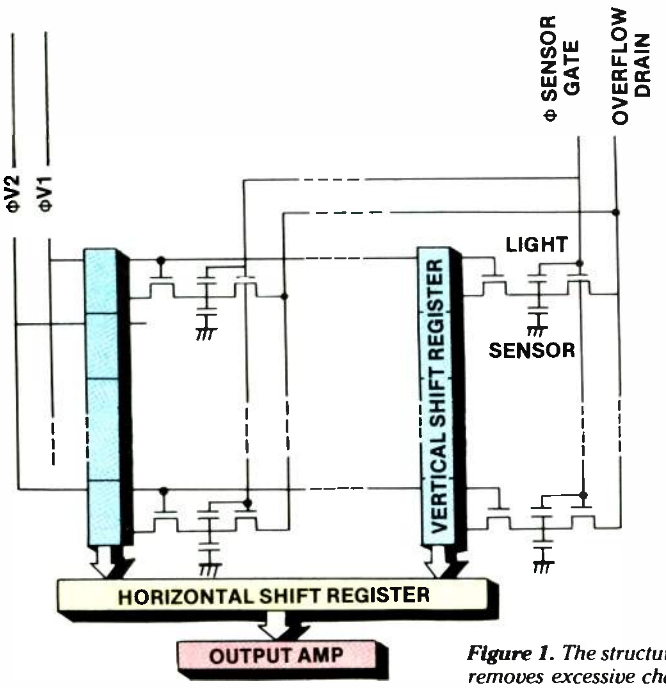
How CCDs work

The Sony solid-state imager, introduced at the 1986 NAB, is an array of photosensing capacitors produced by metal oxide technology. (See Figure 1.) A metal oxide diode sensor generates a charge proportional to the light intensity via the photoelectric effect. The charge is then transferred for storage in *potential wells* that occur when a specific voltage is applied to the chip's silicon substrate.

The next stage of CCD imaging is the appropriate transfer of the stored charge for formulation into an analog video signal. This critical step has been the most difficult to perfect. The particular method of transfer often distinguishes one CCD technology from another.

Perhaps the easiest, yet most dramatic, modification that has improved transfer of the stored charge has been the addition of a thin 50nm polysilicon layer as a transparent electrode in the photosensing image area. This layer improves the transfer and removal of the charge with considerably reduced lag. The MOS sensor diode is provided with an overflow control gate and a lateral overflow drain to eliminate blooming effects.

The latest generation of CCD devices exhibits higher speeds and enhanced efficiency in transferring the charge to the output registers. Earlier devices trans-



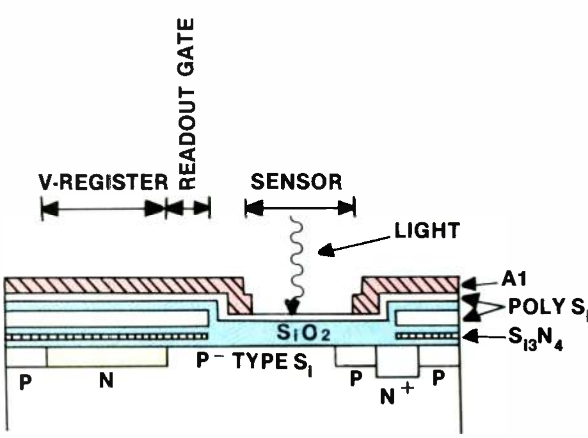


Figure 1. The structure of the CCD shown diagrammed and in cross section. The overflow drain removes excessive charge that would result in overflow phenomena of blooming and lag.

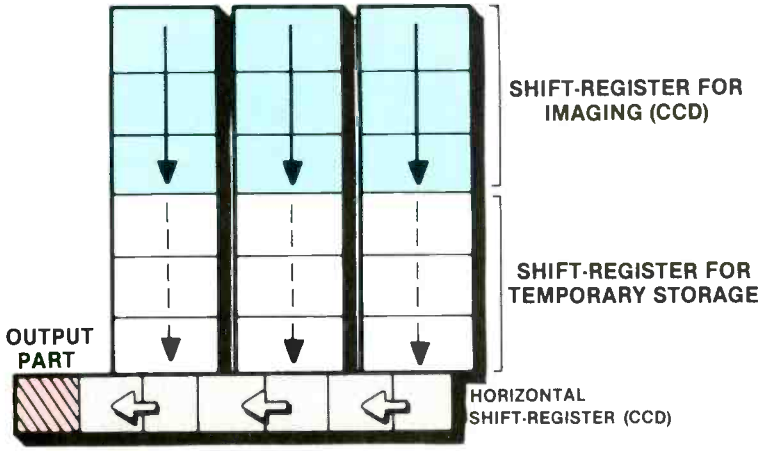


Figure 2. *In the frame transfer organization, charge is moved from the imaging array to the temporary storage array before being transferred again to a horizontal shift register for clocking into a serial video signal.*

ferred the charge to the output amplifier by vertically and horizontally scanning each sensor. Unfortunately, the process was slow, producing lag and creating excessive random noise from the X–Y addressing bus.

The technique was much improved with the addition of a horizontal shift register. Even though each sensor was still vertically scanned, the charge was transferred to the output amplifier by a horizontal register, dramatically reducing random noise. The *MOS-CCD* device, as it was named, immediately transferred the charge once each horizontal line, eliminating the lag associated with earlier CCD devices.

After the introduction of the horizontal shift register, another transfer technique emerged, employing both vertical and horizontal shift registers. Called *frame transfer*, it was a major step to improving CCD imaging.

Each of these transfers involves a process of highly efficient passage of a voltage charge from one cell to another, hence the term charge-coupled device.

Transfer: frame vs. interline

In a frame transfer imager, the charge pattern formed in the separate photosensitive cells is allowed to integrate during the unblanked frame period. Once the array is fully charged, the entire frame is rapidly transferred during the vertical blanking interval to a lower array using vertical shift registers. (See Figure 2.) The lower array is optically shielded to prevent stray light from affecting the charges stored there.

The stored image is then transferred row by row into a horizontal register from which it is clocked into a normal horizontal scan line period. While the lower array charge is being clocked out line by line into a third output register, the upper array begins to register another image. The entire transfer process is repeated at each vertical interval.

The advantages of the frame transfer concept are obvious. Because the charge is immediately removed from the imaging array, a new image cycle can begin. More imaging area is available for photosensing, contributing to higher overall sensitivity.

Disadvantages are also apparent. Two arrays require twice as many elements, that is, twice the number of pixels must be fabricated. This is a major consideration in the production of these complex semiconductor devices. Also, the frame transfer device calls for a multiphase clocking system, requiring a fair amount of power. These points considered, the frame transfer CCD remains an important example of modern CCD imagers.

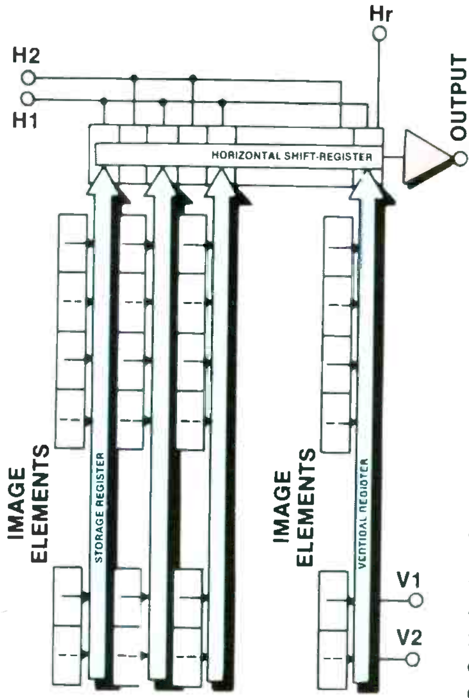


Figure 3. *Interline transfer CCDs include a storage register that is integrated with the photosensitive array.*

The most recent step in the evolution of CCD devices is the *interline transfer* device. It transfers a charge as readily as the frame transfer method, but it involves only one sensor array. The storage register is integrated with the frame register. (See Figure 3.)

Each MOS sensor is accompanied by an individual register, which consists of N-type, buried-channel CCDs formed with the P-well. This register is driven by 4-phase clock pulses. A single sensor and its associated register constitute a unit cell or pixel. A unit cell has dimensions of $17\mu m$ horizontal and $13\mu m$ vertical.

These registers are structured to form vertical register banks. The image and storage areas are interleaved with storage columns placed between active columns. Instead of transferring charge one frame at a time, the interline camera transfers charge one line at a time. After each column of sensors dumps its charge into the vertical shift register during the vertical blanking interval, the charge is

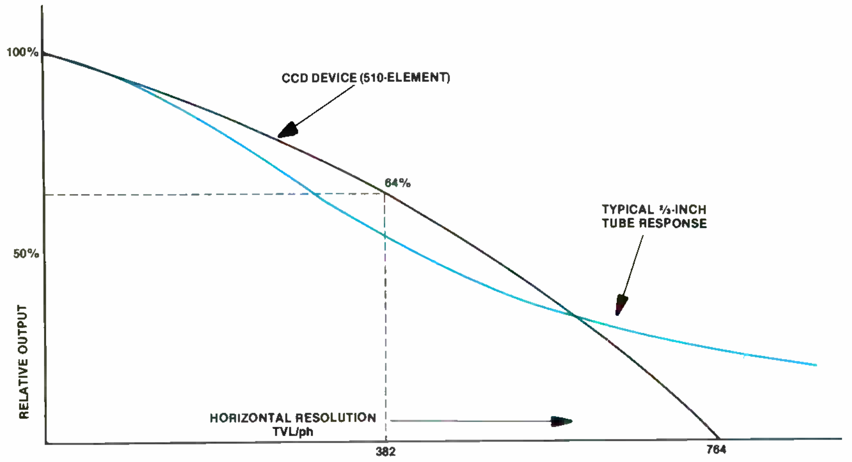


Figure 4. *A comparison of horizontal resolution capabilities of ⅔-inch tubes and CCD devices indicates the present superiority of tubes at high line resolutions.*

quickly transferred to the horizontal register one line at a time. Charges in the horizontal register are clocked out serially for video processing.

Compared to previous technologies, the interline transfer requires only one sensor array and inherently eliminates the need for a mechanical shutter. Because fewer transfers are needed over a frame transfer system, it is also more efficient in overall charge transfer.

Emphasizing resolution

Resolution has been a concern of CCD camera designers. Although CCD cameras offer many advantages over tube-type systems, tube resolution cannot be matched by the CCD. There are ways of enhancing the apparent resolution, however.

CCD resolution is limited by the imaging array, which is discrete and static, as opposed to an electron beam in the pickup tube, which is moved and focused essentially on an infinite number of points. Doubling the resolution would require double the number of sensors. Unfortunately, there is a limit to the number of sensors that can reliably be produced on a given chip under the current state of the art in microcircuit fabrication. Any attempt at a large increase in the number of pixels will result in a reduced yield of usable devices and, consequently, in a higher cost. This limitation will be reduced as new fabrication techniques are perfected.

A solid-state array is advantageous because its nearly perfect geometric reproduction is more durable than a tube. It is unaffected by external magnetic fields. Also, the array is much smaller in total volume, and requires less driving power than a pickup tube. The CCD imager is a spatial sampling device that exhibits a predetermined frequency-response curve controlled by a (Sin X)/X mathematical law. (See Figure 4.) The factor *X* is proportional to the number of

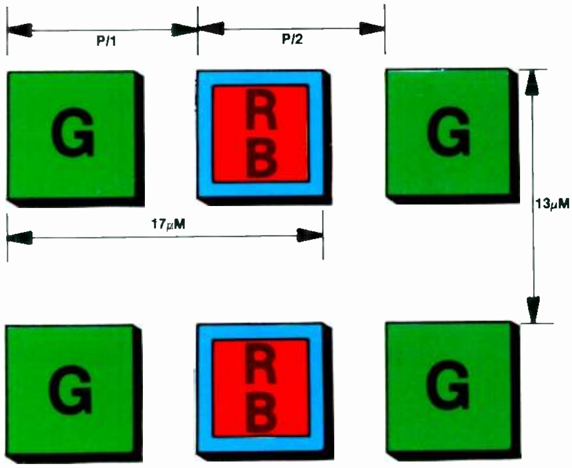


Figure 5. The ½-pixel offset in green (G), compared to the position of the red and blue (R/B) CCDs, allows an effective increase in resolution by a factor of two.

horizontal elements and to the horizontal pixel dimension.

A technique has been found that effectively improves the resolution of the 3-chip CCD camera (one chip each for red, green and blue). In the first CCD cameras, the chips were conventionally *perfectly* aligned spatially before being firmly bonded to the light-splitting prism block.

