BME

FOR TECHNICAL AND ENGINEERING MANAGEMENT

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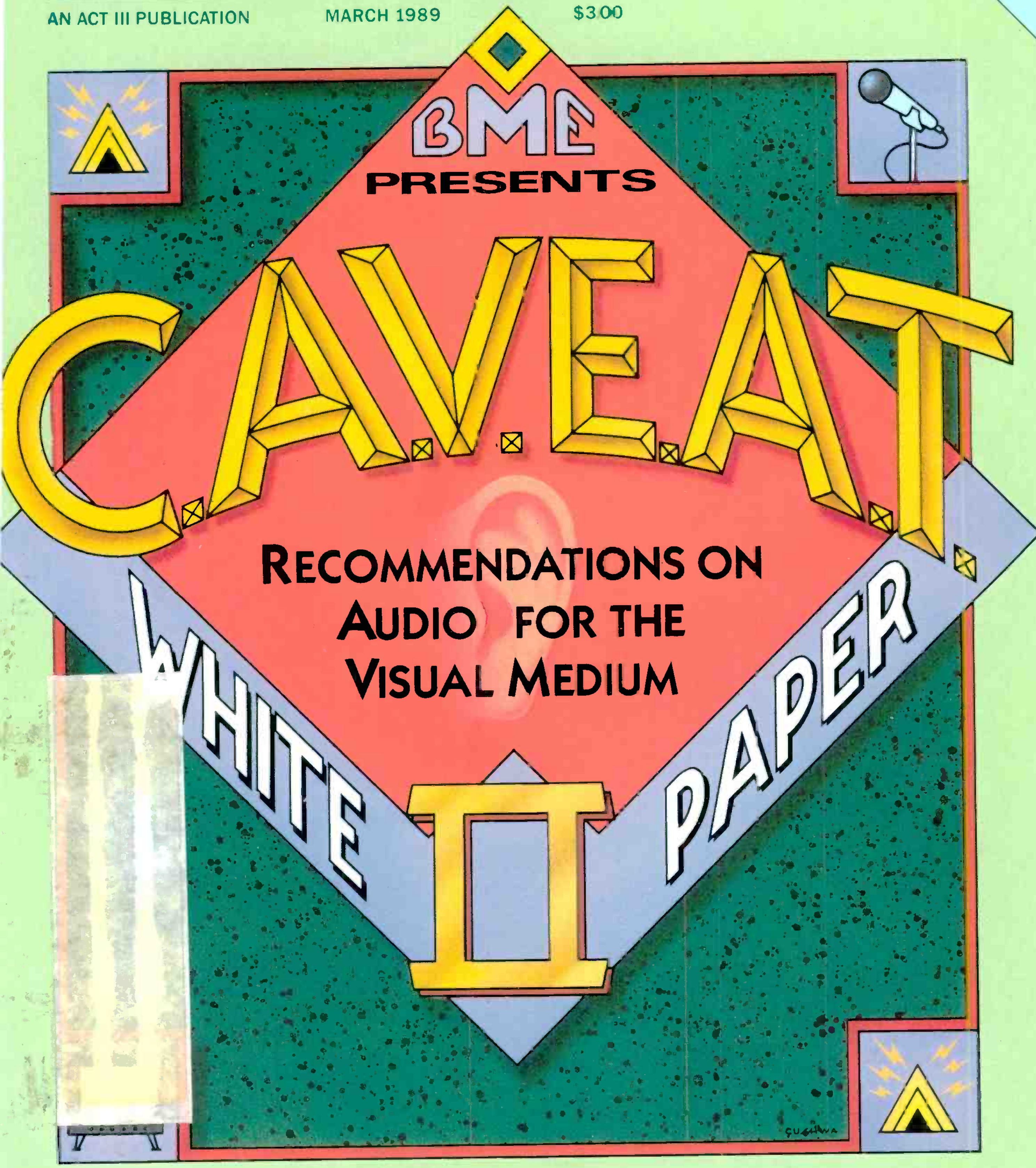
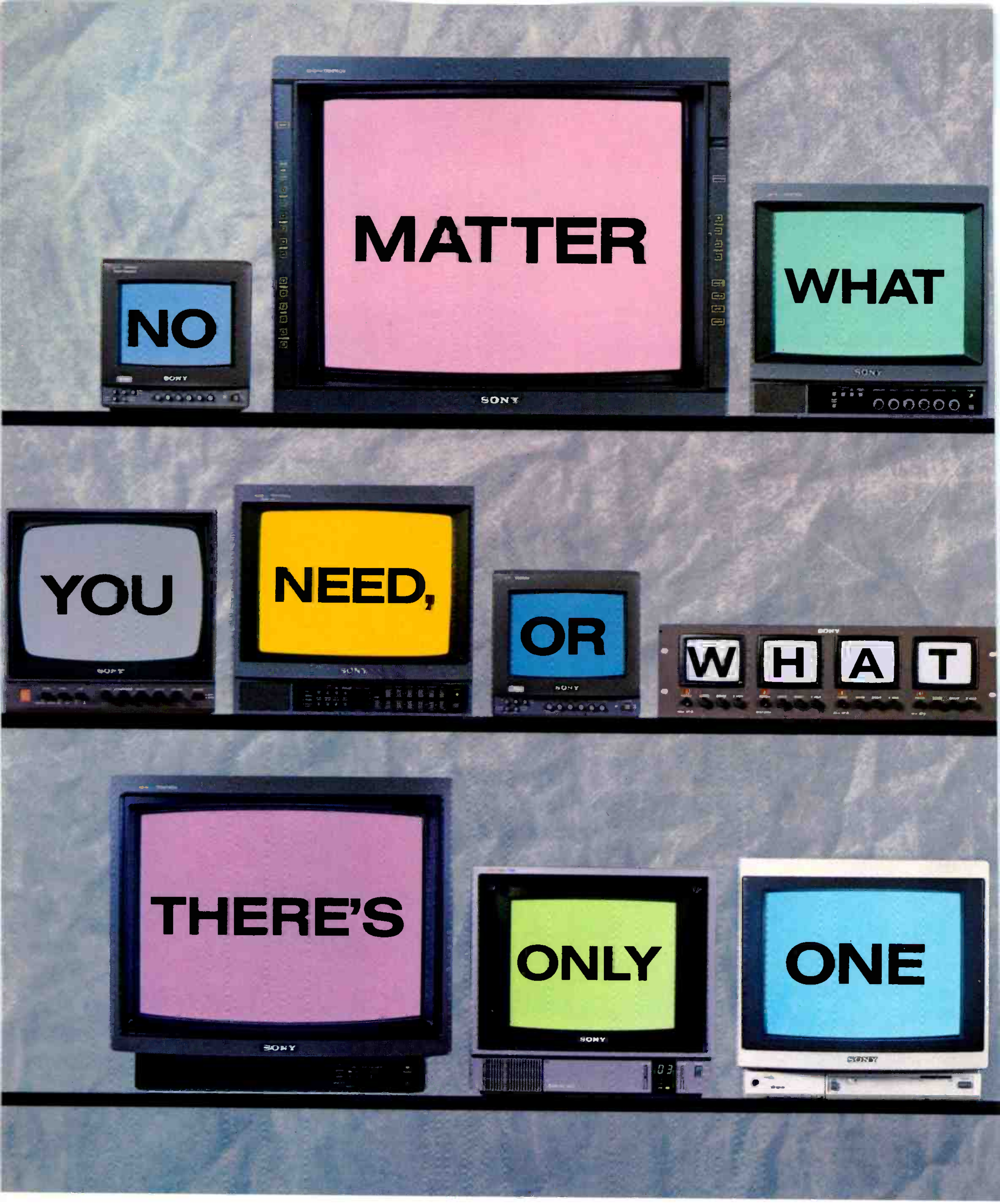
INSIDE: PUBLIC PERFECTION AT WGBH





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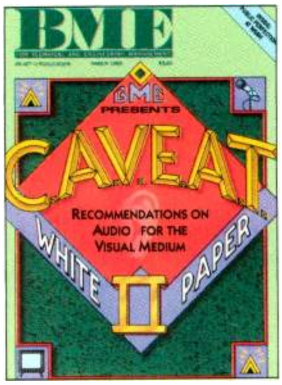

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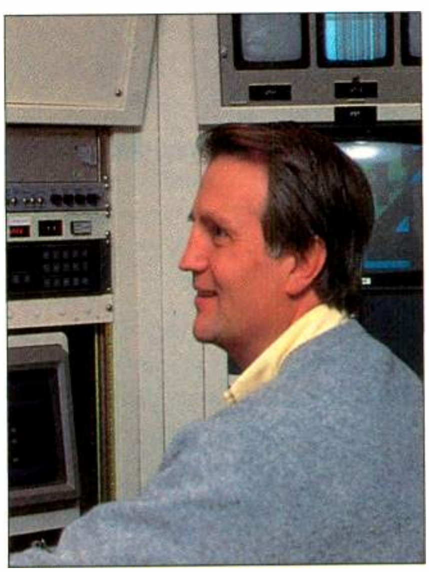

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BME
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MARCH 1989
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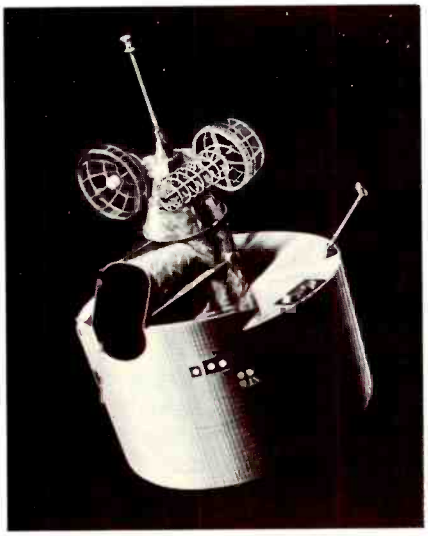

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No dropouts in Russia.

Tape dropouts mean trouble for videotape professionals. No wonder so many of them choose to work with Sony Professional Videotape. Including the producers of two recent documentaries shot in Russia, who minimized dropouts by shooting with Sony Videocassettes.

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VIEWPOINT

In the six years that have elapsed since the publication of the original White Paper, audio for video has undergone an amazing transformation.

A few months ago, members of the Chicago chapter of the International Teleproduction Society approached *BME* with an unusual request: to publish a greatly expanded and updated version of the White Paper on Audio for the Visual Medium. We were interested, not only because of the obvious value of the work itself, but because of the opportunity it afforded to serve an often-neglected segment of our industry, the teleproduction engineers.

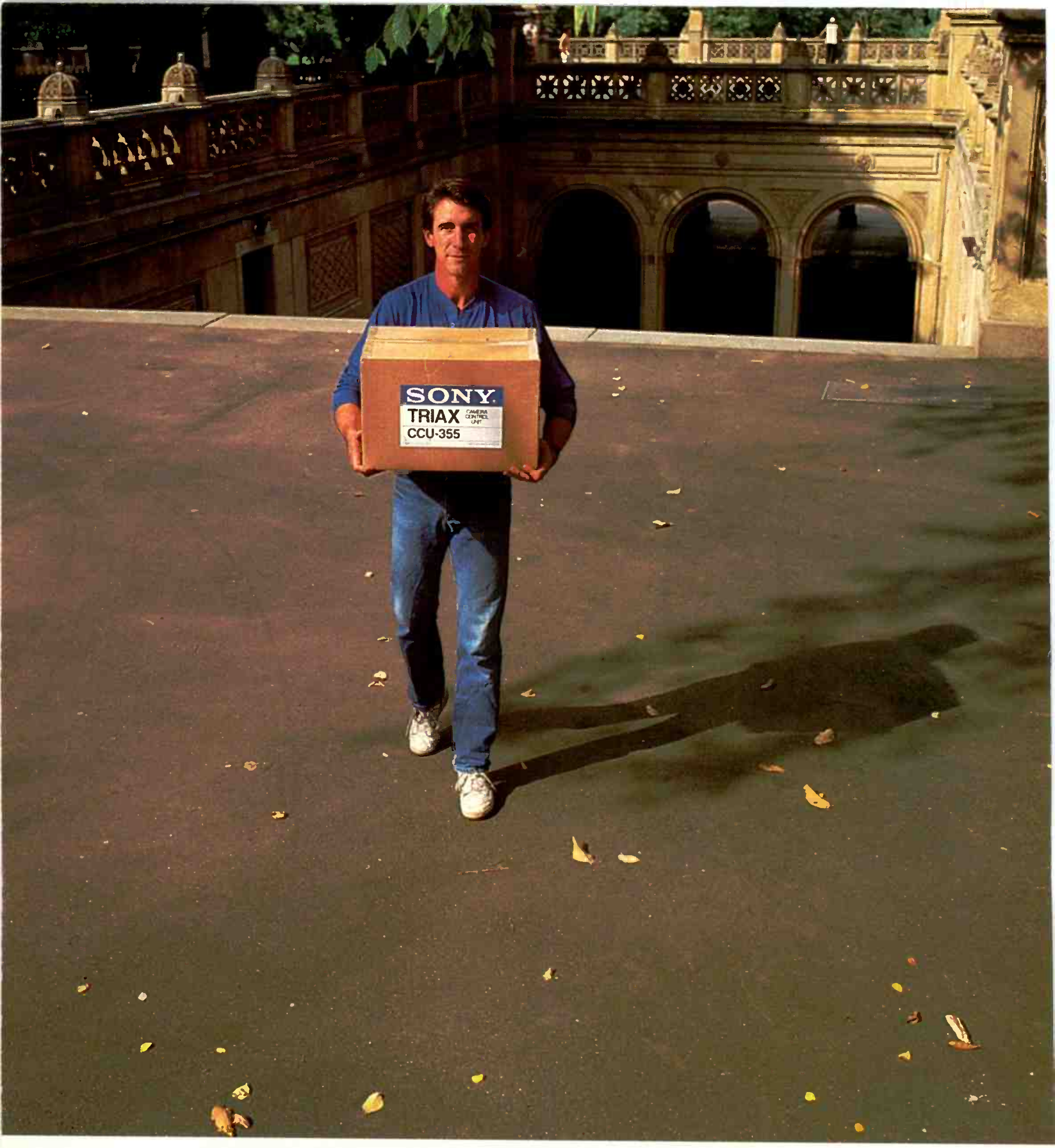
The original 1982 paper, a four-page pamphlet developed by a group known as the "Chicago Coalition," already had proven beneficial by encouraging greater program interchangeability and cooperation among video and audio facilities. In the six years that have elapsed since the publication of the original White Paper, however, audio for video has undergone an amazing transformation. While many audio-conscious video engineers were producing stereo soundtracks even in 1982, the advent of multichannel television sound has made stereo production standard operating procedure. Digital audio has moved beyond the high-end recording studio and into television facilities with the development of digital VTRs. The evolution of entirely new equipment categories, such as random-access digital audio workstations, has changed the audio picture profoundly.