Suppose the green chip is offset by ½-pixel or sensor distance in the horizontal direction, relative to the red and blue chips, as illustrated in Figure 5. The half-element offset effectively increases luminance resolution over other CCD camera designs by almost 50%. The luminance signal is formed from contributions of green, red and blue. Therefore, the luminance signal is effectively sampled by 1,020 sensor elements in the horizontal direction, instead of the 510 elements of a single chip.

The effect of aliasing, a by-product of any sampling system, is countered through a prefiltering technique. This involves restricting the frequency bandwidth of the input energy actually sampled by the imager. That is, the input optical energy is prefiltered. (See Figure 6.)

The complex optical filter is placed on the input port to the light-splitting block and provides horizontal, vertical and diagonal optical filtering characteristics. The result, however, is a final total resolving power for the camera of 550TVL of luminance resolution with a depth of modulation at NTSC band edge (4.2MHz) of almost 50% without detail correction. Aliasing, although not zero, is carefully controlled at higher frequencies. Overall, these specifications are well suited for high-quality ENG use.

Sensitivity

The need for an adjacent storage register with each separate image sensor in the interline transfer CCD inherently reduces the available chip area that is sensitive to light. Also, the increase in

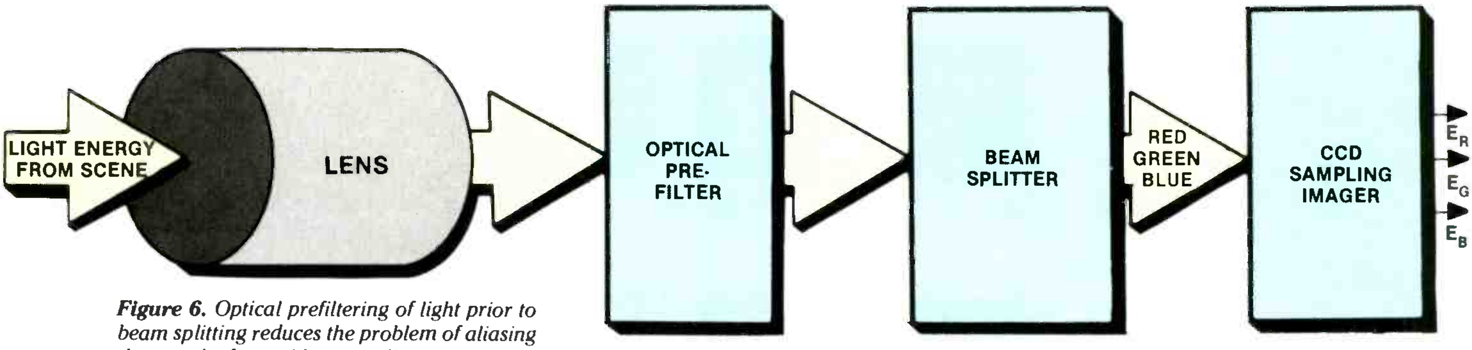


Figure 6. Optical prefiltering of light prior to beam splitting reduces the problem of aliasing that results from video sampling.

the number of pixels required to achieve high resolution results in a reduction of the effective sensing area (and consequently, the sensitivity).

These factors can be countered with an optical window on the MOS sensor diode consisting of three different thin-film layers. By proper combinations of film thickness, considerable enhancement of device spectral response is achieved. The top layer, consisting of an Si_3N_4 material, substantially improves blue sensitivity.

A specific application

The CCD chips in the BVP-5 camera have been structured precisely to a 2/3-inch format. The chip dimensions, 100mm horizontally by 9.3mm vertically, include an image area measuring 8.8mm x 6.6mm. In conjunction with a standard f/1.4 RGB light-splitting block, a total optical speed of f/5.6 can be achieved, based upon viewing a white object of 89.9% reflectance and an incident light of 2,000 lux. The luminance S/N figure (unweighted) is a respectable 58dB with 0dB additional video gain. This compares favorably with the typical f/4.5 and f/4 speeds of 2/3-inch lead oxide and Saticon camera designs using identical conditions and the same lens.

Future CCDs

CCD technology is a 10-year-old story of evolution. The reduction of pixel/sensor dimensions to only a few micrometers, the use of optical prefiltering and thin-film technology that enhances spectral sensitivity have played roles in the development of lightweight, low-power consumptive cameras applicable to ENG and outside broadcasting.

Continued reductions can be expected in the dimensions of the pixels to less than the small, but finite, size of the camera tube beam. At that time, the CCD, without a power-consuming, physically sensitive filament and the need for precise focus and deflection currents, will result in a new concept in camera designs for all applications. It is just a matter of time.

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While camera manufacturers were developing new high-performance ⅔″ studio cameras, Fujinon was busy designing new lenses to go with them. Not conversions, modifications or quick fixes, but totally new lenses. And they're available here and now.

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Weight and size are reduced, reliability and serviceability are increased. Major components are modular and interchangeable. Controls and adjustments are accessible *with the shroud in position.* These include back focus adjustment and lock, servo/manual switch for the built-in 2X extender, and pattern projector color levels and chart positioning. Focal length and aperture are reported through LEDs on the side of the lenses. And options include the full array of Fujinon accessories including remote demands and shot boxes.

To learn more about Fujinon's new generation of ⅔″ studio/field lenses, you'll get more information or a demonstration by calling the Fujinon location nearest you.

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JVC KY-320 camera

By Kerry Donovan

Few decisions directly affect a station's on-air look as much as the selection of its ENG cameras. In mid-1985, when the news department at WBNG-TV faced such a decision, the initial purchase included only one JVC PROCAM KY-320 camera. After using the camera in the field for almost a year, we subsequently added five more KY-320s to our stock.

Important features

We began our search for a new camera by comparing the specifications of similar units. After grouping the various cameras by price range, we were able to make some fairly direct comparisons. One requirement was a camera that used Plumbicon tubes. Because our operators are often required to shoot in low-light situations, we felt that Plumbicons would provide the necessary sensitivity and signal-to-noise ratio performance.

Another important feature is automatic camera operation. The KY-320 provides auto-white, auto-black as well as several other automatic features. The camera's automatic black level (ABL) seems to do a nice job of stabilizing the dark spots common in ENG situations. The automatic beam control (ABC) minimizes the blooming and comet-tail effects that are often seen on night shots. The auto-shift registration circuit is controlled by 8-bit microprocessors. A quick press on the button is all that is required to complete the camera setup process.

The camera provides several standard features that assist our camera operators in getting the right shot. Along with auto-iris operation, a feature that the engineering department appreciates, is the pickup tube protection circuit. When camera power is turned off and the color bars switched on, the iris automatically closes to protect the sensitive Plumbicons. An additional protection circuit detects the absence of either the horizontal or vertical deflection pulses. If either of the pulses fail, the electron beam is turned off to protect the Plumbicons.

Donovan is news director for WBNG-TV, Binghamton, NY. Mike LaMonica, chief engineer, assisted with this report.

Performance at a glance

- *Self-contained, compact, does not require a separate CCU*
- *Lightweight (9.1 pounds)*
- *S/N 57dB*
- *More than 600 lines of resolution at center screen*
- *Low-light requirements (38 lux, 3.6fc at f/1.4)*
- *Full automatic features; auto shift (registration), auto beam control, white/black balance, auto iris*
- *Camera can be gen-locked with either external composite video or blackburst signals.*
- *Built-in color bar generator and color-framing pulse output.*

Another useful feature is *matrix masking*. The circuit helps the operator obtain authentic color reproduction even in poor lighting conditions by adjusting the Plumbicon's effective color sensitivity to match that of the human eye. The complex process is explained in the related article, "Matrix Masking," page 148.

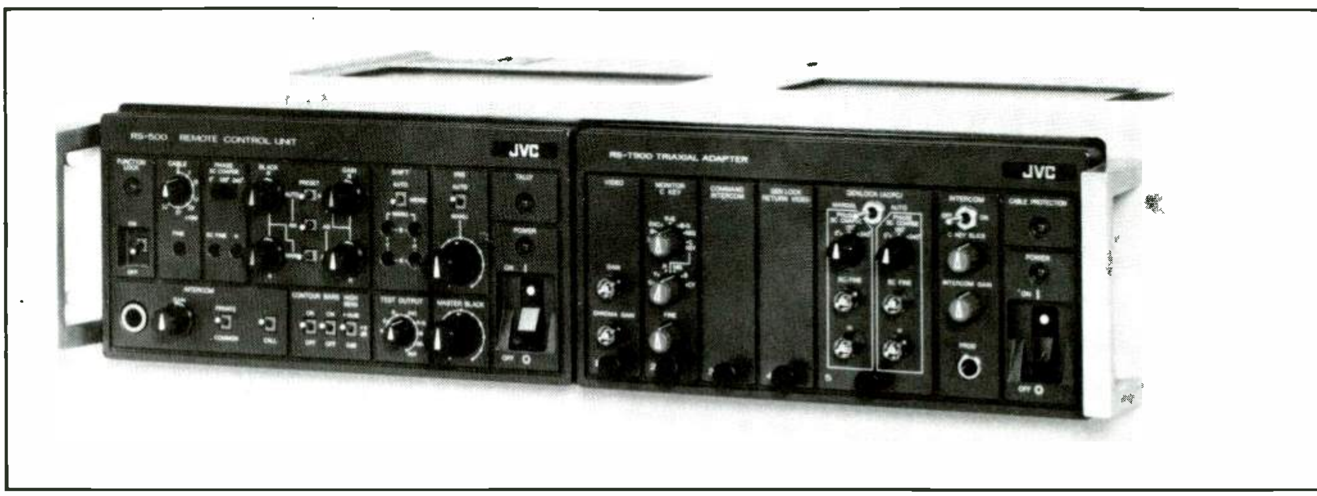
The camera conforms to EIA RS-170A broadcast standard. It provides both split-type color bars and full-field color bars (RS-189) with the flip of an internal switch.

The camera relies on complex circuit boards to perform many of the sophisticated functions. Some circuits use VLSI chips and surface-mounted ICs. Surface-mounted ICs (SMDs) require less space and don't connect through the circuit boards like other devices. This keeps the camera lightweight, compact and reliable. Despite the inherent complexity in these devices, maintenance is actually easier than in some other cameras. The camera has 10 major circuit boards, which can be easily removed for repair or replacement.

Prism optics

Three ⅔-inch Plumbicon tubes and a refined f/1.4 prism optical system provide excellent sensitivity and a crisp and clean on-air look. The camera's optics have an exposure latitude, which allows it to be used for location or studio work. In our tests, we obtained a 58dB S/N, which meets the manufacturer's specifications.

The optical system and a +9dB or +18dB gain boost lets the camera operate with less than 38 lux (3.6fc) of illumination at f/1.7. This sensitivity works well in both low-light and artificial light situations. An optical filter turret contains four different positions: closed,



The optional triaxial adapter can be mounted in a standard rack unit along with the remote-control unit. With triax, the camera can operate with almost 5,000 feet of cable.

3,200°K; 5,600°K; and 5,600°K +25%ND. With these color corrections, the camera does a good job of compensating for changing lighting conditions.

The horizontal resolution measures more than 650 lines at center screen. The 2H vertical contour correction circuit further enhances the image clarity.

Thanks to the gen-lock feature, we've had no problems maintaining a stable picture while switching or mixing with other signals locked to the same source. The camera can be gen-locked by an external composite video or blackburst signal with the standard 0.3V sync and 0.3V burst-flag subcarrier.

Viewfinders

The camera can be equipped with two different viewfinders. We use the smaller viewfinder for ENG work. The larger viewfinder is best suited to studio requirements.

For really sharp pictures, the hot-shoe 1.5-inch viewfinder can be used. It eliminates RFI problems that sometimes appear on the larger viewfinders. The smaller viewfinder provides 400 lines of resolution. If desired, larger eyepieces can be fitted to the viewfinder. A flip-up mechanism and diopter also is provided for people who wear eyeglasses.

A *zebra pattern,* which indicates excessive video, can be turned on or off with an easy-to-reach switch. Other indicators located in the viewfinder allow the operator to monitor the gain setting, black-and-white balance, registration, battery level and recording status.

A viewfinder/test output switch is mounted on the side of the camera. The operator may select different types of signals including ENC. When set to ENC, the 70% picture signal level is indicated by stripes in the viewfinder. This is particularly useful when working in the manual-iris mode. The video level is controlled by the automatic-aperture adjustment when the camera is in the automatic-iris mode.

Operation

The camera is lightweight and its diecast aluminum body weighs only 9.1 pounds. The warm-up period (after power is turned on) can be as short as 40 seconds. I suggest that you give it a little longer to provide maximum camera stability.