It is our great pleasure and honor, therefore, to present *White Paper II*—in its full, unabridged form—in this month's *BME*. The Chicago Coalition, now known as C.A.V.E.A.T. (for Concerned Audio and Video Engineers and Technicians), has produced a handbook that should prove a valuable addition to the library of engineers around the country.

The recommendations of the C.A.V.E.A.T. committee, while designed to foster cooperation among facilities, are careful to leave facilities' own procedures and processes untouched. They deal strictly with ways to streamline the interchange of audio program material. We feel that their suggestions will be of use to teleproduction facilities everywhere, and also to television station engineers making their way through the maze of improved audio.

We're proud to have this opportunity to serve the industry by publishing the C.A.V.E.A.T. White Paper II. Our hats go off to the authors, who overcame competition and professional differences to produce a guide that will prove beneficial to the entire industry. ■

Eva J. Blinder
Editor



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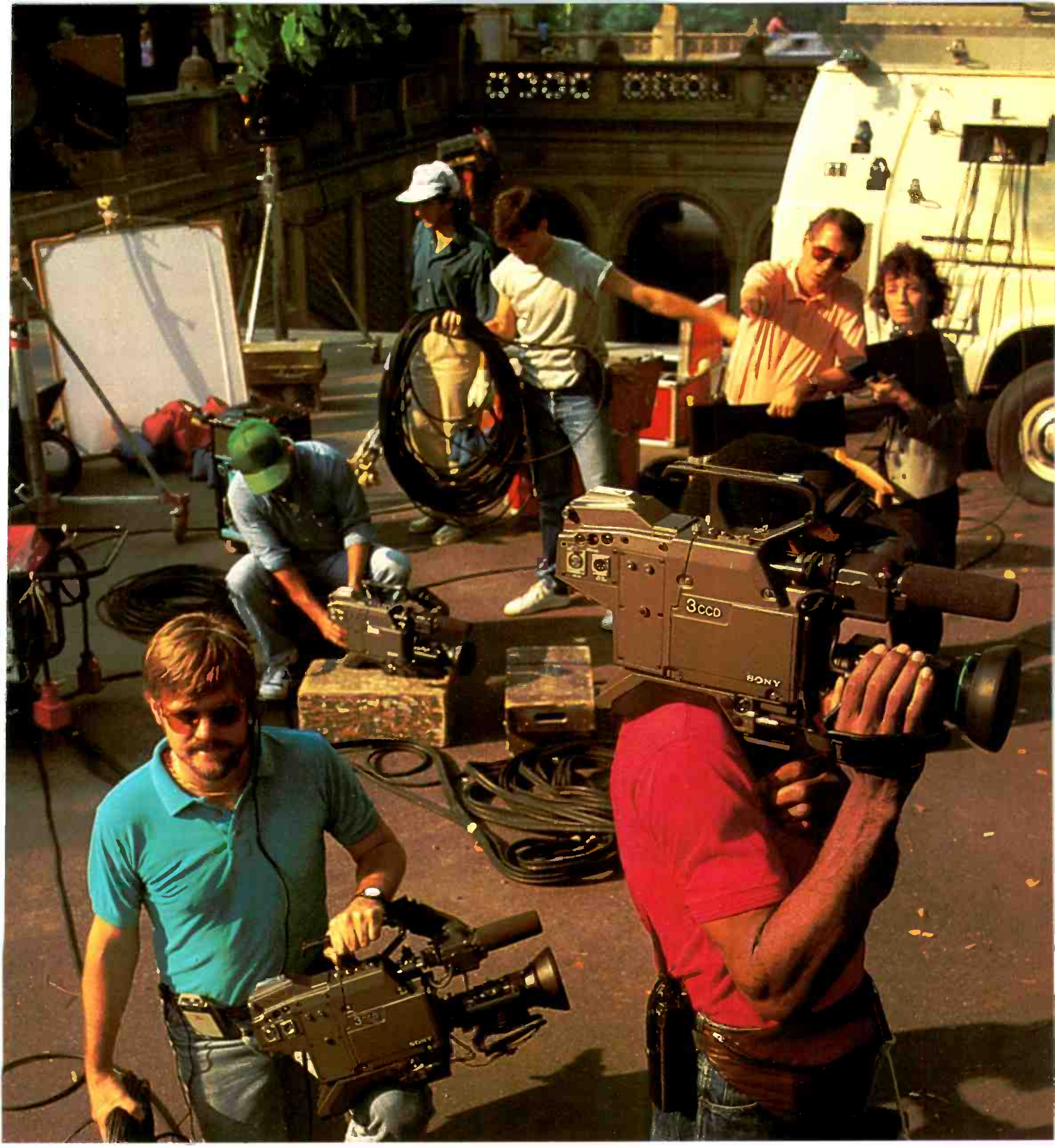

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UPDATE

ABC HDTV Standard Appeal Denied....BME Gets New Publisher....NOAA Weather Satellite Goes Dead.... Paltex Acquires EECO/Convergence.... FCC, Broadcasters Battle EPA for RF Radiation Standards

ABC HDTV Standard Appeal Denied

The American National Standards Institute (ANSI) has denied an appeal filed by Capitol Cities/ABC Television to revoke SMPTE 240M as an American standard for high definition video production. SMPTE standard 240M covers the 1125 line/60 Hz format. The appeal was filed October 14, 1988 and rejected February 2, 1989. SMPTE and ANSI standards are voluntary and nonexclusive.

Documentation filed by ABC stated that 240M should be a SMPTE standard but not an American national standard. The company said that 240M did not meet essential industry criteria. Its three complaints were that the standard "did not achieve industry consensus," that it "was not suitable for national use", and that "the requirements of due process were not satisfied in the procedures followed by SMPTE inpromulgating the standard."

"No stature!"—Cap Cities/ABC

"It's interesting that a broadcast corporation appealed a standard for high definition production," added one executive who asked to remain anonymous. 240M was declared an ANSI standard in August 1988. Initial work in SMPTE committee began in 1983. Industry sources say ABC was eligible to participate in working groups and meetings but did not do so.

"We don't have any problem with 240M as a SMPTE-recommended practice," said Tony Uyttendaele, director of allocations and rf systems for Cap Cities/ABC. "We just don't think it should have the stature of a U.S. national standard. In our opinion, it doesn't deserve that." ABC had "not been very involved" in the standards-making process, according to the BO&E office.

"ANSI had accepted 240M as an accredited American production standard. The fact that there was an appeal at all is out-of-the-ordinary," said Alec Shapiro, coordinator for the Washington, DC-based 1125/60 Group.

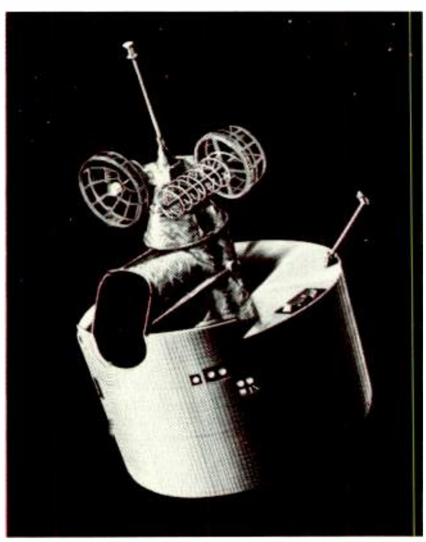
"We find this very difficult to understand because frankly if anything went through due process, this was it," Shapiro said. Two hundred and sixty-seven engineers participated in creating 240M over a five year period, he added. The 1125/60 Group is a consortium of manufacturers whose goals include promoting implementation of the 1125/60 format as an HDTV video production standard worldwide.

SMPTE is the official certifying body for ANSI. The Society would say only that it approved the format as a standard and was therefore able to submit it to ANSI. Appeals of ANSI standardization are relatively common in some industries—notably the computer industry—but they are rare in the broadcast, film and video industries.

NOAA Weather Satellite Goes Dead

The failure on January 21 of the GOES-6 weather satellite which transmitted pictures of cloud cover over the Pacific and Western United States caused a temporary partial interruption of service to television weather forecasters. Failure was due to the unavoidable wearing out of scanning lamps used in the satellite to activate the TV imaging process.

According to a statement issued by the National Oceanic and Atmospheric Administration (NOAA), the satellite was launched on April 28, 1983 with a life expectancy of five years. Actual life was extended nine months beyond expectations by shutting down the TV imaging process during periods when no pictures were needed, thus



The GOES-6 weather information satellite.

extending the life of the scanning lamps. NOAA will launch a replacement satellite in mid-1990 containing light emitting diodes (LEDs) which will be used to supplement and extend the life of the standard scanning lamp elements on the satellite.

In the meantime, a surviving satellite, GOES-7, will be moved from its present position at 79.5 degrees west longitude to a new position at 108 degrees west longitude where it will cover the entire country plus major portions of both the Atlantic and Pacific. In the spring, the remaining satellite will be moved back 10 degrees to watch for Atlantic hurricanes and next fall it will be moved westward again to watch for western winter storms.

Major suppliers of satellite weather imaging and data to the television industry report only minor inconveniences, if any, to their customers. George Cares, senior meteorologist for Weather Service International (WSI) says, "We have not been affected by the loss of GOES-6 and if the plan to reposition GOES-7 proceeds smoothly, there should be no interruption of service."

Jim Menard, manager of system operations for Environmental Satellite Data (ESD) reports, "Service to Hawaii was lost altogether and the Western States experienced a one-half-hour delay in service while our computer switched over to receiving data from the GOES-East (GOES-7) satellite only. As the GOES-East is repositioned, storms normally picked up over Africa will be picked up over the Atlantic. In order to compensate, we plan to supplement GOES-East coverage with data from the European Meteosat and others." ■

FCC, Broadcasters Battle EPA for RF Radiation Standards

The FCC, NAB and the Electromagnetic Energy Policy Alliance (EEPA) are pulling out all the stops to induce the Environmental Protection Agency (EPA) to reconsider its decision to drop work on the establishment of radiofrequency (rf) radiation guidelines. The EPA made its decision to stop work last fall in response to budgetary considerations and the need to focus limited resources on selected issues, according to an EPA statement.

Ralph Justus, NAB director of engineering for regulatory and international affairs, explained the danger by saying, "In the absence of federal standards, localities will adopt a patchwork of local regulations not based on scientific fact that adversely affect broadcasters with no clear offsetting public benefit.

"Scientific literature is uncertain of precisely where and under what conditions rf radiation constitutes a hazard to humans, but standards of safety such as have been adopted by the American National Standards Institute (ANSI) can be established on the basis of scientific best guesses."

FCC chairman Dennis R. Patrick, in a letter last November to EPA administrator Lee M. Thomas, requested that the EPA review its decision to defer the rf radiation program and stated, "In many cases, the lack of federal standards has already led local officials to favor significant restrictions on rf transmitters that are not supported by scientific evidence and that can delay and disrupt telecommunications services."

Patrick also noted that considerable progress had already been made in the research and that re-establishing the effort at a later date would be difficult and time-consuming.

The EEPA, whose board of directors represents the NAB and such industrial giants as GTE, GE, SRI, Rockwell, NBC, Raytheon, Motorola and AT&T, is adding its weight to the struggle. In his November letter to the EPA's Thomas, EEPA president Jay J. Brandinger wrote, "Failure to use the comparatively few manhours now needed to complete the electromagnetic guidance document constitutes unconscionable waste."

In a January reply to Patrick, EPA assistant administrator Don R. Clay

BME Gets New Publisher

Act III Publishing (Technical Division) has named Michael D. Bailenson the new publisher of *BME*. Bailenson joins Act III from Intertec, where he was most recently publisher of *Electrical Construction Technology*.

"Michael is a real pro and we look forward to his enthusiasm and energy," said Kevin Condon, group publisher for Act III's technical publishing division. Condon continues as group publisher and Pat Moloney continues as associate publisher for *BME*.

Bailenson, once also with Lebhar-Friedman, is married and lives in New York City.

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wrote, "At this time I do not think we will be able to go forward with the rule-making procedures." Cancer fears were expressed by Norton Nelson, chairman of the Executive Committee of the Science Advisory Board of the EPA, in his July letter to administrator Thomas. Nelson said, in part, "The agency must not totally abandon its work in the area of non-ionizing radiation. This recommendation is particularly relevant in the light of two studies dealing with non-ionizing radiation reported in the current issue of the American Journal of Epidemiology, which evidence both the continuing interest in this field and the ambiguous nature of most current data."

Last July in Massachusetts, the lack of federal standards led local officials to put into force their own non-ionizing radiation law. Huck Hodgkins, president of WBRK-AM in Pittsfield, MA said, "I would support the NAB position in regard to the need for a federal rf radiation standard. As far as the present law is concerned, I don't know of anyone who had trouble with the inspection, but you do have to go off the air to perform any maintenance on the antenna."

Marc Peters, chief engineer of WHRB-FM, Cambridge, MA, said a national standard is necessary. "The FCC is correct, a more comprehensive national standard is best," Peters said. "A city law, for instance, would not affect the area outside the city limits, but this might be the very place the station has its antenna. The EPA or the FCC should set the standards which would then be available to all cities." ■

Paltex Acquires EECO/Convergence

With the major acquisition of EECO/Convergence, Paltex International has gained a leading share of the market in videotape editors, joining such giants as Ampex, CMX, Sony and Grass Valley. The sale involves only EECO's video editing business which EECO acquired two and a half years ago when it took over Convergence. In a January 20 statement, EECO explained that divestiture of this and other business units will permit it to concentrate on its core business of manufacturing electro-mechanical switches, computer keyboards, membrane keyboards and avionics products.

Sale of the video editing business, which has been unprofitable, will result in a $7.7 million one-time pre-tax loss. Also on the block are the company's hotel computer property management subsidiary and its eighteen-acre Santa Ana, CA, headquarters. These transactions, when completed, will allow EECO to realize substantial cash proceeds. Operating losses are expected to continue through the fourth quarter.

Industry reaction to the takeover has been guarded. Ampex public relations manager Dave Detmers said, "The acquisition is indicative of some of the changes taking place in the industry." Users of Convergence products also took a wait and see attitude. Eliot Reed, director of ENG operations at ABC (which uses several Convergence units) commented, "Time will tell how Paltex continues the Convergence line and how they will deal with the network."

Paltex has assured owners of Convergence equipment that the newly reformed Convergence Corp. will assume all customer service activities, providing full system and software support, and that Convergence editing systems will continue to be represented by the current distributors.

In the scant ten years of its existence, Paltex claims to have become the largest independent manufacturer of video systems in the world. The company will manufacture all products in Tustin, CA.

In looking to the future, Roger Bailey, chairman and managing director, stated, "We will certainly not drop any product and in the long term hope to add new lines. At the sustaining level, we have already integrated manufacturing and engineering and we also intend to integrate R&D. Convergence products will continue to be marketed under the Convergence name, including the IVES and EMME editors which were originally EECO products." ■

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SBE Holds Mid-Winter Forum....Tower Tumbles....Hi-Def for the Masses?

SBE Holds Mid-Winter Forum

Several issues of interest to the broadcast community were discussed at a forum held by the Society of Broadcast Engineers in Washington, DC on January 11, 1989. Panelists were Lex Felker of the FCC's Mass Media Bureau, Wallace E. Johnson of the consulting firm Moffet, Larson and Johnson, and Michael Rau of NAB's Science and Technology Division. Bob Van Buhler, SBE executive VP, chaired the panel.

Felker listed the major items currently in motion at the FCC, which included AM interference, the extended AM band, FM class-of-service upgrades, movement toward contour assignment methodology for FM, and high definition television broadcast standardization. On HDTV, Felker said the Commission will rely heavily on the recently formed Advanced Television Test Center for its data, praising the ATTC as a great example of private sector cooperation. A final decision on the National Radio Standards Committee (NRSC) AM recommendations will be made in early 1989, according to Felker.

Wally Johnson, who also serves as executive director of the Association for Broadcast Engineering Standards (ABES), raised concerns about trends in recent broadcast regulation that he felt seemed to protect the entrepreneurial interests of broadcasters at the expense of the public good. He questioned the current validity of the FCC's traditional notion that interference should only be dealt with if sufficient public complaints are received.

"Those days are long gone," said Johnson. "With so many choices today, the audience just tunes elsewhere if interference is noted. Yet a service is lost." He exhorted the Commission to avoid making allocations "with Vaseline and shoehorns," and urged them to continue updating their calculation methods.

Mike Rau voiced the NAB's interest in pending FM directional antenna (DA) regulation. He expressed support for proposed FM contour-protection allocation methods, similar to those currently in use for AM. Rau also announced that the SBE and NAB will jointly sponsor a series of Uplink Seminars for broadcast earth station personnel. The five-day events will be held at various locations and accept 20 attendees on a first-come, first-served basis. Seminar content will stress safety and interference management in all types of uplink hardware, C band and Ku, fixed and portable. One day of hands-on with a portable uplink will be included. Contact Janet Elliott at the NAB for further information at (202) 429-5346.

SBE personnel reported that the Society's search for an executive director and the consideration of a possible HQ move from St. Louis, MO to Washington, DC are both still underway. The SBE's engineer certification program continues to gain momentum, according to the society. More classified ads mentioning the certification as a criterion for employment are appearing, the SBE notes. In addition, the Broadcast Education Association has approached the SBE to discuss the possibility of establishing an operator's-class certification, approximating the function of the old FCC Third-Class license. A survey of station managers is under development to determine whether this is a worthwhile undertaking. Meanwhile, the SBE has established a committee on minority training, inviting Ellis Terry of WETA-FM, Arlington, VA, to chair. (See Terry's Guest Editorial on the subject in the November 1988 BME.)

Panelists at the SBE's Mid-Winter Forum, from left: Michael Rau, NAB vice president, science and technology; consulting engineer Wallace E. Johnson, executive director of the Association for Broadcast Engineering Standards; Bob Van Buhler, executive vice president, Society of Broadcast Engineers; and Lex Felker, FCC mass media bureau chief.

Tower Tumbles

Engineers at WBRE-TV, Ch. 28 in Wilkes-Barre, PA, faced one of their worst nightmares early in January when the station's 849-foot tower collapsed during an ice storm.

The accident occurred between 6:30 and 6:45 a.m. on the morning of Sun-

day, January 8, just minutes before Ch. 28's scheduled 7:00 a.m. signon. That's an hour when WBRE normally operates its transmitter by remote control, so no one was injured. Another piece of luck was that the tower fell away from the transmitter building, which minimized the damage. Three equipment racks were pulled into the air when transmission lines to radio relays and ENG equipment failed to separate, but most of the resulting damage was to connectors. The only other damage was to the roof, caused by the tower guys.

According to WBRE's assistant chief engineer, Barry Erick, the tower originally was designed to withstand 125 mph winds, but with no spec for ice. Ice storms are fairly frequent in the winter on Mt. Penobscot, where the tower was located, but generally don't involve high winds. The unusual combination of wind and ice proved too much for the two-decade-old structure.

Erick and his staff lost no time in getting the station back on-air. By 1:00 p.m. the same day, a microwave link had been established to one of the local cable companies, which in turn passed the signal to about 70 percent of the other cables that carry WBRE. It took about two days to get a temporary tower into operation with a 30 kW antenna. With the transmitter sited atop Mt. Penobscot, 2000 feet above sea level, a 25-foot antenna got the signal out locally and to the station's two translators, at distances of 60 and 90 miles.

A "permanent" 200-foot temporary tower from Stainless and 30 kW Bogner antenna with 8 dB gain were installed by SG Communications two days after that and will serve until WBRE's engineering staff settles on a design and supplier for the permanent replacement.

Hi-Def for the Masses?

Well, maybe not exactly for the masses—not yet, anyway. But Rebo Research, the new product development subsidiary arm of New York City's Rebo Studios, has a few ideas on how to make HDTV production more flexible and affordable for the few companies that are now using it.

Rebo Research is introducing three products for the fledgling HDTV production market, all promised for NAB late next month and all designed to accomplish some basic needs economically and in a compact package. They include a bidirectional, full-duplex, single-wire fiber optic system for HDTV camera control and signal routing up to 12 miles; an HDTV framestore (described as a "poor man's Graphics Paintbox") built on a Macintosh II platform and enabling picture manipulation with off-the-shelf Mac software; and an HDTV-to-NTSC downconverter.

While the HDTV production market is small at present, the company is looking also to market the products to other fields, such as print graphics and medical imaging.

Rebo's entry into product development, unusual (though not unheard-of) for a production company, stemmed from the company's experiences as one of the first regular users of 1125/60 HDTV production equipment.

According to Rebo Studios founder Barry Rebo, many of the production techniques standard in NTSC were difficult or impossible in HDTV due to lack of peripheral equipment. "We've been spoiled by a lot of NTSC accessories," he said. Rebo's innovative approach to field production was another influence; the fiber optic system was developed in part because of the signal losses experienced in HDTV production with runs over 300 feet or more.

All the products share two characteristics: low cost and small size. Rebo Research CEO Denis Bieber is still being cagey about the exact price ranges, which will be announced, along with availability, at NAB. But Barry Minnerly, chief engineer of Rebo Studios and president of Rebo Research, predicted, "The guy who's just spent his last dollar on an HDTV camera and VTR will still be able to afford our equipment." ■

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TECH WATCH

"Digital Paper" Sets New Storage Standard

By James A. Ackerley

It's cheaper than magnetic media, holds more data in a smaller space, and promises to be the next big breakthrough in optical data storage. What is this newly emerged wonder material? It's "digital paper."

This recording medium, which is a dye polymer on a plastic substrate, has set a new standard for the amount of data that can be recorded on a square inch and, at only half a cent per Mbyte, is easily the cheapest material for the purpose. Two companies are presently working to produce drives, one tape and the other disk, designed to use the new material.

The tape drive is being developed by Creo Products, Inc. of Burnaby, BC, and is intended for mass storage of data and document imaging including high definition video recording. Don't expect it to replace conventional magnetic recording techniques, however. The digital paper tape is a nonerasable or "write once read many" (WORM) medium, eliminating any application that requires reuse of recorded tape.

Also, the Creo optical tape recorder is much slower than conventional VTRs. This disadvantage may someday be corrected by improvements in design. For now, however, the 24 megabit-per-second rate at which the Creo recorder transfers data compares poorly with the 115 megabit-per-second rate at which a D-2 VTR transfers data and even more unfavorably with the 225 megabit-per-second data transfer rate of a D-1 VTR. At present transfer rates, the Creo recorder will be able to handle images, but not regular video programming.

One big edge which digital paper tape has over magnetic tape, however, is the sheer amount of data it can record. The Creo recorder stores one terabyte (one million Mbytes) on an 880m by 35mm digital paper tape mounted on a 12½-inch open reel. If this information were played back at the maximum rate of 24 megabits (3 Mbytes) per second, the process would take four days. Impressive as this may seem, the relative concentration is even more noteworthy.

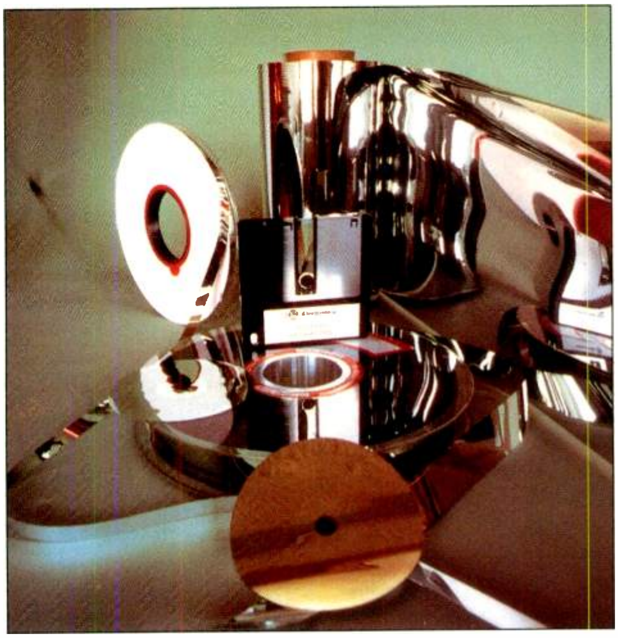
The density at which data may be stored on digital paper figures out to 168 megabits per square inch, far greater than the 57 megabits per square inch data density of magnetic tape. Despite the huge amount of data storage, particular data may be accessed quickly. The average time to access a record is only 28 seconds.

Early attempts to build an optical tape recorder ran into two major difficulties. Gas lasers proved unreliable and dust consistently obscured the bits. In the present machine, these problems have been effectively solved by the use of solid state lasers and the application of an extensive system of error correction.

Each of 33 solid state lasers receives a logic 1 or 0 from an encoder and emits either a high or low level of infrared light. The beams of light are reflected toward the digital paper tape by a mirror mounted on a slide. They then pass through lenses and impinge the digital paper tape as points of light in a vertical line or column. These points of light are each one μ in diameter and are spaced 1.6 μ apart, center to center. High levels of light create pits which reflect a reduced level of light in the read cycle.

Air bearings guide the slide, which does not wander or skew more than one tenth of a micron. A coil drive impels the slide at a constant speed, allowing 20,000 columns of bits to be laid down in one move across the tape. The tape then makes an incremental move forward and the slide reverses direction and writes the next record on previously unexposed tape by going across from the other edge.

A column consists of four bytes with one bit for error correction, and a record consists of 80,000 bytes, of which 64,000 are for data and 16,000 are for error correction. Creo will ship the first of four units to the Canadian government in May 1989 and will begin shipments to commercial users in October 1989. Archival life of the digital paper is estimated to be 15 years.



Digital paper in some of its many forms.

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Two obvious areas of application suggest themselves. One is the inexpensive storage of great volumes of data such as is produced by medical imaging, geophysical surveys and meteorological, mapping and defense imaging from satellites. The other is the inexpensive archiving of extensive data such as tax and business records. As Creo's marketing manager, Lou Misshula points out, "Availability will create new applications. When the product comes on the market, potential users will see applications they don't now contemplate."

Bernoulli Optical Systems Corp. of Boulder, CO, a subsidiary of Iomega, is developing an optical data disk drive (ODDD) that will use digital paper in the form of a flexible 5¼-inch disk. This drive, which company spokesman Andy Goldstein expects will be ready for market in about a year, takes advantage of Bernoulli's effect, a principle of physics, to allow the disk to come very close to the optical head without danger of crashing.

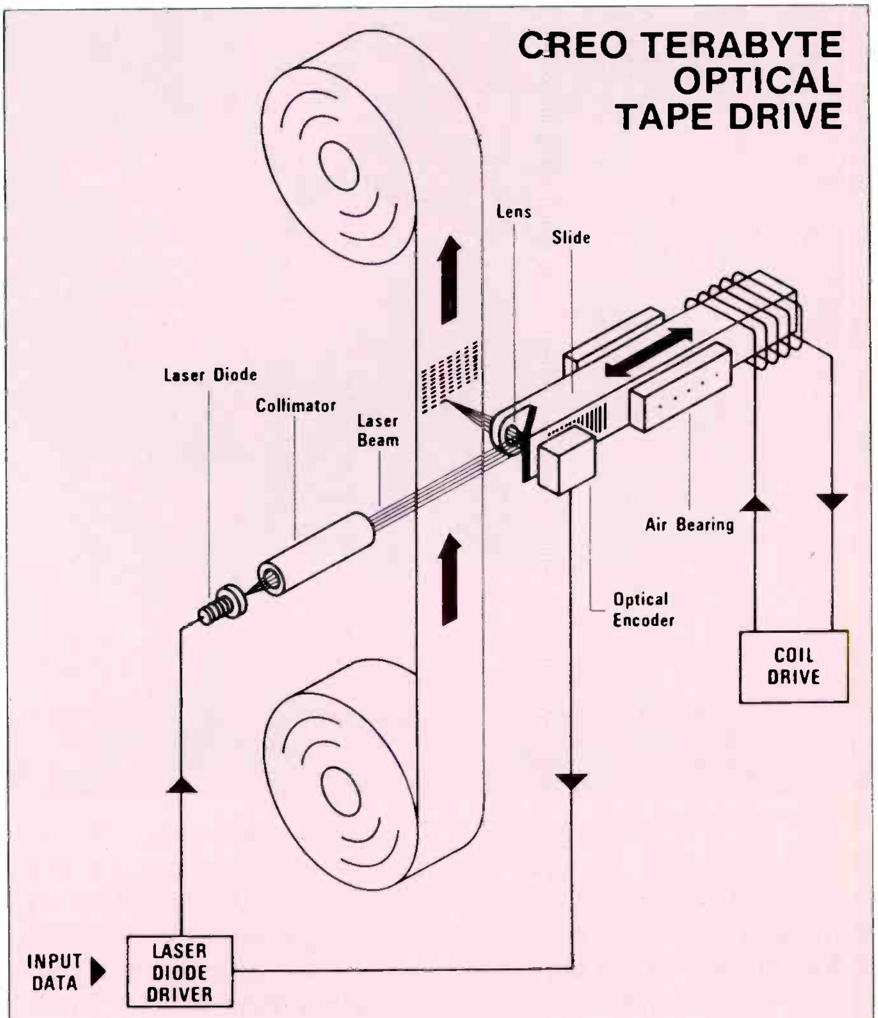
Because of Bernoulli's effect, air flowing between the disk and a plate located above the disk draws the disk toward the plate on which the microhead is mounted and, at the same time, provides a cushion of air to maintain a constant distance (on the order of 1 μ) between the disk and the head. Any failure or interruption of the flow of air that maintains the separation between disk and head also causes the disk to fly away from the head—a built-in safety feature.