The operational switches are mounted on small control panels. The adjustment switches, on the other hand, are grouped behind the door of the switch box. This arrangement seems to make camera operation easier and reduces the chances of someone accidentally flipping the wrong switch.

The VTR trigger mode-select switch is mounted on the outside of the camera. The switch changes the trigger voltage from high to low or to a pulse. This combination allows the camera to be used with just about any VTR on the market.

Tripod-mounted, the KY-320 allows long-term operation without operator fatigue.

The video recorder connector is mounted at an angle to avoid interfering with shooting. Operators find that the arrangement helps them when they have to handhold the camera for long periods of time. Our engineers appreciate the connector-mounting location because it reduces damage to the connector when the camera is set on its base.

We modified our units slightly so everything runs from the same battery pack. Although this reduces the length of time the operator can record, the modification saves the operator from toting a bunch of battery packs.

Picture quality

At several recent C-band co-op satellite pools for the New York State Republican and Democratic Conventions in Albany, we've noticed that our pictures are as good as any other station's. Although we expected good performance, it was nice to see our cameras performing as well as some that cost a lot more.

One area we've had to watch is talent lighting. Because the Plumbicons reproduce shadows so accurately, additional lighting is sometimes needed. In some cases, we've even had to add extra light for day shots.

Maintenance

The camera comes with a 1-year parts and labor warranty. Although that doesn't eliminate the need for station maintenance, it's nice to have that kind of support. Because our day and night crews share the same equipment, our maintenance shop is open at all times. The maintenance staff has regular access to the equipment, so the cameras are always in top shape.

Maintenance usually consists of standard alignment checks and procedures. If a major problem develops, the boards are easily removed with a special tool supplied with the camera. The manual is easy to use and complete with large schematics and extensive assembly drawings.

Accessories and options

There is a wide range of accessories available for the camera. Although we don't use many of them, it's nice to know they are available.

One accessory we do rely upon is the 2X extender for the zoom lens. By coupling it with the 12X zoom lens, we've been able to obtain excellent pictures.

For those stations contemplating component video operation, the KY-320 is ready. A KA-3 component VCR adapter allows the camera to handle component video signals including M-II and other ½-inch formats. The adapter attaches to the back of the camera head and supplies R−Y/B−Y or Y/I/Q signals to the recorder.

The camera can also be used with triax cable. From the RS-500U remote-control unit, the camera can be operated at a distance of almost 5,000 feet. The triax feature allows chroma-key capability.

The JVC KY-320 camera has proved to be an excellent choice. The camera provides the high quality, light weight and consistent performance required in an ENG-intensive operation like ours.

Editor's note: The field report is an exclusive **BE** feature for broadcasters. Each report is prepared by the staff of a broadcast station, production facility or consulting firm.

In essence, these reports are prepared by the industry and for the industry. Manufacturer's support is limited to providing loan equipment and to aiding the author if support is requested in some area.

It is the responsibility of **Broadcast Engineering** to publish the results of any piece tested, whether positive or negative. No report should be considered an endorsement or disapproval by **Broadcast Engineering** magazine.

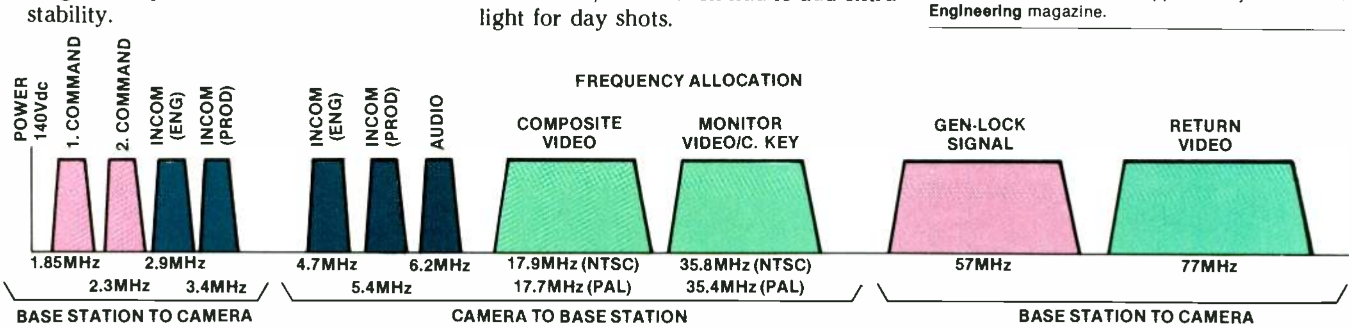
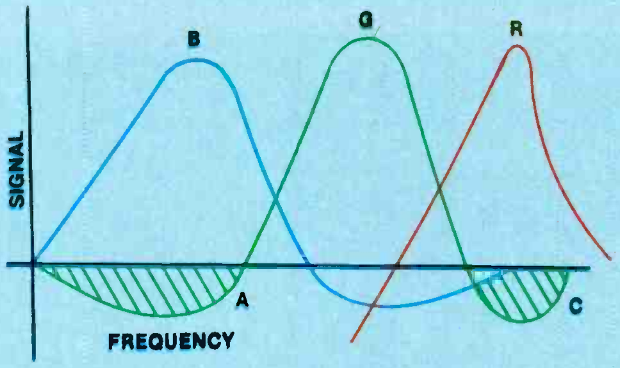
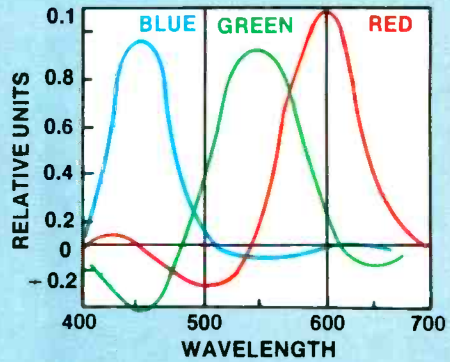


Figure 1. *Frequency allocation for triax operation of the KY-320 camera.*





Above left, the curves represent the relative quantities in output needed to produce correct colors. The shaded areas are the negative signal components that must be used to produce ideal NTSC colorimetry.

Above, relative values for the R, G and B signals for correct NTSC colorimetry.

Matrix masking

Color correction (color matrix masking) is one of the most important changes that a video signal undergoes as it travels along its electronic circuit. Modern cameras provide complex circuits that help color-correct the images recorded on tape or transmitted.

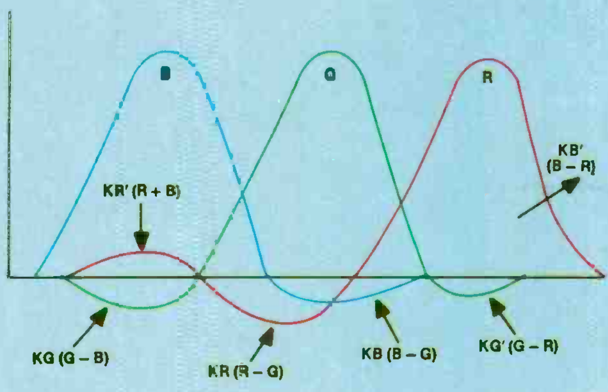
The color camera and its monitor comprise a tri-stimulus system. This is a system in which an additive mixture of three primary colors is used to produce any other color within its range. The spectrum of colors that can be displayed on a TV screen is limited by the coordinates of CRT phosphors.

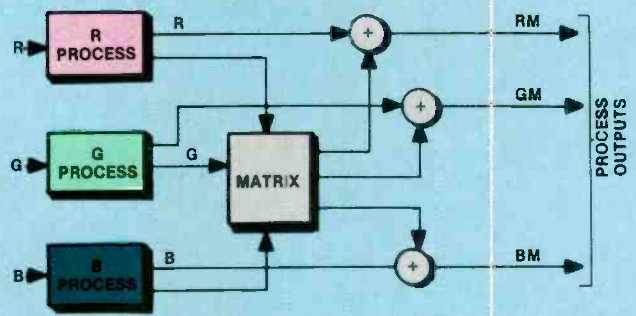
The matrix-masking system assures authentic color reproduction by changing the output color curve of the Plumbicon tube. The tube's output is changed to match the colors in the same way as the human eye perceives color.

Ideal color display

By analyzing the color-camera responses required to obtain perfect colorimetry, in conjunction with an NTSC coordinate system, you obtain the characteristics shown in the frequency allocation diagram, above left. The shaded areas represent negative responses, or negative sensitivities, required to obtain ideal or perfect colorimetry. Fortunately, in television such negative sensitivity can be achieved by matrixing these color signals.

Negative sensitivity simply means that some colors could not be matched with the primary colors used in the light-matching device. However, if light from the available primaries is transferred to the sample side of the camera light box, a match can be achieved. This process effectively sub-





Applying a bit of algebra to the matrix equations produces the negative signals shown in the diagram above.

Above right, a block diagram of a matrix masking circuit.

tracts that primary color from the matching side. Studies completed in 1931 showed that all colors can be matched with suitable primary colors of red, green and blue. Matching is, of course, an additive and not a subtractive process.

Color-correction circuits

Matrix masking is a way of electronically altering the video signal to make it more closely match the ideal color characteristics shown in the light-response graph, facing page. Because this process cannot be achieved by the optical system alone, a color-matrix circuit electronically compensates for the negative elements of the signal. The result is a closer match to the required ideal characteristics.

A more detailed representation of the R, G and B signals, shown above, illustrates that the matrix process needs to be quite complex to accommodate all of the negative signal elements within the spectrum.

The values of the coefficients must be optimized for the corresponding characteristics of the beam splitter. Within the matrix-masking circuit, the ideal characteristics negative section decreases the amplitude of the R and B channel signals of the waveform as shown in the frequency-allocation diagram.

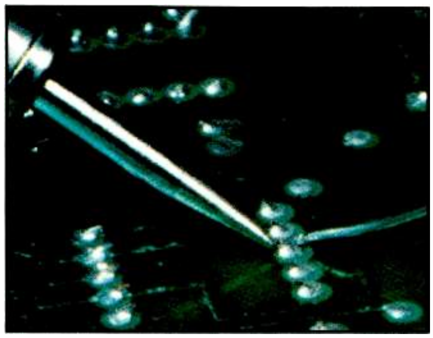
The desired output signals can now be represented as follows:

$$B_m = B + K_B(B-G) + K_B'(B-R)$$

$$G_M = G + K_G(G-B) + K_G'(G-R)$$

$$R_M = R + K_R(R-G) + K_R'(R+B)$$

Diagrammed above, right, is a representative circuit to develop the matrixed signals. ❚❚❚



Designing with CMOS

By Jerry Whitney

There are an almost unlimited number of versatile integrated circuits available today. Several years ago, dozens of components were required just to implement a simple flip-flop. Today, a single IC can provide several flip-flops in a simple and easy-to-use package. Other ICs provide amplifiers, switches, drivers and almost any other type of circuit a broadcast engineer might ever need. These devices can be the solution to many problems.

At any broadcast facility there may be hundreds of applications involving control logic. Turntables need to be started and stopped. Cart machines need to be interfaced to telephone couplers and counters. Many times, audio and data signals need to be routed around to numerous locations in the station. ICs can provide the required logic, buffering, amplification or other signal processing to solve these needs within the station.

Integrated circuits

A key to the effective use of today's IC is a knowledge of how its capabilities can be effectively applied to the broadcast engineer's problems. For instance, there are several families of ICs. One common IC family is the complementary-metal-oxide-semiconductor (CMOS) type.

The CMOS IC is available from many different manufacturers at reasonable prices. Furthermore, the extensive number of devices in the CMOS family allows for astounding flexibility. To get an idea of how useful these devices can be, look at a typical CMOS application to a broadcast interfacing problem.

Getting started

One question that must be answered with any digital circuit centers on the power-up sequence. Some CMOS logic designs require that a reset pulse be applied before the circuit can operate properly. The reset pulse is a simple version of the reset button found on most computers. With the computer reset button, all of the internal circuits are *reset* to a ready state. In the case of an IC, applying a reset pulse does much the same thing. The IC's internal logic is cleared and reset to a known condition.

Figure 1 shows a simple power-up reset circuit. When power is first applied to the circuit, the transistor is turned off. This places the +12Vdc logic voltage (via R9) to any chip connected to the reset line. R5 and R6 form a voltage divider that applies approximately 3Vdc to the RC network consisting of R7, R8 and C3.

The RC network creates a time delay in turning on transistor Q1. Approximately two seconds after power is applied to the circuit, the transistor is turned on. When the transistor turns on, the reset line switches to a *low* state and remains there until the power is turned off. This automatic cycle is repeated every time the power is applied to the system.