According to the company, the system replaces the usual focusing servo with a lightweight fixed focus and replaces the secondary fine positioning mechanisms with servo-system tracking. Capacity of the digital paper disks is 500 Mbytes per side.

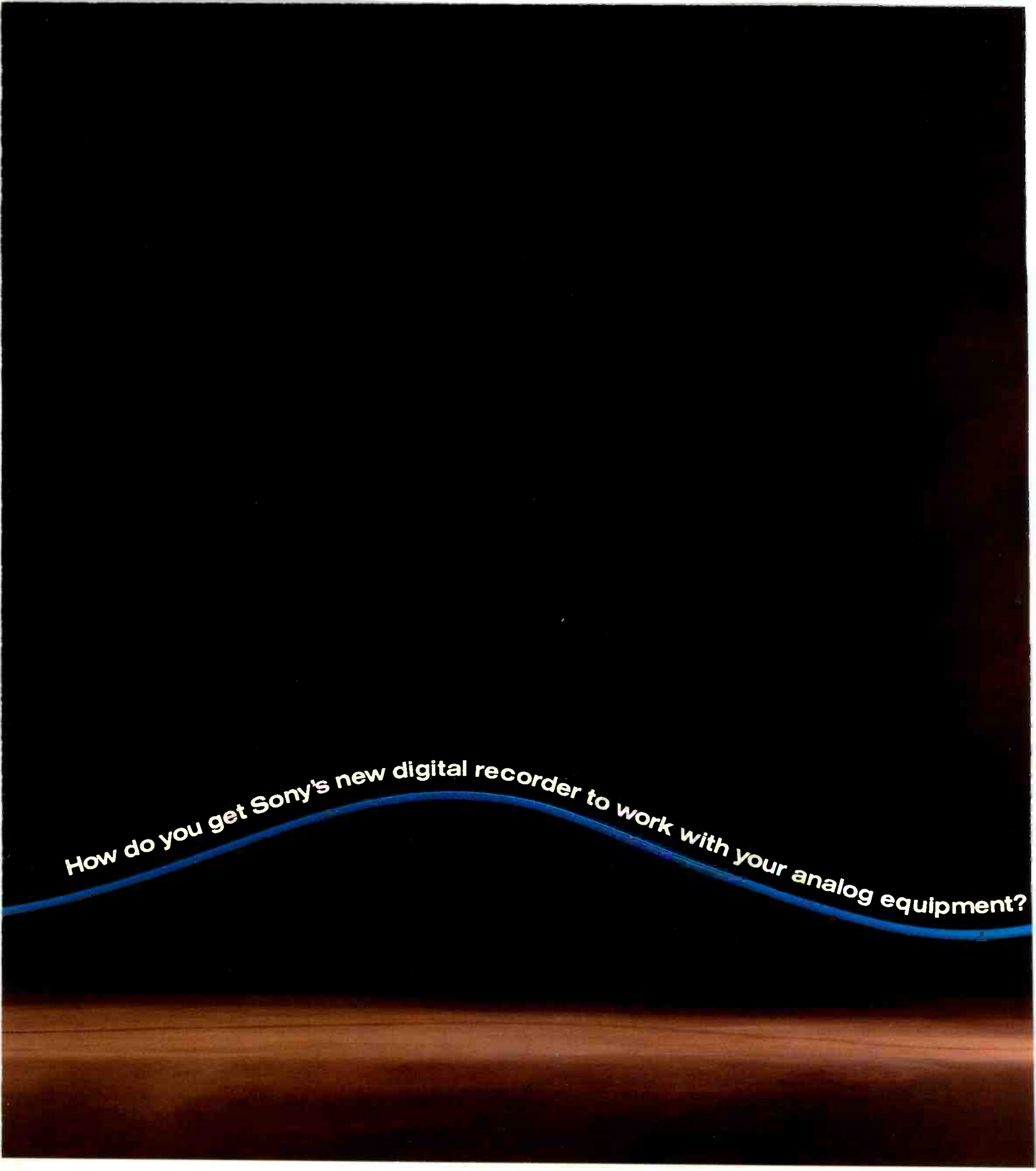
The digital paper itself is made by Imagedata, a subsidiary of the chemical company ICI. This material, a 25 μ thick Melinex polyester-based substrate covered with a layer of dye polymer, records the digital information transmitted by narrow beams of infrared laser light. According to David Owen, developments executive for storage products at Imagedata, "Chemically bonded dye absorbs energy in a narrow bandwidth, specifically the 830nm infrared wavelength of the laser. This energy, at the point where a high-intensity laser beam hits the digital paper, expands the dye and sets up a stress gradient with the surrounding material. The resulting plastic flow forms a physical pit or depression 1 μ in diameter. The thin dye in the area of the pit does not reflect light as well as it does elsewhere. For this reason, the recorded information can be read by sensing the reflection of a laser directed to the same area."

Digital paper clearly has a bright future in the areas of imaging and documentation. Data from any activity that can benefit from the maintenance of vast data files, such as satellite and other imaging, need never again be inaccessible or nonexistent due to considerations of space or expense. While the average broadcast engineer is more likely to be affected by records kept on digital paper than he is to find himself loading it into a VTR, direct studio applications are certainly possible in the future. ■

Ackerley is BME's technical editor.



Recording data on a digital paper tape.



You can slip Sony's new composite digital video recorder right into your current editing suite. With its analog inputs and outputs, it connects directly to your existing equipment.

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PHOTOS BY MONIKA ANDERSSON

Despite its reputation for high-quality production, WGBH hadn't upgraded its routing facilities since the early 1960s. A new rebuild has propelled the station into the 1990s and beyond.

BY JAMES A. ACKERLEY

This was the lowest steerage compartment of the Titanic. I had seen plenty of facilities coast to coast, and this was the worst." The speaker was Joe Anderson, manager for production services at WGBH-TV Channel 2 and WGBX-TV Channel 44 in Boston and the occasion was a ribbon-cutting ceremony held last December 16 in the station's newly rebuilt master control room. If the place had once been a disaster, there was no evidence of that now. Everywhere consoles, panels, equipment racks, walls, ceilings and floors looked more like the main deck of a newly launched QE-2 than the bilge of some rotting hulk. It was actually the scene of a great transformation both in appearance and in capability for the present and for the future.

The heart of this new facility which has risen phoenix-like from the ravages of age and neglect is a remarkable routing switcher designed by BTS with the cooperation of WGBH engineers and featuring a flat response of 0.5 dB over a bandwidth of 30 MHz. The new facility includes, in addition to the new master control room, two completely reconstructed and modernized studios and three edit suites.

The WGBH Educational Foundation in Boston is one of two main PBS production centers—the other is at WNET in New York—and as such is the source of about one-third of all PBS national programming. PBS productions have earned a well-deserved reputation for quality, but this has often reflected the dedication of the engineers rather than the environment in which they work.

Anderson recalls his first visit to WGBH some 14 years ago, "This was the worst place I had ever come to, it was a hellhole. I was working on a PBS series that required captioning. There were two one-hour programs needing 400 to 500 captions each and it couldn't be done in Hollywood without doing it piecemeal and going down a generation. This was the only place in the country that could do it. Everything in the WGBH engineering area looked like it had been set up for some kind of emergency, but the attitude of the engineers was great." Later, as the newly appointed head of production services at WGBH, Anderson set about improving the working environment of the place.

The planning phase for a complete renovation began in March of 1985 with the first money for design allocated in September of the same year. Except for layout drawings to satisfy the building code and the requirements for the necessary permits, all electrical and construction design was done in-house. Personnel resources were considerable. The WGBH Educational Foundation employs about 700 people of whom 115, including 60 engineers, work in production services—the largest single department and the technical center for WGBH.

The problem was not the number of engineers and others available for the project, but the fact that everyone involved in the renovation effort had to continue his regular duties and that all broadcast and other facilities had to remain functional amid the din and confusion of reconstruction. It is a great tribute to the overall control of the director of engineering, David MacCarn, and to the day-to-day direction of the engineering head of design and transmission, Dave St. Onge, that the work progressed smoothly and that a total of only 20 seconds of air time were lost during the entire project.

"As soon as high definition television (HDTV) technology progresses to the marketplace, WGBH will be in a position to broadcast high definition and digital television."—St. Onge, WGBH-TV

According to MacCarn, "[The project] started when I got here in March of 1985. [It's a] plan that's going to extend and extend and extend. We took all of the routing and master control in the plant [which] went back to 1963 and completely redid it. The old system had been added onto many times and an update was overdue."

Planning began when it did because money and people were then available. The old technology required heavy maintenance, also the second TV channel (WGBX-TV) had no dedicated master control switcher. Planners expanded both TV channels, making many more sources available than with the old equipment. One immediate benefit of this expansion is that WGBX-TV is now one of the few UHF stations in the country to broadcast stereo.

In regard to the design of the routing switcher which made everything else possible, the station took its specifications to several vendors. They finally selected Bosch (BTS) as being best able to meet their requirements and ended up making many trips to Salt Lake City in order to work closely with them on the design and testing of components. As a result of this close collaboration, the station requirements have become the BTS specifications for high-end routing.

The newly developed switcher is 100 x 100 in a 200 x 200 frame with 100,000 cross points. It has been added to the BTS product line as model 2001. BTS and WGBH entered into agreement to design the switcher in the fall of 1986. The video portion was delivered in March 1988 with the audio portion having been delivered earlier. Frequency response is 0.5 dB, or virtually flat, over a bandwidth of 30 MHz and only 3 dB over a bandwidth of 60 MHz. In effect, the only thing that limits the bandwidth is the cable itself.

Because all departments of WGBH must stay competitive with the market at large, the engineering department took the opportunity of the rebuild to accommodate future technological requirements. A full 30 MHz bandwidth HDTV distribution system on three channels is in now in place; when this is coupled with the BTS switcher, the station is now able to produce high-definition video signals and distribute them anywhere around the WGBH plant. Material which is produced in high definition for other clients must currently be bicycled to them. St. Onge observes that, "As soon as high definition television (HDTV) technology progresses to the marketplace, WGBH will be in a position to broadcast high definition and digital television. We are the only station nationwide that has a routing system that can handle an HDTV production signal. The technology is approaching at a rapid speed and we're ready."

Actual work began in the fall of 1986. Everything was done in-house using WGBH personnel except the carpentry work on the floors and walls which was contracted out. The new master control has 40 times more capacity for video signal distribution and over 80 times more audio capacity than the station's old system. There are 132,800 different combinations for connections of equipment throughout the station including redundant emergency connections. Concealed beneath the floors is over 23 miles of new video cable plus over 11 miles of audio cable.

The master control area consists in part of the routing switcher and two identical master control rooms, one for channel 2 and the other for channel 44. Everything in the master control rooms is brand new. In addition to items such as the microwave switcher which was designed and built in-house, each room contains a BTS model 2000 master control switcher, two Tektronix model 1750 video waveform monitors, three Ikegami 14-inch color monitors, 12 Panasonic three-inch color monitors, six Ikegami nine-inch black-and-white monitors and the equipment arsenal is filled out with two Sony model BVU 800 ¾-inch VTRs.

Other new equipment for the master control area includes a Sony model 3000 CCD camera for use as a film chain and two Betacart videocassette playback systems. The intention is to convert to full Betacam (SP) as far as local promotions and productions are concerned.

Not only has the WGBH Educational Foundation caught up with the rest of the industry, the entire facility is now in a position to move ahead of the industry in the rapidly developing areas of HDTV and digital processing. According to MacCarn, "We are looking at various projects and will probably buy some HDTV equipment within the next few months to a year. We will also look at composite digital for the next upgrade of our post-production environment."

As a nonprofit organization, WGBH is strictly accountable for the funds it expends. It chooses, in turn, to make each of its departments show a return on investment independent of the organization as a whole. The effect is that each department operates as though it were an independent company. Everything is on a strict cash basis and each department rates all users of its services even if the user happens to be WGBH or a division of WGBH.

The cost of renovating studio B was justified by the increase in revenues resulting from the simple expedient of making the studio B control room into a combination control room and edit suite.

Revenue for new equipment or renovation must be generated by the department requesting the expenditure. The new master control system had been badly needed for a long time, but it could never have come into existence if department revenues had not been sufficient to cover the expense. In the final analysis, it was Anderson's ability to manage money that made it possible.

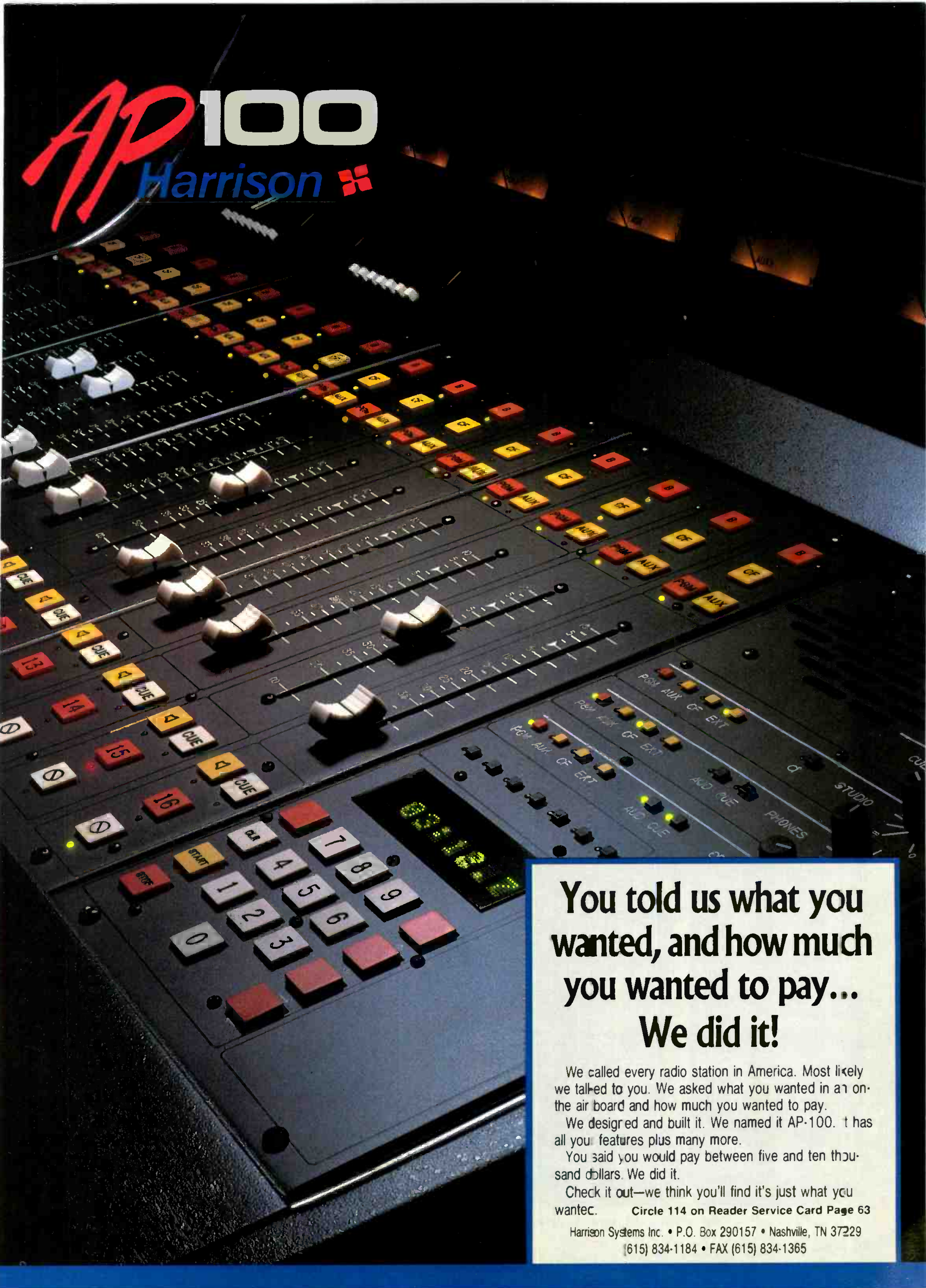
Of the various edit suites and studios, all of which were in a sad state of aging and neglect, the studio B control room was the very worst. The layout was poor, there was little space in which to move around or do work, a number of exposed cables gave the appearance of clutter and impermanence with much of the equipment dating back to the early 1960s. Studio B was clearly the area of greatest need and, as it happened, was also the area where the greatest improvement was possible and the greatest expenditures could be justified. As a result, the studio B control room has become, outside of the new master control room, the site of the WGBH facilities most dramatic broadcast chain improvement.

The entire WGBH Educational Foundation occupies some seven buildings, but because of the space requirements of the other departments, there was no way for support services to expand its space allotment. There was, however, a way to enlarge the floor area of the studio B control room. This was done by sealing off a stairway that was no longer needed. There was also a way to give both studio A and studio B access to a larger number of cameras. Camera control equipment previously shared by the two control rooms was brought from the master control room up to the second floor and divided between studio A and studio B. This made it possible to share cameras between the two studios.

The cost of renovating studio B, the expense of purchasing new equipment to replace existing equipment and the purchase of equipment not previously owned was all justified by the increase in revenues resulting from the simple expedient of making the studio B control room into a combination control room and edit suite. The increase in revenues simply resulted from post-production work being more profitable than production work and, consequently, the payback on investments in post-production equipment being greater than the payback on similar investments in production equipment.

Since much of the equipment is used for both functions and since the facility is rarely used as a control room except at night, adding the editing function was an excellent way to bring in the money to pay for both the renovation and the new equipment. At night, as a control room, the facility serves the nightly news and

Opening page: Engineer Ken Corcoran in the channel 44 master control room with his hand on the microwave switcher. Like much of the new equipment, the switcher is an in-house product. Above: BTS model 2000 master control switcher located in the channel 2 master control room.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other local productions. In the daytime, as an edit suite, it serves the needs of post-production.

In addition to the actual increase in space for studio B, the greatly improved layouts, redesigned consoles and new under-the-floor cabling provide all areas with a great deal more functional space than existed under the old system. The feeling, totally unknown before the renovation, is not merely one of adequate space but of roominess and freedom.

New equipment replacing existing equipment in the studio B control room/edit suite includes the Grass Valley model 300 digital production switcher, the Grass Valley editor, model 51, the Rupert Neve model 5114, 24 x 4 x 2 stereo console, and the Harris VWS stillstore. New first time equipment includes the Chyron model 4100 EXB character generator and the NEC System 10 digital video effects (DVE) system.

Edit suite no. 1 also has a new Chyron model 4100 EXB character generator and a new NEC System 10 DVE in addition to an existing Neve model 5114 audio production 24 x 4 x 2 mixing console, a Grass Valley model 51 editing system with 256 kB of memory and a Grass Valley model 300-2A 24-input video production switcher.

Edit suite no. 2 shares a Chyron with edit suite no. 3 and has, in addition, a new NEC System 10 DVE, an existing Central Dynamics model 9 16-input video production switcher, a Grass Valley model 51EM editing system with 2 MB of memory and a Tweed model 12/4 audio mixing console.

The new master control system had been badly needed for a long time, but it could never have come into existence if department revenues had not been sufficient to cover the expense.

In addition to a new NEC System 10 DVE, edit suite no. 3 has a Grass Valley model 100 video production switcher, a CMX model 340XP edit system with 28 kB of memory and a Neve model Kelso 10 x 2 audio mixing console.

Studio A shares six cameras with studio B: five Ikegami model HK312 and one Ikegami model 79D. Additional studio A equipment includes a Quantel DPE 5000 DVE, a Central Dynamics model CDL 480 production switcher and a Neve model 5315 24 x 4 x 2 audio console.

Other equipment distributed among the three edit suites includes seven model 528, two model 1750 and two model 1480 Tektronix video waveform monitors, five model 1420 Tektronix video vectorscope monitors and one model 1740 Tektronix video waveform/vectorscope monitor. Also in this category are 15 Sony VCRs including five model BVH-2000 Type C VCRs, one model BVH-2500 Type C VCR, three model BVH-1100A VCRs, one model BVH-1000A VCR, four model BVU-800 Umatic VCRs, one model BVU-200 Umatic VCR and four Beta machines.

The transformation of WGBH from one of the most backward to one of the most modern facilities in the nation is yet another example of what to expect when engineering excellence is supported by progressive management.

The WGBH rebuild is remarkable for several reasons. For one thing, it's a public station. While known for quality programming, public stations often don't have the budget to produce it. Although WGBH has maintained a reputation for very high-quality production, its facilities have been in poor physical condition for a long time. This upgrade has made its technical facility one of the best in the country.

The WGBH rebuild is remarkable because in all the confusion and noise of rebuilding, normal station operations continued and, over a two-year period, the station lost a total of only 20 seconds of air time and even that was lost in several small bits rather than all at once. This is better than some stations are able to do without distractions and illustrates the careful planning that went into the project.

The WGBH rebuild is remarkable because it solved the problem of inadequate space not by adding space, but by cleverly reallocating the space it had. And finally, the WGBH rebuild is remarkable because it was not subsidized by the government, or by a grant, or even by another division or department within the same organization, but was paid for by the profits from the investment. ■

These BTS power supplies provide the power to activate the BTS routing switcher.

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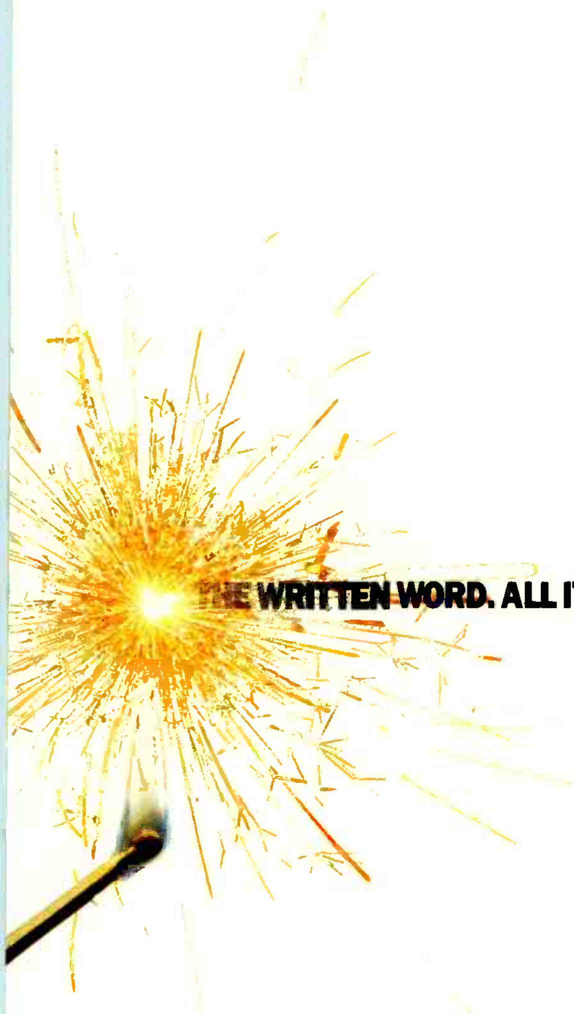

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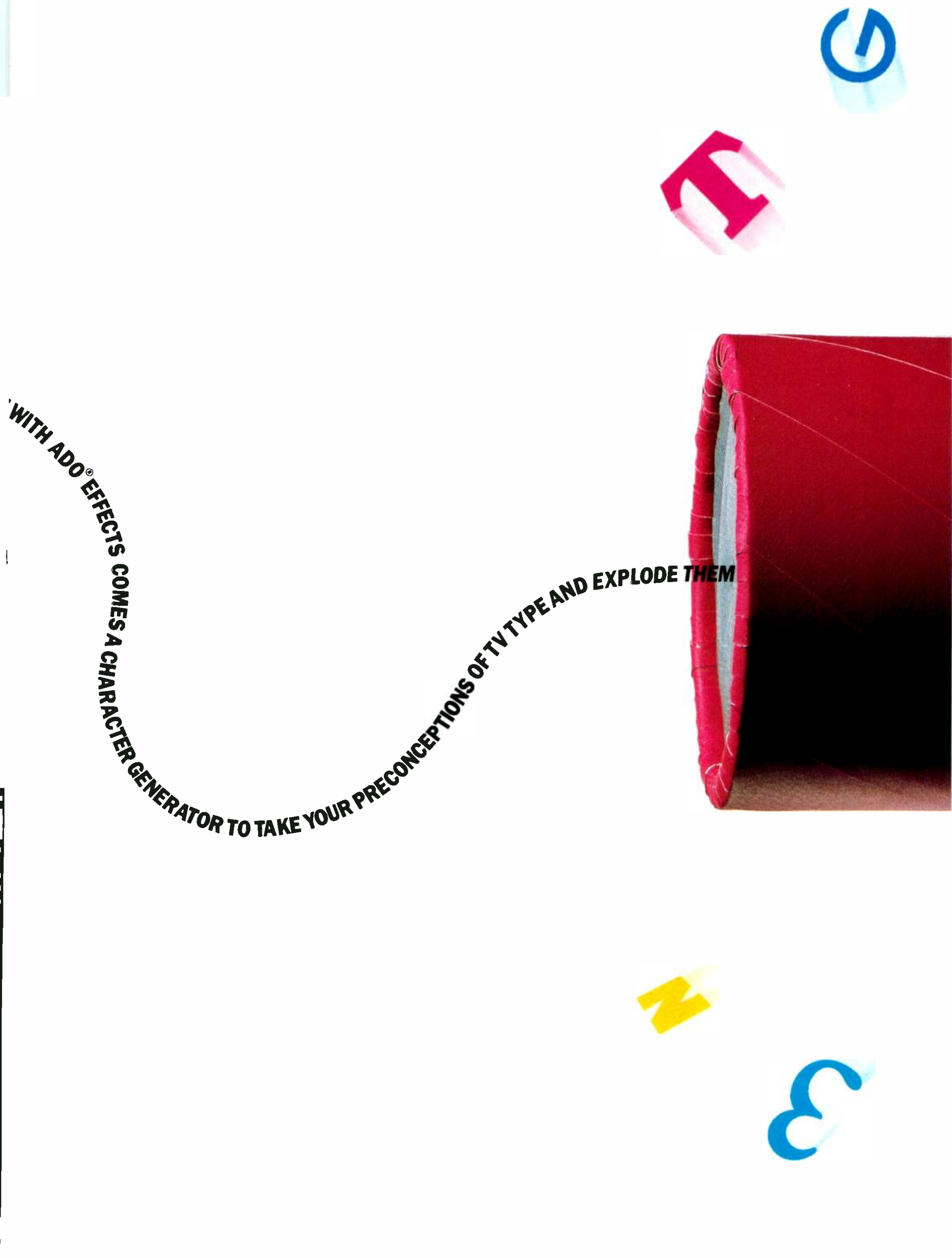
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CAVEAT: WHITE PAPER II

RECOMMENDATIONS ON AUDIO FOR THE VISUAL MEDIUM

At the onset of this decade, things were simpler. When a burgeoning audio technique caused confusion among video producers in Chicago, 10 people got together and discussed the problems over a two-month period. The result was a four-page White Paper on audio for video. But things would never be that simple again.

Back in 1982, "audio sweetening" was already a part of most producers' vocabularies. The practice was technologically mature, but procedures and equipment varied from place to place. And since terminology was nonstandard and too often misleading, producers sometimes had difficulty coordinating a project when multiple post facilities were involved. In reponse to these concerns, the Chicago Coalition, an organization of producers and services chartered to strengthen the local production environment, invited interested parties to get together to write a paper that would recommend exchange practices between video and audio facilities. After five evening meetings, representatives of the Coalition, along with four audio and three video companies, had compiled a four-page document specifying preferred exchange formats, speeds and header tones and stressing the need to communicate with other services when problems occur.

The motives of the Chicago Coalition were not totally altruistic: if these rules of order could streamline work and reduce stress in Chicago, work would remain here. Free from disputes among facilities, producers could confidently use different facilities for differing operations.

Over time, the proliferation of audio and video formats, not to mention stereo television, begat situations the original White Paper had not addressed. In late 1986, an independent committee of engineers, which would eventually be called C.A.V.E.A.T., proposed an update. The committee started with well-attended "town hall" meetings, then progressed to subcommittee field study and actual writing. The working paper was excerpted in the 1987 handbook of the International Teleproduction Society.

White Paper II on Audio for Video dramatically eclipses its predecessor in size and scope, much as the new technology has the old. Broadcasters, editors, mixers, technical managers and engineers, as well as facility owners, contributed their talents for the two-year effort.

In White Paper II, C.A.V.E.A.T. has produced an exceptional document under exceptional circumstances: competitive services in a single locality, freely giving of information and time. C.A.V.E.A.T. will continue to champion what has been honored since the first White Paper—open communication, quality in our work and pride in our industry. ■

The C.A.V.E.A.T. committee. Seated (L to R): Rebecca Albrecht, recording secretary, Optimus, Inc.; Ric Coken, executive chairman, Zenith/db Studios. Standing (L to R): George Slominski, video co-chairman, Optimus, Inc.; Patrick Garvey, recording secretary, Genesis Creative Group; Donald T. Adydan, video chairman, Optimus, Inc.; Tom Miller, audio chairman, Universal Recording Co. Not pictured: Mike Moats, audio co-chairman, Zenith/db Studios.