Input conditioning

One of the most useful devices for connecting logic inputs into a system is the flip-flop. It accepts a wide range of input logic states from fast, short-duration pulses to a steady-state dc value. Flip-flops also can be configured to form a circuit debounce scheme. Figure 2 shows how two flip-flops can be interconnected to provide such a circuit.

Although two flip-flops are needed, they are both contained in a single IC package. The circuit shown in Figure 2 uses two D-type flip-flops, each functioning independently. The interconnection scheme provides a lockout feature when either gate is actuated. This design helps the circuit ignore more than one command until it has completely cycled.

A transient filter consisting of R3, C1 and R1 form the input section. Because these logic gates have an extremely high input impedance, R1 is needed to pull the gate's input down to logic 0. Be careful when selecting the values for R3 and R1. The logic input gate should have at least 70% of the logic voltage applied if it is to turn on properly.

Another method of terminating input lines ties R2 and R1 to the positive supply rather than ground. Tying the pull-up or pull-down resistors to the circuit power supply or ground reduces the chance of impulse noise and RF from affecting the circuit. If the inputs are left to float, the circuit can become unstable.

Timing

A precisely timed sequence of events can be developed quite easily with a circuit like that shown in Figure 3. A master oscillator is formed by using CMOS

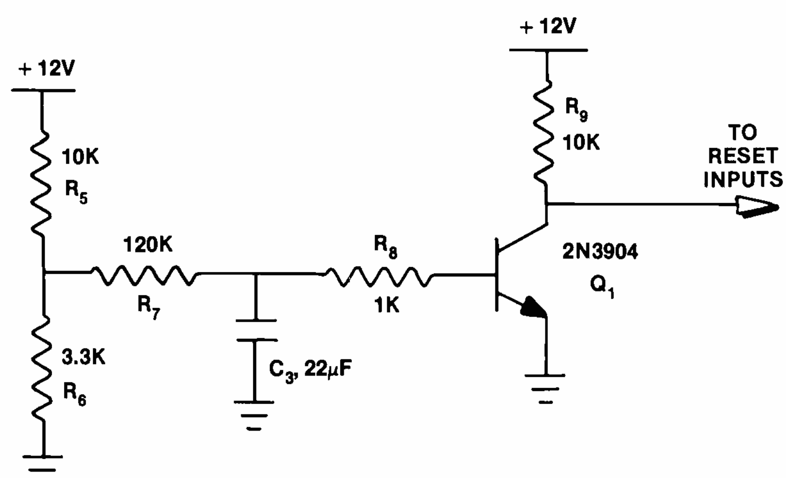


Figure 1. *Simple power on reset circuit. The length of the reset pulse can be adjusted by changing the R7, C3 combination.*

Whitney is chief engineer for WPXY-AM and FM, Rochester, NY.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4049B inverters. This free-running output is then applied to the clock input of a 4020 binary-ripple counter. The counter provides 12 different outputs. These outputs are divisions of the input clock frequency having the standard binary weights of 1, 2, 4, 8, 16, etc. The counter remains off until the reset pin is set to logic 0.

For this particular timing circuit, outputs Q8 and Q13 were selected to drive a 4017 decade counter. As noted on the diagram, the clock input is tied to Q8 while the reset pin is tied, through an inverter, to Q13. This design allows the 4017 to remain reset until Q13 switches to logic 1. Once this happens, Q8 is allowed to clock the 4017, which will increment the output once for every clock pulse. The result is an initial time delay of 41 seconds ($200Hz/2^{13}$). After this period elapses, the 4017 outputs a signal every 1.28 seconds ($200/2^8$).

Interfacing

Although all of these circuits are nice, you need to apply them to real world problems. One of the first things you need to look at is what you are going to control. If you need to drive relays, their voltage source should be different than that used for the logic circuits. Relays and other switching devices can cause noise on supply lines that may upset the logic circuit's operation. Transient spikes often produced by relays can be eliminated by optical isolators. However, in many applications, open collector outputs are acceptable if a separate power supply is used for the relays.

Practical application

If you are lucky enough to have an auxiliary transmitter, a properly timed and controlled sequencer might be a useful device. Switching to an auxiliary transmitter often involves going through a long list of operations. In addition, the announcer is often unsure of the process and may be hurried by programming circumstances. The net result can be delay in returning to the air or equipment damage. The whole transmitter switching sequence can be automated by using a CMOS controller. It will provide the proper timing and operational sequence to switch between transmitters.

Figure 4 shows a collection of the CMOS building blocks previously discussed.

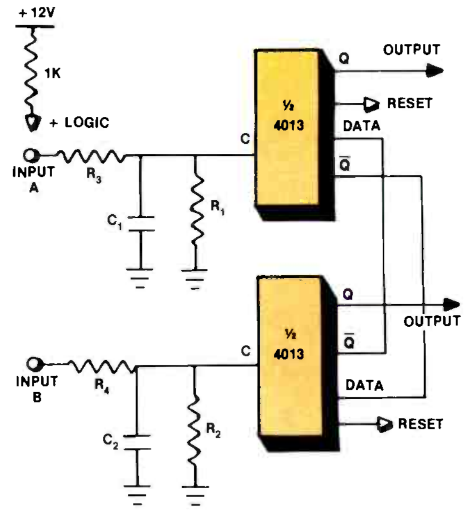


Figure 2. Typical debounce circuit using two D-type flip-flops.

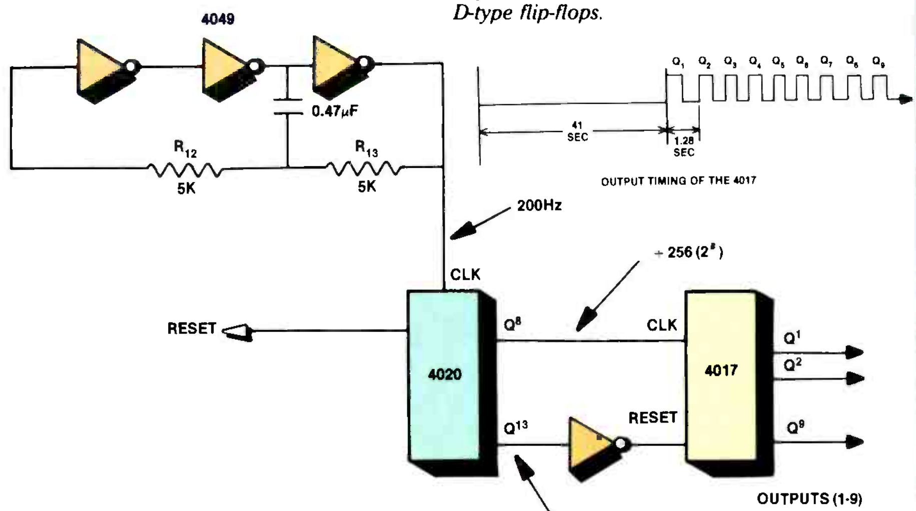
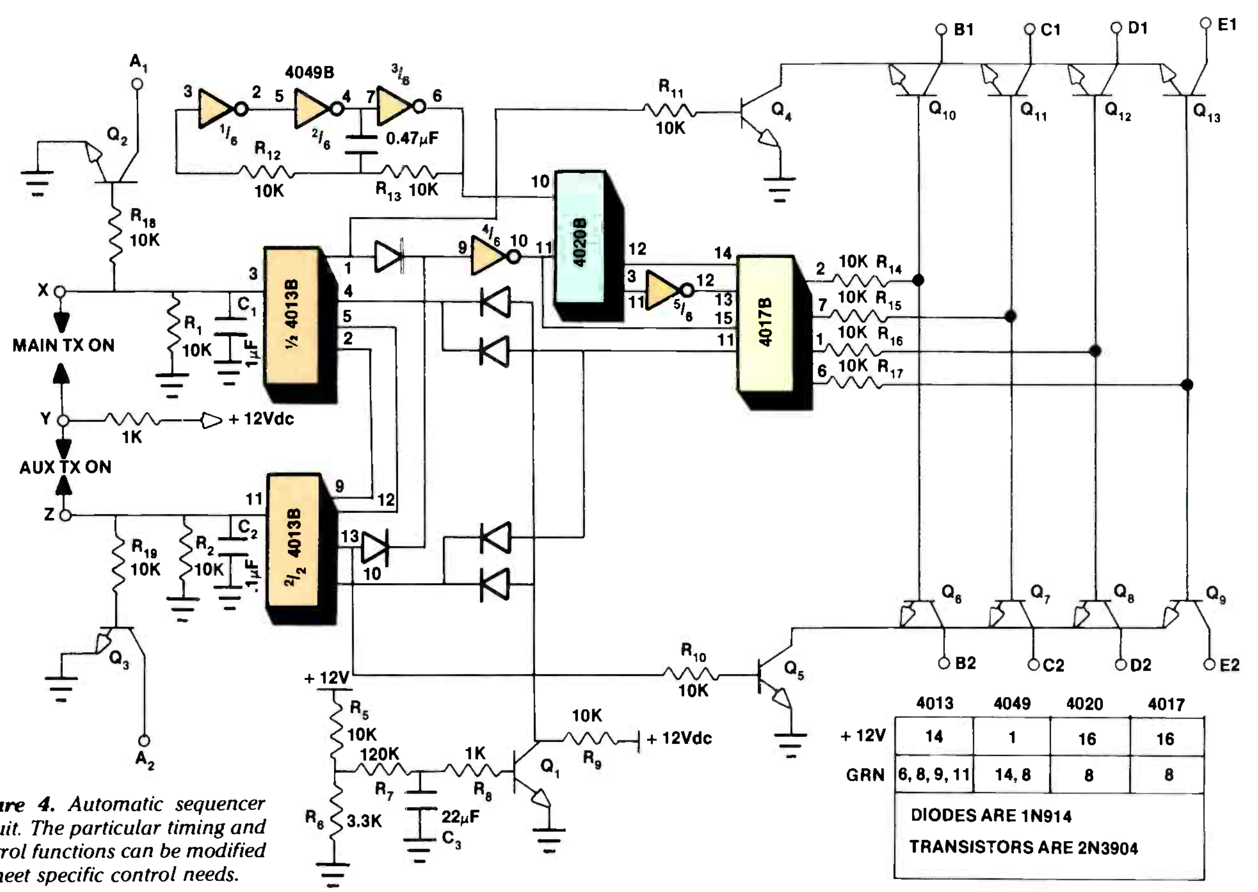


Figure 3. Master clock generator and frequency divider.



	4013	4049	4020	4017
+12V	14	1	16	16
GRN	6, 8, 9, 11	14, 8	8	8

DIODES ARE 1N914
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Figure 4. Automatic sequencer circuit. The particular timing and control functions can be modified to meet specific control needs.

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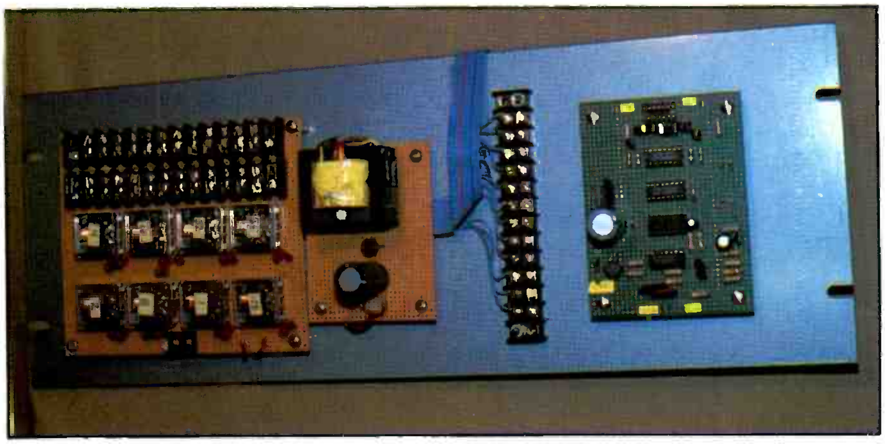


Sequencer mounted on a rack-panel with a power supply and relay interface.

Here, they are combined into a practical and efficient circuit. The circuit takes advantage of redundancy by using the same timing for both the auxiliary and main transmitter switching. It also provides the needed isolation between the two transmitters. Blocking diodes are used in the circuit so that more than one output can be connected to a single input gate. This is necessary to prevent a potentially damaging voltage from being applied to another output gate.