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All charts drawn by Matthew M. Babich

INTRODUCTION

The information that is contained in this document is representative of more than a year's effort on the part of a group of audio and video production and post-production professionals. This "white paper" is evidence of a continuing emphasis by professionals to provide clients with the best possible product available.

The technological and operational advances that have occurred in the production community, by both equipment manufacturers and users, have been extreme and continuous. With that in mind, the following is a sincere attempt on the part of the authors to establish a set of recommended standards and procedures in the use and exchange of audio materials for use with picture. The key word here is *recommended.*

From the outset it was acknowledged that guidelines could not be formulated that would require significant operational restructuring of any given facility. Instead, the focus of the group was to limit its recommendations to a) current technology that is in place and is used as part of the daily operations of a facility, and, b) professional audio for film or video that would be used as an exchange medium between facilities or as a finished release product.

For these reasons, as you read through the Recommendations on Audio for the Visual Medium, you will notice that there are only mentions of such emerging technologies as S-VHS, D1, D2, etc. These new technologies represent the newest innovations in audio and video but are not yet widespread enough in the marketplace to be considered commonplace "exchange" technologies. The authors are aware that, with rare exception, the current use of the latest hardware is probably limited to the internal operations of a facility.

The combined list of committeemen, forum attendees and supporters in kind is too lengthy to appear here, but does appear in the appendices. The committeemen would also like to extend a general word of thanks to all who gave their input and support to this effort and to you, the user, for taking the time to refer to these writings. Comments, criticisms and suggestions are encouraged and welcomed. Please send your correspondence to: CAVEAT c/o 770 N. LaSalle Street, Chicago, IL 60610.

Section I: LABELING & STORAGE

Among the items of highest concern with the committee is the ability to recover information pertaining to the conditions under which a recording was made. Concise labeling and proper storage techniques are essential steps in the maintenance and exchange of quality recorded material.

In an effort to standardize label content, it is recommended that several items regularly be included on labels for both audio and visual materials. This information, exemplified in Figures 1 and 2, can be categorized into two major areas: general and technical.

Part A: GENERAL LABELING

- Company name, address and phone number (including area code).
- Client name.
- Product code and description. Additional space can be provided by affixing a label or attaching a reference sheet to the interior of the reel box.
- Client reference number.
- Date of the recording.
- Editor, recording engineer, or company contact.
- Reel number and the total number of reels in the job or session.
- Tape recorder and/or studio used for the recording.
- Tape operator, if applicable.

Part B: TECHNICAL LABELING

- Qualification of the recording. The generation of recording should be clearly indicated. When the term "Master" is used, it should be qualified with a modifier as indicated in the Glossary of Terms.
- Format and/or tape size.
- Tape stock manufacturer and tape type.
- Type of audio recording and/or number of channels. Monaural, stereo, N-Channel element (N = number of channels) and N-Channel master are examples of types of recording; as indicated in the Glossary of Terms.
- Placement of audio signals on tracks.
- Reference or time code signals recorded and their placement, when applicable.
- Type of noise reduction used, if applicable. The appropriate reference tones should be recorded in the header when noise reduction is used.
- Use of time compression, if applicable. The corresponding original duration and re-recorded duration should be indicated on the label.
- Reference level (nWb/m) used for 0 VU. Especially applicable to audio formats.
- Type and placement of reference tone sequences. A reference tone sequence, such as the CAVEAT standard header, is used for determining operational level and frequency response characteristics of program material.

To further clarify characteristics that are unique to individual audio and video formats, the following information is recommended to be in the respective labeling categories.

Part C: FORMAT SPECIFICS

Audio Format

- Speed of the recording.
- Equalization of the recording.
- Type of digital recording, if applicable.
- Type of automation used in the mixing process, if applicable.

Video Format

- Presence of closed captioning material and placement of the encoding in the vertical interval.
- Indication if the product has Visual Time Code, sometimes called Window Time Code or Burn-In Time Code.

Figure 1 **Face label**

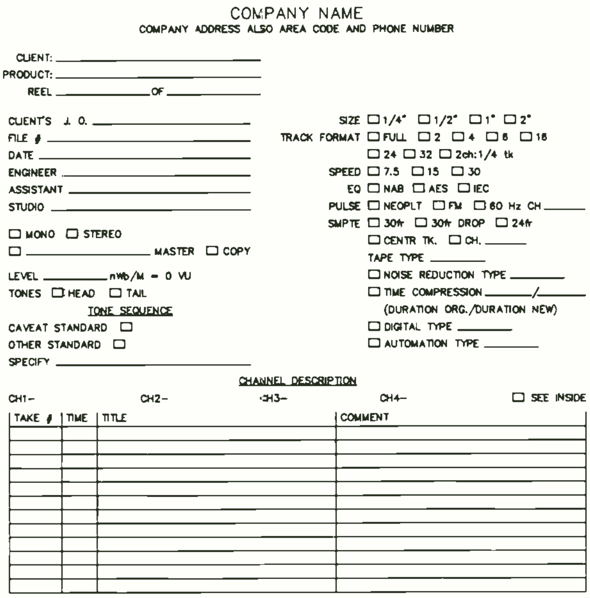


Figure 2a **Face label**

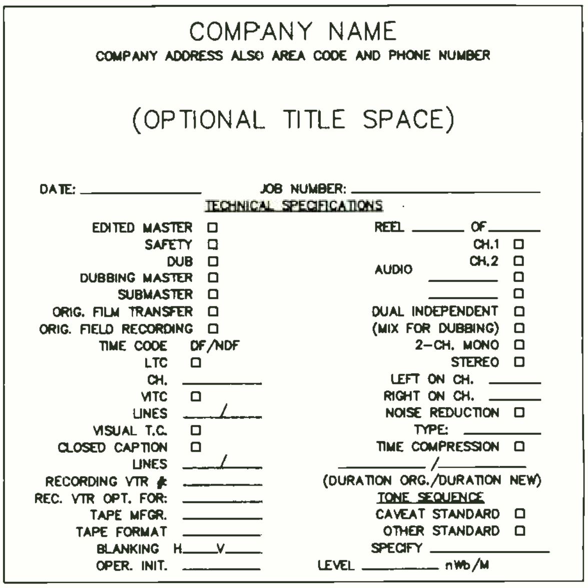
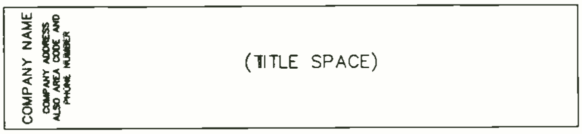


Figure 2b **Edge label**

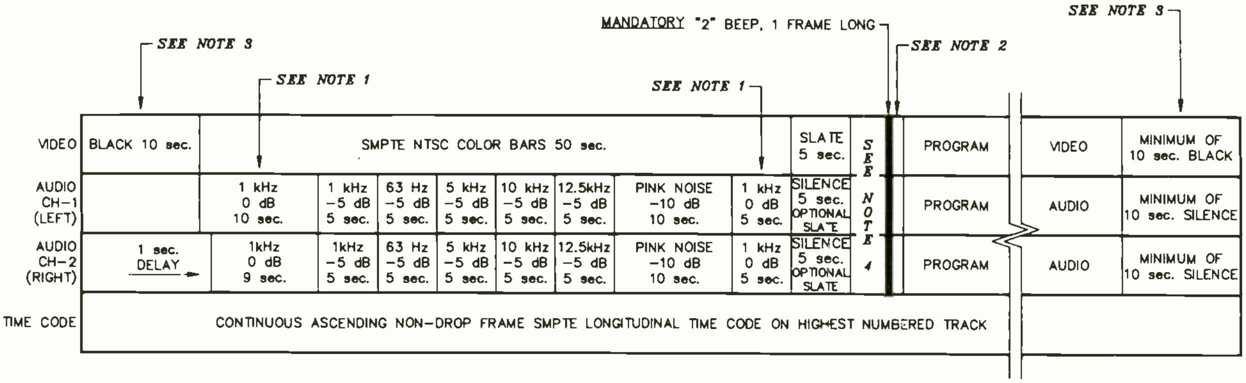


- Horizontal (µsec.) and vertical (lines) blanking measurements recorded at 4 IRE to meet RS-170 standards or 20 IRE to meet RS-170A standards.

Part D: STORAGE

- Audiotapes should be stored "tails out" to help prevent

Figure 3



NOTE 1: THE FIRST 1 KHz TONE IS FOR LEVEL SETTING. THE NEXT 5 TONES AND PINK NOISE ARE FOR CHECKING FREQUENCY RESPONSE AND PHASE. THE LAST 1 KHz TONE AT 0 DB HAS THE POSITIVE PEAK CLIPPED AT APPROXIMATELY 20% FOR POLARITY CHECK.

NOTE 2: TIME CODE AT FIRST FRAME OF PROGRAM VIDEO (FADE-UP) SHOULD BE AT XX: XX: 00: 00 (NON-DROP FRAME).

VIDEO HAS BLACK FOR 1 SECOND, 29 FRAMES AND AUDIO CHANNELS ARE SILENT FOR SAME.

NOTE 3: THE 10 SECONDS AT THE HEADS & TAILS IS WITH MACHINE THREADED.

NOTE 4: THE VIDEO COUNTDOWN SHOULD BE 3 SECONDS LONG, STARTING AT 5 AND ENDING WITH ONE FRAME OF THE 2. AUDIO WITH THE COUNTDOWN CAN BE SILENT WITH A ONE FRAME BEEP AT THE 2, OR BEEP AT EACH SECOND UNTIL THE 2.

print-through, 70 percent of which occurs during the first 24-hours of storage.

- Videotape, especially cassettes, should be stored "heads out" to avoid hub impressions.

Subscribing to the use of these recommendations will certainly aid in the best possible recovery of a recorded product. In any application however, the underlying idea should be to provide the next professionals with the information they need to do their jobs.

Section II: HEADER GEOGRAPHY

The CAVEAT Header serves several purposes. It is primarily a quality control test signal, but also serves to identify program content and how it was recorded. This header, as shown in Figure 3, contains synchronizing information between picture and sound, and is designed to be used with all audio materials intended for visual applications. By using the header, operators will be able to reassure themselves and their clients of not only good audio, but that this audio is preserved from one generation to the next.

Since the header test signal has been designed to have the same duration as the currently used SMPTE color bar test signal, the additional operating cost is nominal. The audio header consists of eight (8) test signals, a place for a slate, and a synchronizing beep. Video tapes would also include color bars, visual slate, countdown, and a synchronizing mark. The header should be recorded on all audio for use with picture.

In order to show the cumulative effect of each generation, the header should be copied each time the program is duplicated. It is important that the header be kept with its associated program material. This practice is especially important with stereo programming, due to the sensitivity of its mono compatibility.

If the header is removed or damaged, the next user cannot guarantee that the quality of the material will be maintained.

The main intent of the header is to flag the operator if something has gone wrong in the post-production process. Operators are not expected to align equipment to match each roll of tape that they receive. If, however, the header indicates that a tape is questionable, the operator should contact the source of the tape. The cooperative effort of the two companies should lead to the solution of the problem and help prevent its recurrence.

Table 1

CAVEAT Header Geography

AUDIO	LEVEL (in VU)	PLACEMENT (Channel)	DURATION (in seconds)	FUNCTION
Noise Reduction Tones	---	---	15	optional NR type ID
1.0 kHz	0	1 / 2*	10	Level set
(*NOTE: Right Ch. starts 1 sec. after left or Voice Ch. ID for 1 sec.)				Ch. identifier
1.0 kHz	-5	1 & 2	5	Equalization Check
63.0 Hz	-5	1 & 2	5	"
5.0 kHz	-5	1 & 2	5	"
10.0 kHz	-5	1 & 2	5	"
12.5 kHz	-5	1 & 2	5	"
Pink Noise	-10	1 & 2	10	Azimuth Check
1.0 kHz	0	**1 & 2	5	Level, Polarity Check
(**NOTE: Both Ch. positive sine wave top clipped approx. 20% from 0 axis)				
Slate	---	---	5	optional audio
Countdown	---	---	3 (minimum)	optional audio
1 kHz	0	1 & 2	1 FRAME	SYNC
Silence	---	1 & 2	2 sec minus Pullup	1 FRAME
Program Material	----------------------------------			
Silence	---	1 & 2	10	Runout

Part A: RECORDING THE HEADER

1) The header should be recorded on all audio materials for visual use. Its use on check copies (client approval) is optional.

2) The tones should be recorded simultaneously on all audio channels except the time code channel(s) and where noted.
3) New tones (and/or color bars) should be created when new program material is created, or when program material is altered (except time compression work).
4) The header should be copied when material is copied (including time compression work).
5) When segments are edited together, a header that is considered to be representative of the various parts should be used.
6) Multichannel film masters should include: header recorded simultaneously on all tracks, then 5-sec. segments of 1.0 kHz recorded sequentially on each channel.
7) Digital recordings should have the full header since it will be needed to check analog copies.
8) If there is no time, or tone generating equipment is limited, at the very least, tones near 1.0 kHz and 10.0 kHz should be recorded.
9) For in-the-field recordings, when no oscillator is available, the traditional tone at -8 on the quasi peak meter will at least provide a level reference. This tone can be treated as 0 on a VU meter. Any additional tones would be very helpful to ensure that adequate transfers can be made.

Part B: PLAYING THE HEADER

1) Set playback level using the first reference 1 kHz tone.
2) Observe the tones that follow: frequency response should be better than +/-2 dB at all frequencies relative to the -5 VU 1 kHz tone, and azimuth should be better than +/-30 degrees at 10 kHz. Tapes should meet these specifications when delivered to the final presenter. These specs represent an error budget that has to be shared by everyone that works with that program. Azimuth should be maintained within +/-15 degrees per generation.
3) If the tones are questionable, check the playback machine with a test tape.

If the playback machine appears to be aligned properly, then contact the facility that supplied the recorded material. A decision can then be made as to whether a fresh copy can be made available. Notifying the source of the problem tape also allows them to correct their equipment to prevent further problems.

Part C: EXPLANATION

The committee decided that since the Header Geography information supplied above may be quite different from what your facility has been accustomed to using, an in-depth explanation of how the tone series was derived would be helpful.

Noise Reduction Identification Signal:
Several types of noise reduction devices have an identifying signal. If noise reduction encoding is being used, this signal will identify which type it is, and what the reference level is. Since not all units generate such a tone, its use is optional. Therefore, it is important to refer to the labeling information to determine if noise reduction has been used. Since this tone is first in the header, it is easily omitted when a decoded copy is made; leaving this tone on a decoded copy would cause much confusion.

Level Set Tone: 1 kHz at 0 VU:
This tone represents average program level. This should match the test tape 0 VU level set tone. This is the only tone in the header that needs to be used to adjust a machine on a tape-by-tape basis. This signal will also give a clear indication of polarity match between channels.