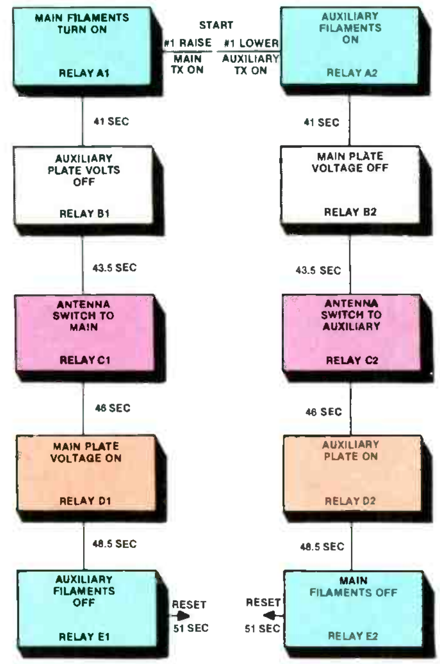


Figure 5. *Flow chart of timing sequence for the sequencer shown in Figure 4.*

The circuit uses a +12Vdc regulated power supply, which allows a higher *on* logic threshold than conventional TTL logic. This design requires that input noise be at a higher level in order to create logic gate errors.

Figure 5 shows the sequence and circuit timing developed in the circuit of Figure 4. The circuit can be connected to relays through the open collector outputs, which then could be wired to an existing remote-control unit. The timing sequences could, of course, be modified for any particular application by changing the clock frequency or the frequency divider scheme.

The circuit and devices shown are just a small sample of what is readily available. Many major manufacturers provide excellent resource material through their local distributors. Next time you pick up some electronic parts, ask about the data sheets. Armed with the information and a bit of ingenuity, you can design useful and expensive circuits for your station.

Exec committee sets 2-year growth plans

By Bob Van Buhler

The July SBE executive committee meeting in Washington, DC, set the stage for rapid society growth during the next two years. At the meeting, Richard Rudman, SBE president, and members of the executive committee developed the society's major goals and objectives. The result of this plan will be to increase membership and visibility for the society and to expand educational opportunities.

The major step toward more educational opportunities centers on the Ennes Educational Foundation, which has now been officially established. It will operate on its own 4-year plan, which is being developed.

One element of the Ennes work will be updating and republishing the Harold Ennes books on radio and TV technology. The foundation also will expand upon the already successful Ennes scholarship, oversee the SBE certification program and support chapter-level certification courses.

Another important element in the foundation's work is the development of the technical articles for the *SBE Signal* and other publications. Efforts will be made to support regional convention education programs. The society also is planning to develop a list of SBE members who can act as sources for technical papers for the NAB convention and other technical presentations.

An important society goal is to promote SBE participation in industry and FCC activities. Relationships with the FCC and fellow societies such as SMPTE and the AES will be expanded and nurtured. The SBE will actively support and interact with state broadcast associations by providing information and speakers on SBE education, certification and frequency coordination.

The SBE's executive committee for 1986-87 includes the following officers: Richard Rudman, president; Roger Johnson, immediate past president; Jack McKain, vice president; Brad Dick, secretary; and Wally Dudash, treasurer. Other committee members include Chuck Kelly, Joe Manning and Jim Wulliman.

Van Buhler is chief engineer for WBAL-AM and WIYY-FM, Baltimore.

Committee assignments

Committee assignments for the national board were made at the July executive committee meeting. The assignments were based on the interests and talents of the committee members.

The nominating committee is responsible for the selection and screening of nominees for national office positions. The committee is chaired by Doyle Thompson. Other members include Tom Weems and Chuck Morris.

Bob Flanders continues to chair the admissions committee. He has filled this post for many years. The committee is responsible for screening applicants for membership eligibility. Because of the recent membership growth, this is one of the most active SBE committees.

The sustaining membership committee is chaired by Joe Manning. Members include Roger Johnson and Tom Weems. Because of the success in increasing sustaining membership, the committee is sure to be busy. This year the emphasis is on encouraging individual stations and broadcast groups to become SBE sustaining members.

There are several other important SBE committees that will be discussed in a later column. Some of these committees include: education, scholarship, general membership, fellowship, FCC liaison technical advisory, editorial, industry and public relations, awards, conventions, SMPTE and AES liaison committees, the National Frequency Coordinating Committee and the conventions committee.

Billing error

Because of a mistake made by the printing company, some SBE members received second notices for membership dues even though they had already paid.

In tracking down the error, Helen Pfeifer, national secretary, found that the printing company had used the incorrect floppy disk to develop the billing list. Our apologies to anyone who mistakenly received a second notice. Because computers don't make mistakes, we'll just call this a people-generated computer error.

Special offer for members

Need some top-quality reference material? As a special service to SBE members, the NAB is offering a discount on both the *NAB Engineering Handbook* and the 1986 *NAB Proceedings.*

The 7th edition of the *NAB Engineering Handbook*, which was released in early 1985, is a compendium of knowledge specific to the broadcast industry. It is authored by some of the country's most experienced engineers. The handbook deals with subjects ranging from working with the FCC to frequency coordination to specifications on current technology antenna and transmitter systems. The handbook also provides useful information on the normal range of technical systems and equipment encountered by both radio and TV engineers.

The *Proceedings* of the 40th Annual Broadcast Engineering Conference is a bound edition of the formal papers presented at the 1986 NAB Convention. This year's proceedings cover a broad array of subjects. Many of these articles discuss technology now in the forefront of our industry. Some of the topics are: multichannel TV sound, high-density TV systems, synchronous AM transmitters, new antenna designs and non-ionizing radiation considerations. This year's edition is particularly strong on how-to papers.

Both volumes are worthwhile additions to the engineer's library. If you don't have these publications, you can purchase them from the NAB at a discount. The *NAB Engineering Handbook* normally sells for $209.50 to stations without NAB membership. SBE members can now purchase the book for $149.50. The 1985 *Conference Proceedings*, normally $80 for stations without NAB membership, can be purchased by SBE members for $40. The SBE prices are the same charged by the NAB to its own members for these publications.

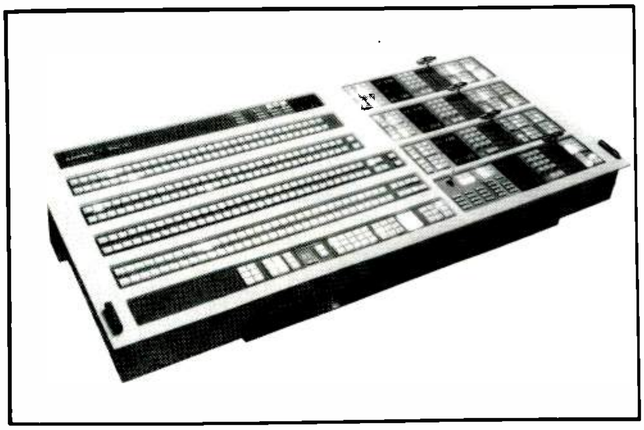
The publications may be ordered by credit card by calling 800-368-5644 or by letter to NAB Services, 1771 N. Street NW, Washington, DC 20036. When ordering by mail, enclose a check for the correct amount. Please indicate your SBE membership number.

Audio level display

Apogee Electronics has introduced the Audioscope model 3211 multichannel audio level display, which provides accurate monitoring of up to 32 channels simultaneously on a separate RGB color monitor. Columns, graticules and secondary graticule colors may be programmed internally to suit individual requirements. Meter characteristics are switchable VU or PPM. If the meter is used with a multitrack machine, a color square may be displayed at the top of each column to indicate the record mode of that channel, and switching may be affected automatically.

Circle (350) on Reply Card

Post-production switcher



Ampex Switcher Division has introduced the AVC Century series. It includes three full-capability keyers per M/E. Up to four discrete video buses allow selection of separate video inserts in the keys performed in each M/E and the DSK. Each keyer includes independent rectangular key masking capability. The key memory stores and recalls four different setups for each key source, including the mask and all other settings. Expanded auto transitions have user-selectable times in seconds/tenths, seconds/frames or frames only.

Circle (351) on Reply Card

Reinforcement consoles

Wheatstone has introduced the MTX-1080 reinforcement console. Features include programmable muting; eight effects send controls (each with pre, post and off functions programmable to pre-fader or pre-EQ); 4-band sweepable equalization with switchable Q and peak/shelf modes; tunable HPF; separate electronically balanced mic and line inputs; XLR direct-channel outputs; and channel, subgroup and main output insert points. The console also has eight 11x1 input matrix mixes (up to 16 are available using optional matrix expander modules).

Circle (352) on Reply Card

Playback automation and traffic control systems

Videomedia had introduced the following products:

- The Q-Star II/A playback automation system includes a user-defined, high-level programming language that allows the user to program in GOTOs and subroutines. Features include 500-event memory with six levels of subroutines; ID label generator; real time clock/date/calendar with battery backup; control of up to 18 VTRs; random access; can use tones, FSK data or SMPTE time code; manual, auto, real time and external modes; user-definable sources; programmable net delay; selectable error source; and on-line HELP menu.
- The VMC-202A traffic control system addresses and automates the editing process in addition to commanding the automation portion of the system (the VMC-200). Features include multichannel operation; broadcast or cable software package; sales tracking; generation of auto log, contracts and mailing list; availabilities; program files; format files; edit cuts files; graphics; and word processor.

Circle (353) on Reply Card

Software upgrading enhancements

NEC America, broadcast equipment division, has announced software upgrades and enhancements for the DVE System 10 digital video effects generator. The upgrades include single-axis control, which limits any movement of the joystick or input of numbers from the keyboard to one axis without affecting the others; automatic equal-windowing for multifreeze control, which divides the screen into four or 16 equal portions during multifreeze; and transition velocity control, which permits manipulation of velocity of movement between screen positions. The software upgrades are included in all new DVE System 10 units.

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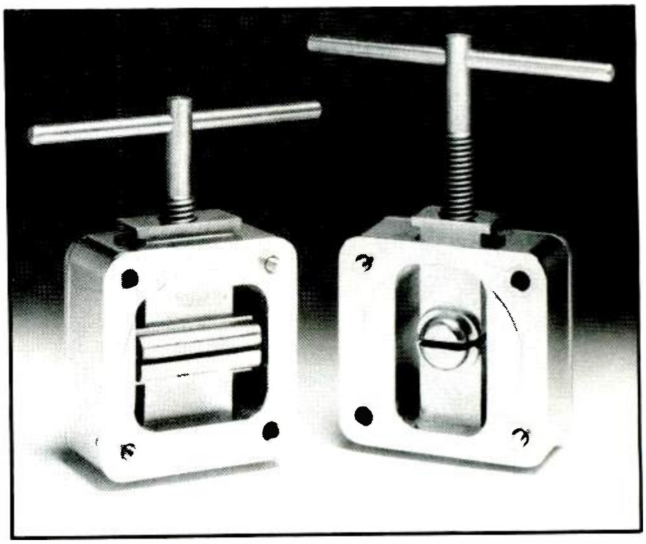
Flaring tool kit



Andrew has announced a flaring tool kit for the HELIAX elliptical waveguide. It produces low VSWR waveguide flares for connector and splice installations. The tools are small, lightweight and use a 2-step procedure that can trip and flare a waveguide in three to five minutes without disturbing the connector assembly.

Circle (355) on Reply Card

Diffusion filters

Birns & Sawyer has introduced Supafrost filters. These acrylic diffusion filters emphasize highlights by spraying the light into shadow areas without sacrificing image, definition or focus. They can embellish high contrast, back light and night exterior scenes. The filters are available in seven strengths and most sizes.

Circle (356) on Reply Card

Microwave link system

International Microwave Corporation has introduced a 23GHz microwave link system for paths up to 10 miles. The ICM 2123 FM link carries broadcast quality video/audio/data

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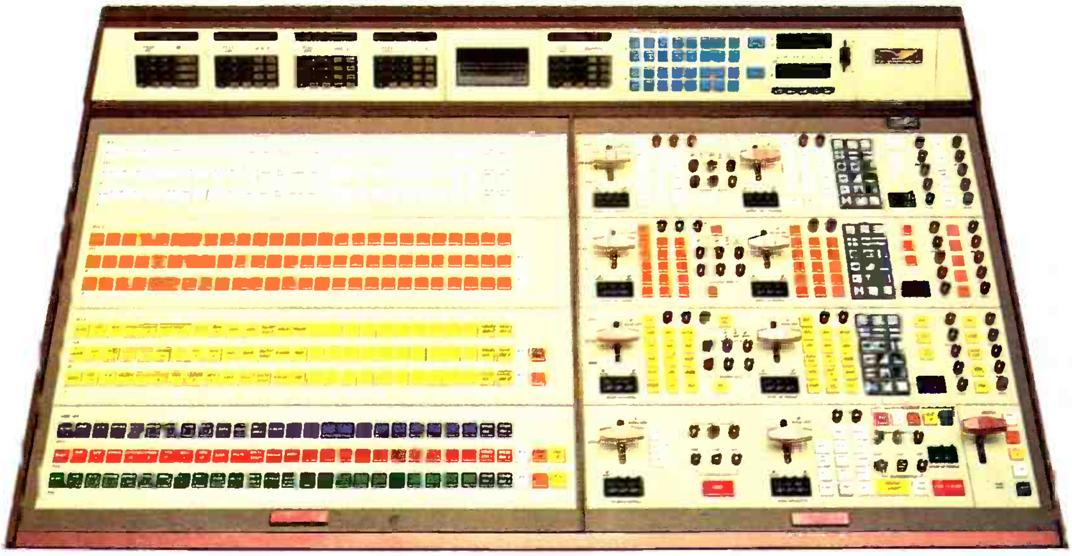

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signals and can accommodate up to four audio and/or data subcarriers along with full color video. The link may be configured for 2-way, full-duplex operation for transmission of T 1 or T 1C. Up to 12 T 1s can be transmitted with the addition of external multiplex units. Weatherproof, tower-mounted RF sections connect directly to 18-, 24-inch or larger antennas. Indoor, rack-mountable terminals provide dc voltages for RF units and baseband processing. The system operates from 21.2GHz to 23.6GHz under FCC parts 21 (common carrier) and 94 (private user).

Circle (357) on Reply Card

Video frame grabbers

Chorus Data Systems has announced the PC-1500 series of real time video frame grabbers. The series if IBM-PC, -XT, -AT compatible and requires a single PC bus expansion slot. It features 1/30-second capture and display from standard RS-170 or RS-330 video sources and has programmable resolution up to 768x512.

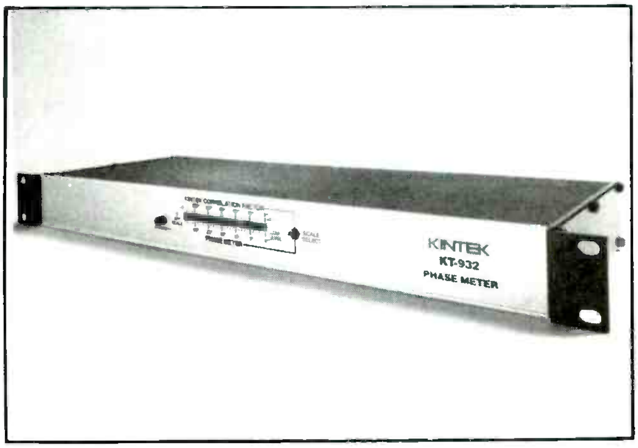
Circle (358) on Reply Card

Touch-activated computers

MicroTouch Systems and *Media Touch Systems* have announced combined hardware and software packages for a computerized approach to broadcast control. The touch-screen system features the MicroTouch Screen and Media Touch's Touchstone software installed on the IBM AT, and allows touch-screen control over broadcasting events. The system can replace the standard broadcasting booth control panel and eliminate the need for a daily paper log.

Circle (359) on Reply Card

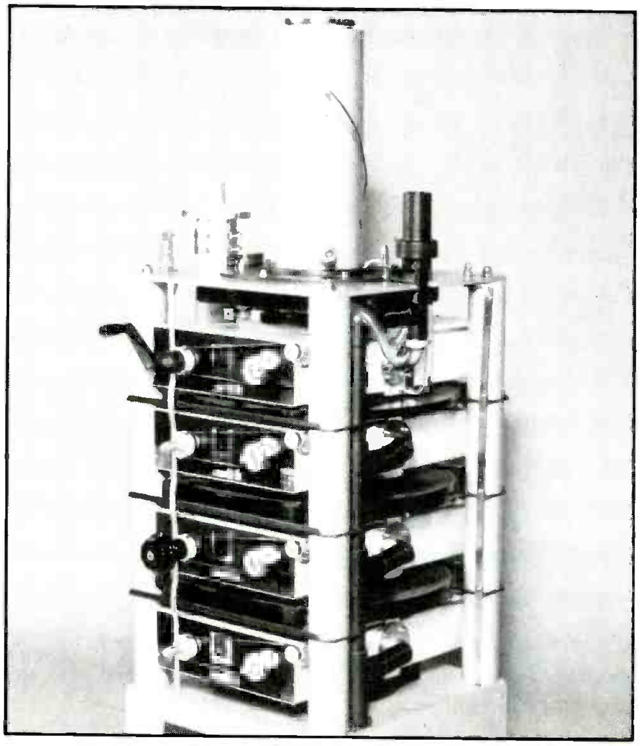
Audio phase meter



Kintek has introduced the KT-932 audio phase meter. It is frequency blind in the audio spectrum and is insensitive to level. It will measure phase in 1° increments up to 30° and up to 180° in 6° increments. The instrument is calibrated at the factory and requires no field calibration.

Circle (360) on Reply Card

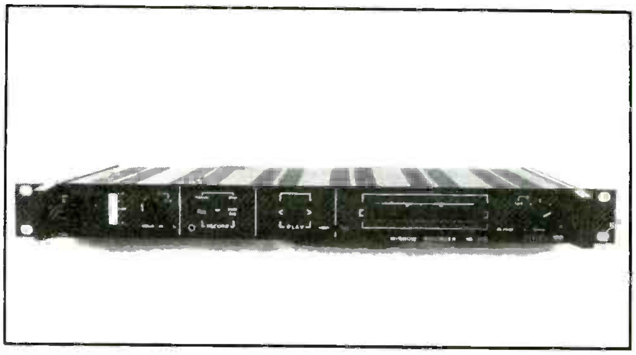
Wideband klystrons



EEV has introduced a wideband series of UHF TV klystrons with a power output range of 5kW to 60kW and efficiency of greater than 60%. The tubes are supplied with a beam control device and fitted electron guns.

Circle (361) on Reply Card

Window recorder



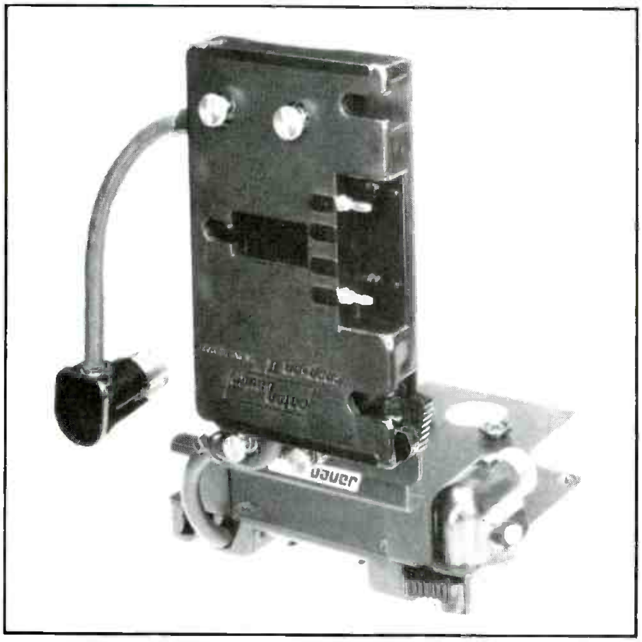
Giant Electronics has introduced the MDB window recorder, a 16-bit, high-resolution studio sampler available in 3-second, 6-second or 12-second versions. The system is modular and expandable and features 5-minute digital recording, no data compression, full bandwidth, dynamic sampling and polyphonic expander, audio scanning, digital synthesis and editing, and digital mixdown.

Circle (362) on Reply Card

Circle (102) on Reply Card

Circle (103) on Reply Card

Camera battery brackets



Anton/Bauer has introduced the Snap-On II quick-release battery brackets for the Sony BVW-105 and the Sony DXC-3000 cameras. The brackets adapt Pro Pac Snap-On batteries to the appropriate camera. The QR-Beta-5 bracket features a dual battery mounting system for the Sony BVW-105 camera/recorder. When used on a tripod, the battery is attached to the back of the recorder.

Circle (363) on Reply Card

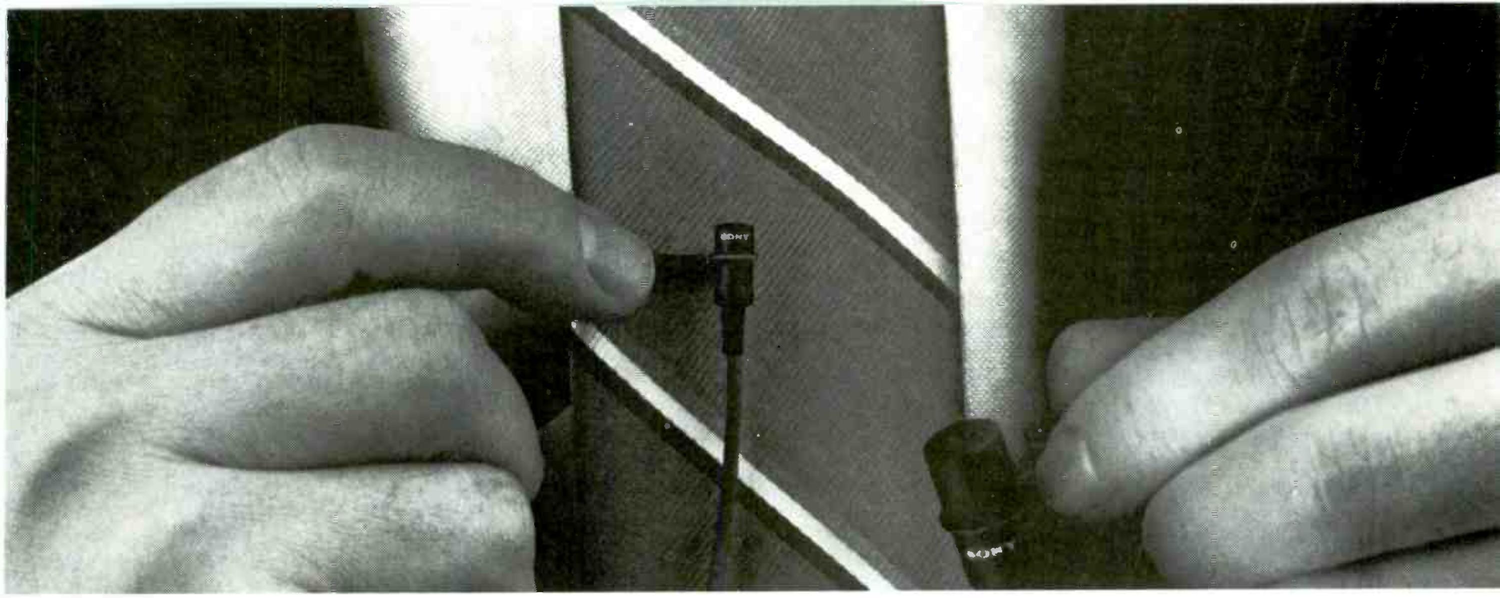
Cubicomp PictureMaker is complete hardware-software system

Cubicomp Corporation's PictureMaker computer graphics products are being sold as complete hardware and software systems. PictureMaker hardware includes an 80286-based 640k computer with a 40Mbyte high-density hard disk and 1.2Mbyte floppy disk, a 4Mbyte memory expansion board, a 19-inch RGB monitor, 12 x 18-inch data tablet, pen and puck and all connecting cables. The model 331 graphics package includes a CS/16 gen-lockable frame buffer, 3-D modeling, animation and rendering software, eight type fonts, and True Color Paint software. The model 321 graphics software includes the CS/16C frame buffer, 3-D modeling and rendering and eight type fonts. User manuals and on-line system documentation are included. Each system arrives with its software and hardware components fully tested and installed by the factory.

Circle (364) on Reply Card

RF radiation testing services

Comsearch has introduced testing and support services for compliance with FCC regulations on exposure to RF radiation hazards. It also is offering testing services for compliance with state and local laws and regulations and testing for use in con-



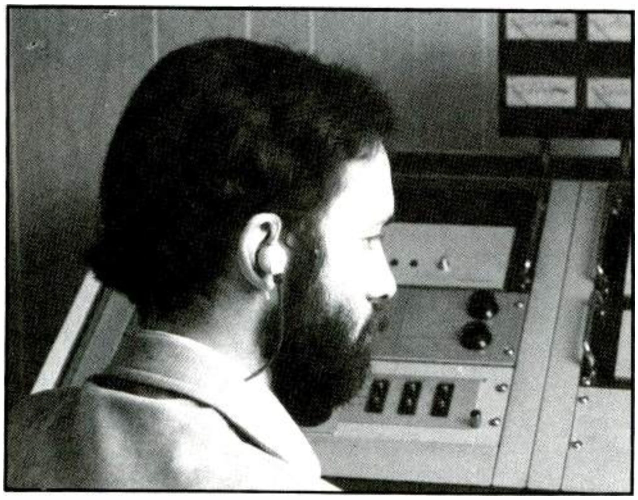
SONY

SONY
SONY

nection with zoning and land use applications. Comsearch provides the facility owner with an independent assessment of RF exposure hazards. It certifies compliance by calculation and by on-site testing. Where calculation shows potential for levels in excess of the guidelines, Comsearch goes on-site to test actual energy levels. Comsearch provides full documentation of procedures, findings and recommendations.