Channel Identifier:
The level set tone on the right channel starts 1 sec. after the left channel. The channels can be identified by listening or by watching the meters. An alternate identifier is to replace the first 1 sec. of the level set-tone with individual voice announcements on the appropriate channels. The total duration of the announcements should not exceed 1 sec. Another alternative to voice announcements is one beep on the left channel followed by two beeps on the right channel. The total duration of this set of beeps should not exceed 1 second.

Equalization Check: 1 kHz, 63 Hz, 5 kHz, 10 kHz, 12.5 kHz all at -5 VU:
The first tone in the series is for the operator to pick a reference point on his meters. The next four tones will be compared to this first tone. The EQ tones are at a reduced level to assure compatibility with all tape formats. Frequencies were chosen to display typical problems such as head wear and alignment, electrical alignment, and choice of equalization standard. The high frequency is also compatible with the Altair wow and flutter analyzer.

Azimuth Check: Pink Noise at -10 VU:
This provides a quick visual and audible check of head azimuth. Errors can be seen on an oscilloscope as a fuzzy ball. If a mono sum is listened to, errors will be heard as a high frequency loss or swishing sounds. This signal may also be used for frequency response checks if a ⅓ octave analyzer is used. However, low frequency readings may not settle on many analyzers within the 10-sec. duration of this signal.

Level and Polarity Check: 1 kHz at 0 VU:
This tone is intended mainly as a level reminder following the reduced level signals. In addition, the positive portion of the waveform is clipped approximately 20 percent. This serves to identify whether or not a signal is inverted. Inversion errors are subtle if channels are matched in polarity. Recording formats are not standardized with respect to absolute polarity. Therefore, inversion errors where both channels match can be left to the final exhibitor.

Slate:
Visual and optional audio identification of program. This should be a non-ambiguous description. If material is time compressed or non-synchronous, it should be stated. A low frequency tone at a low level may be included to help identify this point on the tape when shuttling. The visual slate should be separate from the countdown. The slate can then be revised without destroying the countdown.

Countdown:
An accurate visual indication of time before program

start; optional beeps each second. When the visual countdown is taken from film, and the film frame rate is 30 frames/sec., a 24 frame/sec. SMPTE Leader should not be used. This would lead to incorrect placement of the "2" frame leading to incorrect audio sync.

Synchronization: 1 kHz at 0 VU for 1 video frame:
This signal is used to synchronize the audio and the visual portions of the program material. It allows the two portions to be processed independently and joined together again. It should be included on any audio elements with a known relationship to the picture. It should also be included on all work videocassettes. The visual mark can be anything recognizable, but has traditionally been the numeral "2".

Pullup and Runout:
This should be silent with a video black picture, thus fostering a smooth presentation. The pullup can also be used to judge noise build up.

Allowable Program Length for Commercials:
Automated spot players have a possible error of up to ¼-second when starting and stopping. Therefore, to avoid having a portion of the program cut off, the total program length should be ½-second less than the allotted on-air time; i.e. 14.5 sec, 29.5 sec, 59.5 sec. The countdown and 2 beep in the header allow audio to begin while picture is still black. However, in manually controlled systems, operators usually wait until picture is visible before a program is switched to air. This method could lead to a loss of the opening audio unless it starts after the picture is visible.

Part D: RATIONALE

The primary goal in designing the header was to create something that could be copied through all the production steps. This meant that time was limited due to duplication costs. It is now standard practice to provide 45 sec. of color bars in video duplication. If the audio header were much longer than this, duplication costs would increase. The CAVEAT header has 50 sec. of test tones. The allowable high frequency energy was limited by the abilities of ¾-inch videotape and 16mm films, due to their low velocities across the heads.

Levels were set as low as can be reliably read on machine meters. Frequencies were chosen to match those used on test tapes and in equipment alignment manuals. The tone durations were chosen so that overall levels could be adjusted, and other parameters could be observed. It was desired to have the pink noise last long enough to do a full frequency response check. However, due to the random nature of noise, to get a statistical average in the low frequency bands would require too much time. Therefore, priority was given to pure tones. They can be read quickly with standard equipment. Time constraints also led to the choice of a high frequency for wow and flutter tests.

The tone sequence is rather complicated, and will be difficult to generate manually. There is at least one commercially available tone generator (RTS) that can produce this sequence.

CAVEAT is also working on developing a Compact Disc with the header sequence. This format should be quite cost effective, considering the number of players already in place.

As of this writing, the SMPTE SMART committee is in the process of developing a leader. It will probably share the use of 1 kHz and 10 kHz tones, an NR alignment tone, and the pullup and runout pads. The SMPTE leader will not be of the same complexity and subsequently will not have the power of the CAVEAT header.

Section III: FORMATS & TRACK ASSIGNMENTS

In the interest of expediting the exchange of creative materials between facilities, the committee has developed a list of recommended exchange formats and track assignments.

Part A: EXCHANGE

As shown in Table 2, one video and four audio recording formats are recommended for the exchange of audio elements between facilities. Digital formats may also be used, but it is necessary to contact the receiving facility to choose from the variety of formats available.

Table 2

Track Assignments

FORMAT	CH.1	CH.2	CH.3	CH.4
1"C video	Stereo Left or Mono	Stereo Right or Mono	SMPTE TC (0 VU)	---
35mm mag. film/Mono	Mono (or Stripe Film)	---	---	---
35mm mag. 3-Trk. film/Stereo	Stereo Left	Stereo Right	---	---
1/2" 4-Trk. 15 / 30 ips	Stereo Left or Mono	Stereo Right or Mono	V Drive (optional)	SMPTE TC (-7 VU)
1/4" 2-Trk. 15 / 30 ips	Stereo Left or Mono	Stereo Right or Mono	CENTER TRK. SMPTE TC (250 nWb/m RMS)	---

Part B: DUBBING

Channel identity should be maintained when dubbing stereo material. When reproducing mono material, the left channel of the source should be copied to both channels of the recorder. The right channel of the source can be substituted if the left channel is flawed. The two mono signals should not be summed.

When mono and stereo versions of the same product are to be used, it is recommended that separate mono and stereo masters be produced. In dealing with the product in this manner, several advantages are gained over a mono master created from the summing of two stereo channels. A separate mono mix can be made to avoid level and center-channel build up. Additionally, high frequency cancellations may occur when stereo channels are summed. Since the mono master would be created in the same environment as the stereo version, proper attention can be given to special effects by the mixer and the client.

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Photographed at On Tape Productions, San Francisco, CA.

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How Good is Our 3rd Generation?

Part C: FORMAT COMPARISON

Many factors affect a recording channel's ability to reproduce audio. Audio resolution may be influenced by attributes such as track width, linear tape speed, tape oxides and equalization. Table 3 is representative of some of the recognized professional analog formats available.

Table 3

Recognized Professional Analog Formats

TAPE WIDTH (inches)	RECORDER TYPE	AUDIO TRACK WIDTH (inches)	LINEAR SPEED (ips)
Audio Production			
¼"	Full-Trk. Mono	.234	30/15/*7.5
¼"	2-Trk. Stereo	.080	30/15/*7.5
½"	2-Trk. Stereo	.200	30/15
½"	4-Trk.	.070	30/15
1"	8-Trk.	.070	30/15
1"	16-Trk.	.035	30/15
2"	16-Trk.	.070	30/15
2"	24-Trk.	.037	30/15
.125	*Stereo audio cass.	.023	1.875
*(Used for check copies only)			
Film Production			
16mm	Mono/edge trk.	.200	7.2 @ 24 fps.
(NOTE: at 30 fps. 16mm runs @ 9.0 ips.)			
35mm	Mono/stripe	.200	18 @ 24 fps.
35mm	3-Trk./full coat	.200	18 @ 24 fps.
35mm	4-Trk./full coat	.150	18 @ 24 fps.
35mm	6-Trk./full coat	.100	18 @ 24 fps.
(NOTE: at 30 fps. 35mm runs @ 22.50 ips.)			
Video Production			
2"	Quad.	.070	15
1"	C format	.0315	9.606
1"	B format	.0315	9.646
¾"	U-matic	.0315	3.75
½"	Betacam	.023	4.67
½"	MII	.0236	2.67

Section IV: OPERATIONAL LEVELS

The purpose of setting operational levels is to ensure that recorded audio material can be exchanged without appreciable noise or distortion.

Level Metering:

a) Average Level should be near the 0 VU value established by the CAVEAT header tone reference level. b) Peak Level should not exceed 12.0 dB above 100 nWb/m reference 0 VU level. Recorded program levels should reflect the level of the header tones recorded preceding the program. The average levels reflect perceived loudness and will not fully show program peaks. Peak levels are of particular importance due to the direct relationship of level and distortion. It is recommended that the peak level recorded not exceed the 3 percent distortion point of the tape format for more than 10 milliseconds at a time. For the 1-inch Type C format, a peak level of +12 dB above 100 nWb/m (0 VU reference level) will meet these criteria.

Metering of such parameters may be done in a variety of ways. The best recommendation for metering is to use a device in which both average and peak levels can be metered.

If the preferred metering is not obtainable, a VU meter with a peak LED indicator calibrated to 12 dB above 0 VU can be used. Peak flashing circuits (such as the one shown in Figure 4, p. 54) can generally be made easily if the meters are not so equipped.

There are in-the-field recordings and other circumstances that may prohibit either of the previously mentioned metering methods from being used. In this case, a true "VU" meter may be read using the following "meter hit" guidelines: Needle Hits @ Level

1 @ +3 VU   3 @ +2 VU   @ +1 VU

(NOTE: These numbers are not to be exceeded in any given 30 sec. time span.) In all cases, the aforementioned recommendations are designed to minimize level distortions, noise, and should maintain the highest quality in the recording process.

Section V: FIELD RECORDING

To get the best audio from field recordings, it is recommended that a double system be employed, with a separate sound and picture crew. Extra care taken in field recording will save much time and expense in post-production, as the field recording may be the primary audio in the finished production. Recommendations:

Part A: FORMAT

The preferred format for dialog recording is ¼-inch monophonic, full-track, at 15 ips, with Neopilot compatible pulse. Recording should be made using a low print-through tape. When two-channel recording is warranted, arrangements should be made with the post-production facilities to coordinate synchronizing signals, channel usage, and labeling.

Recording at 15 ips is strongly recommended over the use of 7.5 ips. Although tape consumption at 15 ips is greater, a 7-inch reel of tape will last as long as a 1000-foot roll of 35mm film, and quality levels will be maintained to the highest possible level. Having a higher writing speed, 15 ips recordings experience one half the wow and flutter errors and one third the high frequency losses encountered at 7.5 ips. Further advantages are shown by increased headroom (10 dB over 7.5 ips) and the ability to mask tape defects.

When shooting double system with video, the sync reference frequency should be 59.94 Hz, and labeled as such. There will then be one cycle of pulse on the audio for each field of picture. Sixty Hz can also be made to work, but recordings should be labeled "60 Hz audio ref. / 59.94 Hz picture (video) ref." and special care must be taken in post-production. In either case, the label should reflect both camera and audio references.

Part B: TONES

All tapes should have tones on them. Tones should be recorded at -8 as read on the quasi-peak meter on most portable recorders. This should correspond with 0 on a VU meter (as might be found on a mixer).

Usually the oscillator in the portable recorder is used to record a single tone—not enough to ensure correct playback. Inexpensive ($60) battery-powered multifrequency oscillators are available. Also, the CAVEAT compact disc (when available) can be used with a portable player to provide the same header used in studios. The use of tones is especially important when 7.5 ips must be used.

Part C: LEVEL

Peak levels, as read on the quasi-peak meter, should not exceed zero. This is in accordance with a SMPTE guideline and provides a good signal-to-noise ratio, while preventing print-through and distortion. The "-8" (peak meter) reference tone should be set to 0 VU when transferring field recordings, unless the program level is especially high or low compared to the tones.

Part D: SLATES

Scene and take numbers should be announced at the beginning of each take, and two short beeps should be recorded to signal the end of a take. This is very useful when transfers are being made.

Section VI: BETACAM & MII

Half-inch component video recording allows for a substantial reduction in tape consumption while maintaining picture quality. Unfortunately, conventional longitudinal audio recording was implemented in these recorders; the linear speeds, slow by professional audio measure, require extra care in the handling of audio. There is, however, movement towards the use of AFM and digital audio tracks in these formats which will greatly improve the audio quality.

1) Since these audio channels have a less forgiving nature than professional audio recorders, it is important to minimize generations.

2) Since Dolby C noise reduction is available on Betacam and MII, some precautions are in order: a) The expanded dynamic range provided by noise reduction allows recording at a conservative level which helps to prevent tape saturation. Since the effects of tape distortion may be magnified by NR systems, favoring headroom seems in order. b) Some recorders have switchable NR, so every cassette must be labeled as to whether or not NR has been used.

3) If mechanical or NR mistracking is encountered, an attempt should be made to play back the recording in question on the original equipment.

4) Automatic level recording (AGC) is not recommended due to the generally poor subjective quality to the sound and difficulties experienced in editing. Proper gain setting by a dedicated audio operator and double system recording are recommended.

Section VII: TIME CODE

This section is concerned with Longitudinal, Vertical Interval and windowed SMPTE Time Code; its placement and levels on recording media, relative to program material as well as recommended handling in the production process is addressed.

Recommendations:

1) The first frame of program should start on any exact minute, zero seconds and zero frames, except 00:00:00:00.

2) There will be a minimum of 30 sec. of continuous ascending non-drop frame time code preceding the first frame of program and 10 sec. of time code continuing beyond the last frame of program.

3) Do not pass through 00:00:00:00 time code.

4) Longitudinal SMPTE TC Placement and Levels

5) Vertical Interval Time Code (VITC)—VITC video levels should be between 80 and 90 IRE and are to be located on lines 16 & 18 (line 18 blanked before or during the insertion of dual mode closed captioning), or lines 12 & 14 (1-inch Type C VTR with sync head). Make sure that there are no negative excursions in the blanking portion of the video signal (0 IRE).

Table 4

FORMAT	PLACEMENT	LEVEL
2" Quad	Cue Trk.	+3 VU
1" Videotape	Ch. 3	0 VU
¾" Videotape	Address Trk. (preferred)	Saturation
	Ch. 2 (second choice)	-3 to 0 VU
Betacam & MII	Address Trk.	Saturation
Audio tape	Highest numbered trk.	-7 VU
(except Center Trk. TC machines)		250 nWb/m
(NOTE: Do not frequency modulate time code.)		RMS

6) Windowed Time Code—Windowed Time Code should always match the longitudinal TC and/or VITC time code and should always be specified in the labeling.

7) Editing and Synchronizing—Non-drop frame synchronous time code is recommended for editing and synchronizing. Each frame of code should start with the corresponding frame of picture. (NOTE: Optimally, Field 1, Line 5 should coincide with Bit 0 of the time code. Most professional editing devices will accept +¼ field error.)