Circle (365) on Reply Card

Earphones



Stanton Magnetics has introduced the PBR series announcer's earphones. They are lightweight and available in three different impedances and can be supplied with a variety of cord types and plug sizes. The earphones include a button receiver, nylon ear loop, rubber ear adapter and 5-foot cord.

Circle (366) on Reply Card

Low profile video exciters

LNR Communications has announced the Ku-band model LVE-14 broadcast-quality satellite video exciter series. The exciters weigh 15 pounds, and are 1¾-inches high, with a power consumption of 100W. Highly integrated RF and baseband circuitry provides RS-250B performance. The series features synthesized RF tuning in 0.5MHz steps, and includes up to four front-panel selectable subcarriers that are synthesized in 2kHz steps. Push-button selection of full or half transponder operation is standard.

Circle (367) on Reply Card

Automatic voltage regulator

Hipotronics has introduced the Peschel automatic voltage regulator (PAVR). The regulator provides optional individual output phase control to within ±1%, uses the Peschel variable transformer (PVT) and is available in medium to high power for industrial commercial applications. Input voltage is available from 240V to 13.8kV in ranges of +9% to −14%, or ±20%. Output capacity is available from 50A to 2,000A.

Circle (368) on Reply Card

FM transmitter and telephone interface

Broadcast Electronics has announced the following:

• The FM-10A transmitter is a 4,500W to 11,000W FCC-approved FM transmitter that employs an advanced single tube design. The power amplifier section uses a patented folded ½-wave cavity that eliminates plate-blocking capacitor and sliding contacts. The output tube is an Eimac 4CX7500A tetrode. PA efficiency is rated at 80% to 84%. The IPA stage is solid-state and is mounted in a slide-out drawer. The IPA output transistors are protected against any mismatch condition. Operational aids for the IPA include three front-panel status indicators and buffered back-panel metering outputs. Other features include a broadband input matching network, an advanced digital control system, and an automatic power control with proportional VSWR foldback protection.

• The PC-1 telephone/cart machine interface operates in conjunction with any NAB tape cartridge playback unit or with any remote-start, remote-run playback system. The unit works by detecting an incoming call and relaying a start signal to the cart machine's remote start input. At the end of the message, the unit will disconnect the line and wait for the next call. The interface incorporates automatic gain control circuitry, and is an FCC Part 68 registered terminal.

Circle (369) on Reply Card

Test records

The CBS Technology Center has announced the CTC Professional Series test records. The five direct-to-disc recordings include the CTC-300 used for measuring frequency response, crosstalk, resonance, polarity, compliance and tracking

Circle (113) on Reply Card

Circle (112) on Reply Card

Circle (114) on Reply Card

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Circle (115) on Reply Card

capability of a phonograph cartridge. The CTC-310 evaluates any type of distortion due to non-linear relationships between the stylus motion and the cartridge output, vertical tracking angle error or poor coupling between the stylus and the record groove. The CTC-330 assists in evaluating the performance of audio disc playback equipment. It provides the frequencies and levels necessary to measure sensitivity, frequency response, separation, phase and turntable speed.

Circle (370) on Reply Card

3-tube color camera

JVC has introduced the upgraded KY-210BU 3-tube color camera. It features HR EM ⅔-inch Saticon tubes to increase resolution, lower power consumption and help eliminate donut and butterfly dark shading problems. The electrostatic focus and electromagnetic deflection tubes use a collimation lens that has a 10% larger diameter than previous KY models. The signal-to-noise is boosted to 58dB by incorporating the head amp in the yokes of the tubes. A new 9dB and 18dB gain boost circuit improves amplified signals. Minimum illumination is 32 lux (3fc) with an f/1.4 lens and 18dB gain boost.

Circle (371) on Reply Card

System 10 special effects package

NEC America, Broadcast Equipment Division, has announced the DVE System 10 special effects package. The system's building-block architecture permits the addition of future effects through the soft function keys. These preprogrammed effects will be available through the DVE System 10 soft keys as push-the-button-and-manipulate functions. Effects include: curl, roll, fold or peel.

Circle (372) on Reply Card

Color monitor

Videotek has introduced the AVM-13s 13-inch color monitor with an internal audio speaker. It features A-B-VTR inputs; blue gun; pulse cross; underscan; internal/external sync; external demodulator input; keyed backporch clamping; tally light and 8-pin VTR cable.

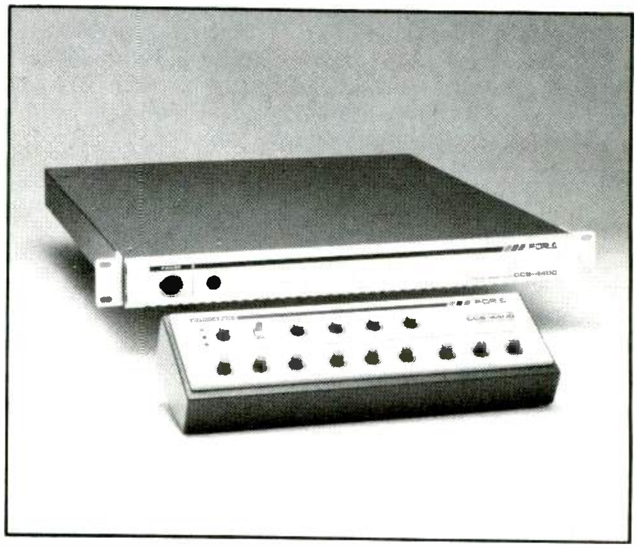
Circle (373) on Reply Card

Clock driving system

Leitch Video International has introduced the master clock system driver CSD-5300. The system can be programmed to dial a number referenced to an atomic clock for accurate time within 3ms/day. Compensation for the telephone line loop-delay is automatic. The unit ensures synchronization across a network of clocks, and time zone differences can be programmed in as well as time changes in the spring and fall. The unit generates SMPTE/EBU time codes. An impulse drive feature is built into the design and up to 25 impulse clocks can be driven with the Leitch unit acting as master. There is an RS-232 interface that allows the system to communicate directly with computers and automated systems.

Circle (374) on Reply Card

Component color corrector



For-A Corporation has introduced the CCS-4400 component color corrector. It incorporates the features of the company's composite color correctors CCS-4200 and CCS-4300. Color correction is applied directly to component signals, providing no added signal distortion. Features include: Y/R−Y/B−Y input and output interfaces with several internal level scaling capabilities; RGB black and white level control; individual gamma correction for RGB; overall gamma correction; and remote operation up to 1,000 feet.

Circle (375) on Reply Card

Electric generator

Harrison Equipment Company has introduced the Hydra-Gen state-of-the-art hydraulic motor-generator system for remote TV broadcast vehicles. The units are standard 6,000W to 20,000W models. The generator and hydraulic components are assembled in a 35" x 23" x 19" frame, ready for mounting in new or retrofit applications.

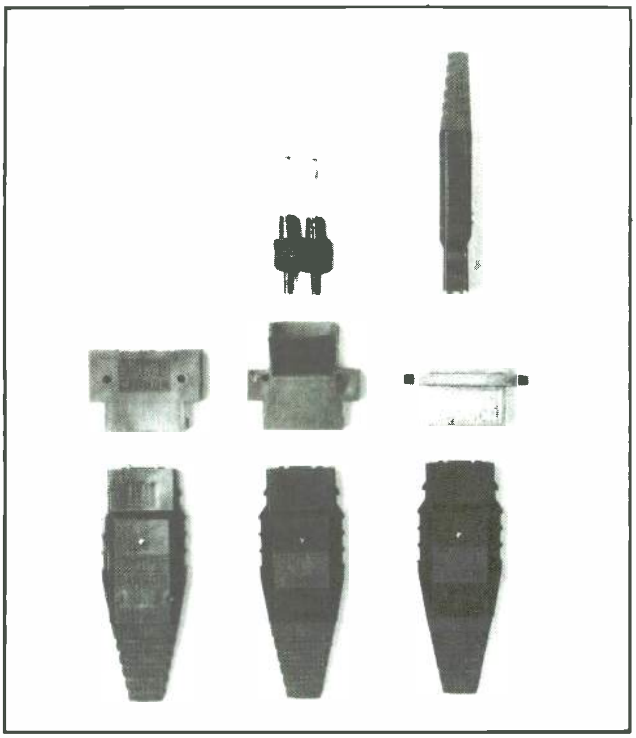
Circle (376) on Reply Card

Broadcast-quality TBC

The Alta Group has introduced Cygnus, a single-channel broadcast-quality production system/video synchronizer/infinite-window TBC. Features include digital picture freeze, variable picture freeze strobe, variable posterization, variable mosaic and dropout compensation. A 4x1 audio and video routing switcher and a horizontal and vertical image enhancer are built in as standard features.

Circle (377) on Reply Card

Fiber-optic single-channel product line



ITT Cannon has announced the addition of the fiber-optic single-channel (FOSC) series to its fiber-optic product line. The FOSC is a single-channel fiber-to-fiber and fiber-to-device connector system that features an SMA-style connector designed for cable-to-cable, bulkhead and PCB applications. It also features a 4-position keyway system and a patented jewel ferrule alignment system, and is suitable for any single-channel point-to-point interconnection.

Circle (378) on Reply Card

Phasing equipment

Vector Technology has announced the Spartan line of phasing equipment for AM directional broadcast stations. The line makes use of certain manufacturing economies that can save about 15% over the cost of a standard Vector phaser. The line offers upgrades and is available in power levels up to 5kW.

Circle (379) on Reply Card

Microphone pre-amplifier

Benchmark Media Systems has announced the MIA-4 microphone pre-amplifier. The PC board pre-amp is designed for retrofit use and custom applications where an ultralow noise gain block is required. The pre-amp has an overall gain range of −2dB through +73dB, a noise figure of 1dB, RF immunity, balanced output and 200kHz bandwidth at all gain settings. It operates on dual (±) power supplies of 15V to 20V.

Circle (380) on Reply Card

Surge suppression device

Panamax has introduced the MaxiStart surge and spike suppression and noise filter combination device. It has five receptacles, one of which is the master control. When the system component plugged into the master control receptacle is turned on, the other four receptacles follow in about 10ms.

Circle (381) on Reply Card

St. Louis facilities purchase video cameras

Two St. Louis-based video production facilities have purchased professional video cameras from *Sharp Electronics*, Mahwah, NJ.

Sights Unlimited, an independent production house, has purchased an XC-A1 for videotaping commercials and promotional efforts. The Life Christian Center, a 1,500-member church, has purchased two XC-800II cameras for production of half-hour to hour-long shows for local cable television.

Storer signs automation system agreement

Data Communications Corporation, Memphis, TN, has announced sales of its BIAS News Room, a computerized newsroom system, to seven Storer TV stations.

The stations are KCST, San Diego; WAGA, Atlanta; WITI, Milwaukee; WJBK, Detroit; WJW, Cleveland; WTVG, Toledo, OH; and the Storer news bureau in Washington, DC.

Thomson-CSF acquires Comark shares

Thomson-CSF, France, and Comark Communications, Southwick, MA, and Colmar, PA, have announced Thomson's acquisition of all of Comark's outstanding shares.

Comark's management will remain virtually unchanged. Nat Ostroff will continue as president and CEO, and Serge LaCamus is the new chairman.

Sony restructures product divisions

Sony, Teaneck, NJ, has reorganized its non-consumer product divisions. The restructuring will provide better service to customers, while allowing the corporation to maximize sales in the non-consumer businesses.

The Sony Communications Products Company assumes responsibility for broadcast, institutional video and professional audio products. William Connolly is president of the new company. J. Philip Stack will head the Sony Information Systems Company.

Comsearch transfers division

Comsearch, Reston, VA, has transferred its system engineering division from Richardson, TX, to its new headquarters in Reston. The division offers product management for communication engineering projects as well as support services.

Wegener delivers TV stereo equipment

Wegener Communications, Atlanta, has delivered Panda II audio equipment to Group W Productions for the satellite distribution of stereo TV programming. Affiliates that are presently receiving mono audio on standard aural subcarriers can upgrade to stereo by adding Panda II demodulators.

Valley Audio opens Atlanta operation

Valley Audio, Nashville, TN, has announced the formation of an Atlanta branch. Negotiations have also been completed for an Atlanta merger with Interface Audio. Opening the Atlanta office will provide clients with local sales and technical support. The opening also will increase growth in the design and supply of large-scale video post-production facilities, broadcast facilities and industrial audio.

STS receives Channel 7 contract

California Microwave, Sunnyvale, CA, has announced that its subsidiary, Satellite Transmission Systems (STS) has received a contract from channel 7 TV station, Sidney, Australia, to provide video satellite earth-station equipment. The equipment gives channel 7 redundant uplinks and downlinks to work with the Aussat satellite. The STS system design provides for a remote-controlled unmanned earth station that is equipped with automatic uplink power control and remote frequency control.

Sun Television purchases Philips cameras

After its purchase of half of ABC Television's West Coast mobile location units, *Sun Television* has taken delivery of 10 Philips LDK6A cameras. Five of the cameras will be used in two 45-foot mobile units.

Klark-Teknik purchases DDA

Klark-Teknik, Farmingdale, NY, has purchased Dearden Davies Associates, an audio console manufacturer located in Isleworth, England. DDA has become a wholly owned subsidiary of Klark-Teknik. The company will continue to operate from Isleworth under the DDA banner, with all existing lines continuing production.

RPG Diffusor Systems expands

RPG Diffusor Systems has doubled its manufacturing/warehousing space and also will be expanding its product line to offer a complete range of new products. These products will include the Abffusor, an absorptive/diffusive panel, and the Ensemble, which provides performers with a heightened sense of ensemble and clarity.

Shook Electronic delivers production vehicle

Shook Electronic Enterprises, San Antonio, TX,, has delivered another mobile TV production vehicle, model 24-31, with a 24-foot housing. It was built for RCOM, a division of REA.

Cubicomp moves headquarters

Cubicomp, Hayward, CA, has announced the expansion and relocation of its Berkeley, CA, corporate headquarters to

Hayward, CA. The lease for an 18,000-square-foot office and manufacturing space at 21325 Cabot Boulevard will double the company's work area. The facility also features a training center offering a full range of video animation classes for PictureMaker owners to those developing advanced expertise on Cubicomp systems.

Scientific-Atlanta receives contracts

Scientific-Atlanta, Atlanta, has been chosen to supply earth-station equipment for use in an educational broadcasting network operated by the Ohio Educational Broadcasting Network Commission (OEBNC). The purchase will provide OEBNC with the capability to supply educational and public broadcasting programming nationwide and will complement its existing statewide duplex microwave relay system.

Scientific-Atlanta also has been awarded a contract by the Turkish government, Post Telephone and Telegraph (PTT). The PTT will use Scientific-Atlanta earth stations and associated electronics for telephony, TV broadcast and reception within the Turkish domestic satellite system and for broadcasts to American military personnel from the Armed Forces Radio and Television Service.

Convergence offers seminars

Convergence is offering 4-day operator seminars once a month at its headquarters in Irvine, CA. The cost per student is $300, and the courses will cover the operation of all Convergence-manufactured A/B roll edit-controllers, post-production and preparation and organization, the nature and use of time code, off-line editing, edit list management and cleaning, preparation of the list for on-line editing, the auto-assembly process and various forms of edit list storage including that of personal computers. For more information contact Lorraine Pinney at 714-250-1641.

PRO Battery expands

PRO Battery, Atlanta, has opened a new factory and sales office in Mountain View, CA.

NBC buys Bosch system

NBC Sports has purchased an FGS-4000 computer animation system from *Robert Bosch*, Salt Lake City. NBC will use the system for graphic special effects. The system also will be used to produce graphics for the 1988 Olympics.

Rockwell International provides radar system

A groundbased Doppler weather radar system manufactured by the Collins Air Transport Division of *Rockwell International*, Cedar Rapids, IA, now is in operation with Atlanta's NBC affiliate, WXIA-TV, the 40th such operator in the United States and Canada.

Wavefront opens L.A. office

Wavefront Technologies, a Santa Barbara, CA-based company specializing in 3-D graphics animation and rendering systems, has opened a Los Angeles office at 8439 Sunset Blvd., Suite 108, West Hollywood, CA 90069; 213-650-8593.

TVS orders Logica system

Logica, London, has announced the first sales of Gallery 2000, its new TV digital still picture system. Television South, the independent broadcaster for the south of England, has ordered two units.

The unit is an integrated still picture system that stores pictures on digital optical disk for long-term storage. The units will be installed by the end of the year.

Mastefonics obtains Otari digital recorder

The new 32-track, PD-format DTR-900 digital tape recorder, from *Otari,* Belmont, CA, has been purchased by Mastefonics, Nashville, TN, a disk mastering facility. A new multitrack digital remix room is being added, where the unit will be interfaced with a Solid State Logic 4000E console.

Group purchases Vidifont system

The Harte Hanks Television Group, San Antonio, TX, has made a 3-station group purchase of the Vidifont V graphics and animation system manufactured by *Thomson-CSF Broadcast,* Stamford, CT. Elements of the purchase include 2-channel operation, font compose and the Vidivote package.

The stations scheduled to receive the system are KYTV, Springfield, MO, WFMY, Greensboro, NC, and KENS, San Antonio.

Studio purchases digital multitracks

Record producer Harold Shedd's Music Mill studio, Nashville, TN, has purchased two X-859 32-channel digital audio recorders from *Mitsubishi,* San Fernando, CA. The units, installed in July, have been used in a variety of recording projects, including a commemorative album for the Statue of Liberty centennial.

NEC America relocates

The offices of *NEC America* broadcast equipment division have moved. The new address and telephone number are NEC America, broadcast equipment division, 1255 Michael Drive, Wood Dale, IL 60191; telephone 312-860-7600.

Peirce-Phelps installs system

The video systems division of *Peirce-Phelps,* Philadelphia, has completed installation of a complete Betacam/component analog video system at AV3 Inc., Wilmington, DE. The system will give AV3 the capability to produce programs equivalent to broadcast-standard, 1-inch tape format at a lower cost. AV3 also is able to provide finished productions in any format.

People

Richard D. Eidson, vice president of Commercial Cable, Chattanooga, TN, has been named national sales manager for all cable and broadcast sales. **Rhonda C. Boyd** has been promoted to vice president and will oversee engineering and software developments.

Ted Birchfield and **David Stewart** have been designated co-winners of Ampex's 1986 Manufacturing Man of the Year award. Birchfield is production manager, and Stewart is senior quality engineer, at the company's manufacturing center at Opelika, AL.

G. Patrick Marr, head of the system engineering division of Comsearch, has joined Litco, Plano, TX, as vice president and general manager. The move is part of Comsearch's and Litco's plans to jointly market communication engineering services. **Ray Senseny,** Litco president, remains as chairman.

Jeffrey N. White has been promoted to assistant national sales manager of professional products for Audio-Technica, Stow, OH. **Jacquelynn Hebrock** has been named product manager.

Anthony R. Pignoni has been appointed vice president of marketing and sales for Panasonic Broadcast Systems, Secaucus, NJ.

Frank Loos has joined Image Devices International, Miami, as senior technician, responsible for quality control for film, cameras and lenses.

Emerson Ray has been named Southeastern regional sales manager for Odetics, Anaheim, CA. He will be responsible for the TCS2000 cart machine.

The Tektronix television division sales force has been reorganized. The new regional managers are: **Bhaskar Pant,** Northwest; **Tom Jordan,** Mid-Atlantic; **Austin Basso,** Southeast; **Steve Brant,** Central; **John Kelley,** Rocky Mountain; and **Warren Beals,** Western.

Martin J. Stein has been appointed vice president of marketing for Cubicomp, Hayward, CA.

Phil Wagner has been appointed Eastern regional sales manager for Rupert Neve, Bethel, CT.

Magni Systems, Beaverton, OR, has appointed **Richard E. Lyons** as its Western regional sales manager.

Ted Szypulski has joined Landy Associates, Cherry Hill, NJ, as a sales engineering representative for Connecticut, western Massachusetts and eastern New York.

Bob Tourkow has joined the home office staff of Clear-Com Systems, San Francisco. Tourkow will be involved in new product development and applications engineering.

Fred A. Barbaria has been appointed operations manager of Moseley Associates, Goleta, CA.

Sound Technology, Campbell, CA has appointed **W. Kent McGuire** vice president of sales and marketing.

J.P. Farrell has been appointed executive director of electronic laboratory services at Pacific Video, Hollywood, CA.

John Harms has returned to Broadcast Systems Inc., Austin, TX, as manager of non-broadcast sales.

Dwuan Watson has been appointed sales engineer for Sony Broadcast Products Company, Teaneck, NJ. He will handle accounts in the Midwest.

Steve Michelson has been named to the board of directors of The ALTA Group, San Jose, CA. Michelson founded One Pass, of San Francisco, in 1976. He also is executive producer of One Pass Productions and president of ScanLine Communications.

John L. Klecker has joined Andrew California Corporation, Upland, CA, as an applications engineer for broadcast products.

John Ahrens has been appointed national marketing director for BERC, The Broadcast Equipment Rental Company, Burbank, CA.

Philip M. Godfrey has been appointed director, professional products development and engineering for Ikegami Electronics, Maywood, NJ. In this newly created position, Godfrey will be active in product design.

Nancy M. Byers has joined Nurad, Baltimore, MD, as a sales engineer with its commercial marketing department. Byers will assume commercial sales responsibility for the western United States, including: California, Oregon, Washington, Nevada, Colorado, Arizona, New Mexico, Utah, Idaho, Wyoming and Minnesota.

Dean Dawson has been promoted to vice president of sales and marketing for Kikusui International, Torrance, CA. He will retain his sales management responsibilities in addition to the marketing functions.

William A. Fink has been appointed vice president and director of marketing for Moseley Associates, Goleta, CA.

J. Michael Hughes, Randy Opela and **Bill Otis** have been appointed to positions at HM Electronics, San Diego, CA. Hughes has been appointed to the newly created position of director of marketing. He will be responsible for coordinating all sales activities and marketing programs. Opela is national sales manager. Otis is product manager of the pro-audio division.

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Nicholas McGeachin
Suite 460, Southbank House
Black Prince Rd.
London SE1 7SJ
Telex: 295555LSPG
Telephones: 01-582-7522
01-587-1578

TOKYO, JAPAN
Haruki Hirayama
EMS, Inc.
Sagami Bldg., 4-2-21, Shinjuku
Shinjuku-ku, Tokyo 160, Japan
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Fujinon Inc.	143	95	914/472-9800
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News
Continued from page 4

Broadcast pioneer Parker S. Gates dies

Parker Smith Gates, broadcast electronics pioneer, inventor and founder of Gates Radio Company, which later became the broadcast division of Harris Corporation, died Sept. 17 in Quincy, IL.

Parker S. Gates

The Gates Radio Company began Sept. 1, 1922 in a rented apartment. Parker Gates, at age 14, was the company's designer and engineer, and his parents were company officers. In 1924, Henry Gates began to work in the family's company full-time. Parker Gates worked afternoons and evenings while attending Quincy High School, where he graduated in 1926.

In the early years of Gates Radio, Parker Gates invented several pieces of equipment which led to the company's growth. With the advent of talking motion pictures in the 1920's, he invented a non-synchronous sound machine, the Gates Electrograph, which was sold to movie houses around the country. On commission from a New York firm, he invented the first transcription turntable in 1929. In 1932, he invented a remote amplifier which enabled events to be broadcast live from locations outside a radio station, and in 1933, he created a new version of the condensor microphone.

In the early 1930s, Gates Radio developed the first radio station master console, and, in 1936, introduced its first radio broadcasting transmitter, a 250W product.

During World War II under Gate's leadership, the company was a major equipment supplier to the war effort, supplying radio transmitters for use in the D-Day invasion of Normandy. After the war, Gates Radio continued to expand and, in the 1950's, won government contracts to supply short-wave equipment to the Voice of America and American troops in the Korean conflict. In 1952, Gates Radio constructed for the VOA its Studio A and master control in Washington, DC.

In the 1950s, the company began to develop high-wattage transmitters for FM radio stations, a 5,000W AM transmitter, and small transmitters to be used by schools. With the advent of television, Gates Radio began producing TV broadcasting equipment and transmission towers.

In 1957, Harris Corporation acquired Gates Radio. Gates continued to serve as president of the Gates Division, which later became the broadcast division, and was a Harris director. He became chairman of Gates Division in 1968.

Gate's received an honorary doctorate degree in industrial relations from Quincy College in 1973; was honored by the Quarter Century Wireless Association in 1976 in 50 years as a licensed ham radio operator, and was inducted into the Illinois Business Hall of Fame at Western Illinois University, Macomb, in 1978. In 1982, Gates, a member of the Rotary Club since 1934, received the club's highest honor, being made a Paul Harris Fellow. In recognition of his contributions to the community, he was awarded the Humanitarian Award of the Family Services Agency of Adams County.

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