8) Dubbing—When dubbing longitudinal time code, it is best to reshape the time code to ensure proper reading of the code. Do not regenerate the time code unless there are bad "spots" in the code which will not copy correctly. If regeneration is necessary, take care to ensure identical regeneration. VITC can be copied directly without reprocessing. All copies should have identical time code with reference to the original program.

9) Non-Time Code Synchronous Recordings—Pulsed tapes should have a minimum 10 sec. of pulsed pre-roll.

Section VIII: NOISE REDUCTION

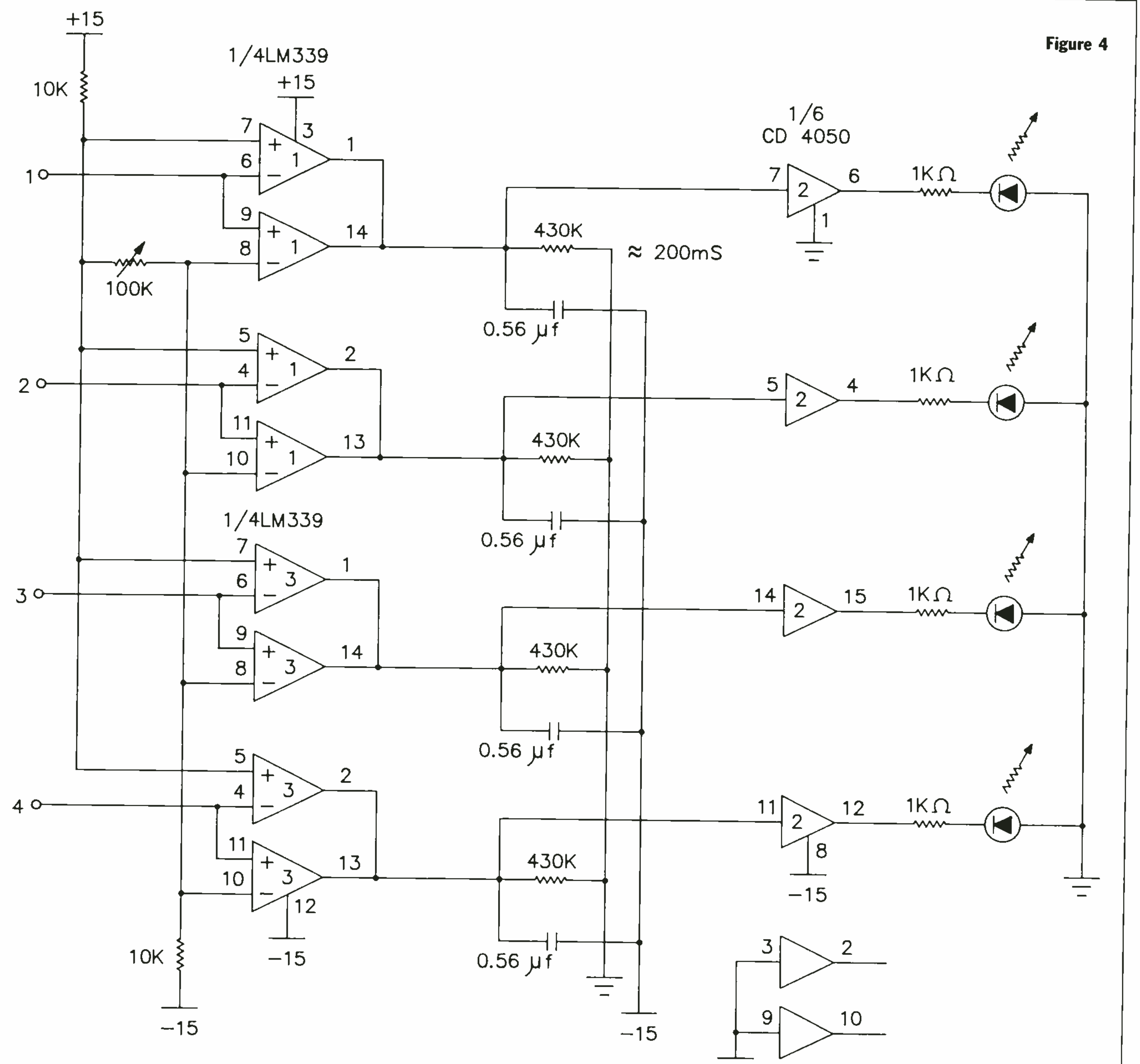
The major problems encountered with noise reduction are knowing when it has been used and what kind was used. Some types of NR have an identifying signal. Recording this signal on a tape clearly shows that NR has been used. However, when an ID signal is not available, the box label is the only way to inform people that NR has been used. There has been a problem with Betacam tapes: possibly due to poor labeling of camera controls, there have been many tapes made without any labeling information regarding the use of NR.

NR-encoded header tones would be confusing to interpret and should be avoided. Similarly, encoding a time code signal will only serve to degrade it.

When making dubs from one tape to another, the signal should be decoded and then encoded again. This process minimizes the error build up with generations; otherwise, slight level and frequency response errors in each tape machine will accumulate and cause noticeable mistracking in the decoder. This method also prevents level errors in the building's routing system from causing mistracking of the NR system.

Recommendations:
1) Calibration— NR reference level (and ID signal) should match the 0 VU header tones.
2) Application—a) NR should only be used on program material. b) NR should not be used on header tones or time code. c) Only decoded audio should be passed between equipment.
3) Labeling—a) The tape box must show what type of NR is used. b) The NR identification signal should be recorded before the beginning of the CAVEAT header. c) No NR ID tone should be on decoded copies.

Figure 4



NOTES:

1. MAXIMUM SUPPLY VOLTAGE = ± 15V.
2. PARTS AVAILABLE FROM RADIO HOBBY STORES.
3. BASED ON NATIONAL SEMICONDUCTOR APPLICATION NOTE.
4. ADJUSTMENT RANGE FROM −30 TO +20 dBm.
5. FOR 2 CHANNEL APPLICATIONS, INPUTS 3, 4 AND ASSOCIATED CIRCUITRY ARE REMOVED.

Section IX: TIME COMPRESSION

Time compression techniques were originally devised as a means of correcting the running length of finished program materials. However, their use is steadily increasing and therefore is becoming more common in the exchange of elements between facilities.

Recommendations:

1) The header tones and the "2 Beep" are to be compressed along with the program material.
2) The original running length, modified running length and the ratio should be indicated on both the slate and the labeling.
3) Since the original time code is of no value due to the speed change, new time code should be laid down starting with the first frame of program material on the exact minute, zero seconds and zero frames, when possible.

It is necessary to compress the "2 Beep" with the program audio because, though the beep will no longer be 2 sec. from the program start, it will still provide a common marker between audio and picture elements.

Section X: STEREO & MTS

This section recommends methods of recording, reproducing, and distributing stereo material for use in Multichannel Television Sound (MTS) and other stereo channel systems.

Part A: FORMAT OF CHANNELS

a) Channel 1—Left b) Channel 2—Right c) Discrete channels only d) Matrix Signals (L + R, L - R) are discouraged.

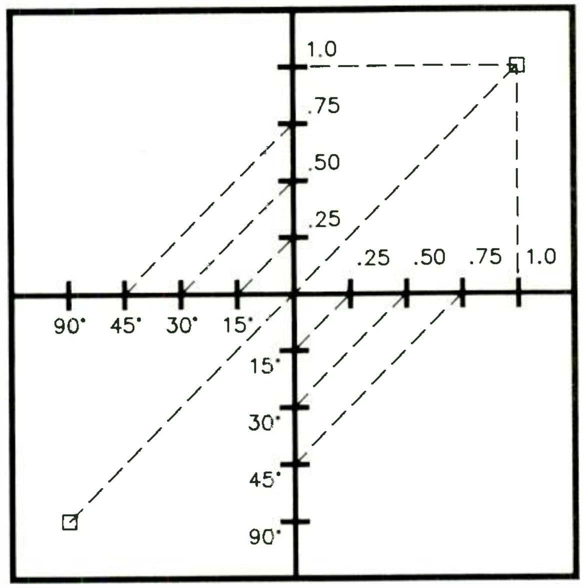
Use of discrete channels is recommended throughout facilities in order to reduce the complication of mixing and processing the audio signals. Audio channels can be easily gain compensated and combined with other material such as mono signals. Matrixed signals (L + R, L - R), although useful in RF transmission, tend to be complicated and cumbersome to distribute and record. Slight errors in phasing and/or amplitude will greatly reduce stereo separation and thus reduce the effectiveness of the stereo program. Monitoring and editing of the matrixed signal can further require costly combining networks to return the signal to its original discrete left/right formats before any accurate changes can be made.

Part B: PHASING

a) Phase errors between channels should not exceed 15 degrees per generation at 10 kHz. b) Maximum phase error on the release product should not exceed 30 degrees.

Through testing in a control room environment, pink noise and various frequencies were monitored in both discrete and mixed mono formats. In varying phase relationships between the channels from 0 degrees to 90 degrees, a perceptible loss in level was detected at 45 degrees for 10 kHz. From Table 5 (next page), this loss can be found to be .68 dB. In the interest of not creating a detectable problem, a maximum out-of-phase relationship of 30 degrees for 10 kHz was agreed upon. This phase relationship, using the formula in Table 5, produces approximately .29 dB loss in the combination of channels. Since most program material generally passes through a number of generations before

Figure 5A

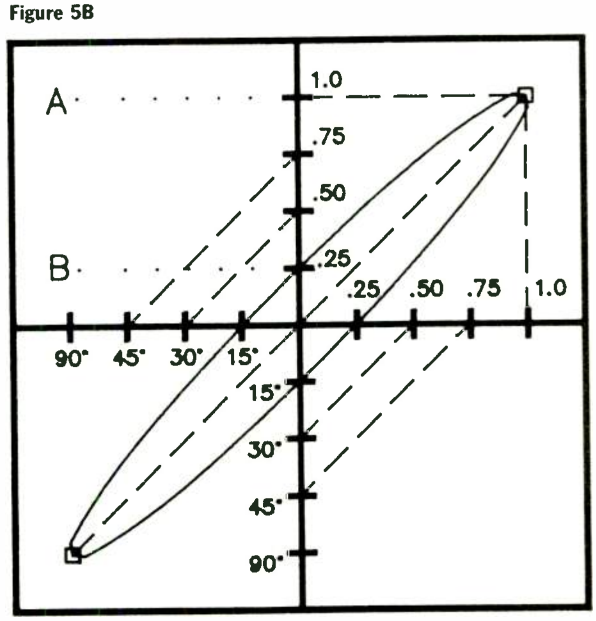


DERIVATION: $\sin \emptyset = \frac{B}{A}$

DEGREES	B/A	CORRECTED B/A FOR ROUNDING OF SIGNAL PHASE PLOT
15°	.25	.26
30°	.50	.52
45°	.75	.78
90°	1.0	1.0

MAKE GRATICULE BY SIZING OVERLAY TO SCOPE FACE AND MARKING POINTS AT 1/4, 1/2, 3/4 AND FULL SCALE HEIGHT.

Figure 5B



EX 15° PHASE ERROR BETWEEN AUDIO CHANNELS release, a 15-degree maximum channel out-of-phase relationship is recommended per generation. The additional 15-degree margin in the standard accounts for errors that may be encountered during final transmission.

Part C: MONITORING

All stereo material should be monitored aurally as well as visually for mono compatibility and stereo imaging characteristics. The use of phase scopes or application of the graticule, shown in Figure 5a, on a standard oscilloscope (X-Y feature) will quickly indicate the material's in-phase and out-of-phase channel characteristics. Figure 5b illustrates a 15-degree phase error between audio channels.

Table 5

Loss (db) at Sample Frequencies
For A Given Phase Error at 10 kHz

FREQUENCY (Hz)	15°	30°	45°
	LOSS (dB)		
1000	0.00	0.00	-.01
2000	0.00	0.00	-.02
5000	-.01	-.06	-.16
10000	-.06	-.29	-.68
12500	-.11	-.46	-1.08
16000	-.18	-.28	-1.83

$$\text{db loss} = 20 \log\left[\sqrt{\frac{\sin \phi^2 + (\cos \phi + 1)^2}{2}}\right]$$

$$\phi = 2\pi f t$$

Section XI: TEST TAPES

The objective of the committee was to establish a set of recommended alignment films and tapes for the professional formats used in the exchange of recorded materials.

Recommendations:

1) Audio Film Standards—35mm SMPTE (MF-35) 16mm SMPTE (MF-16) (NOTE: The 5 mil test films recorded at 185 nWb/m were preferred over the 3 mil test films to aid in the detection and correction of head wrap problems and overall tape path alignment.)

•If not available, use Standard Tape Labs 35mm Test Film.

2) Audio Tape Standards—MRL Alignment tapes for ALL formats. A reference level of 250 nWb/m is recommended. NAB equalization should be used for 15 ips and AES equalization should be used for 30 ips. The exception to this is 16 channel 1-inch recording, where only IEC equalization will work on all machines.

3) Videotape Standards (NTSC)—2-inch Quadruplex = Ampex and RCA Alignment Tapes (110 nWb/m)

Both manufacturers were chosen due to their interchangeable nature. Although 2-inch usage is diminishing, it is still a viable duplication and distribution format.

One-inch C Helical Reference Level = Ampex Full Trk. Audio Alignment Tape 100 nWb/m (part #1498600-03) Track Phasing, Head Height Frequency Response = Sony Alignment Tape (part #BR5-2 NTSC)

One-inch Type C helical recording is the predominant format for editing and element exchange; however, some discrepancies were found between manufacturer's alignment tapes. Therefore, different tapes have been recommended for testing specific functions.

The Ampex Full-Track Audio Test Tape was chosen for reference level as it is the only test tape that specifies flux density (100 nWb/m). This is the specified audio record level for the 1-inch Type C format.

Frequency response measurements were found to be most consistent between samples of the Sony Alignment Tape. Use of the Ampex Full-Track Alignment Tape required use of level correction factors for different frequencies. Although these were applicable to Ampex machines, the factors were found to be inaccurate on machines of other manufacturers. Frequency response is to be adjusted with the Sony Alignment Tape (part #BR5-2 NTSC).

Audio track phasing and head height adjustments are also recommended to be done with the Sony Alignment Tape (part #BR5-2 NTSC) due to the consistencies of the samples.

Three-quarter-inch U-matic = ¾-inch Sony Alignment Tape (part #RR5-4SB) 100 nWb/m

Sony and JVC alignment tapes were tested. For phasing tests, the Sony samples were consistent within 5 degrees. The JVC tapes showed sizeable errors. Sony produces the only ¾-inch test tape that specifies a reference level at 10 kHz.

MII & Betacam = Equipment manufacturer's test tapes

The respective manufacturer's alignment tapes are recommended for their specific format.

Summary

Although these findings are not definitive with regard to testing and alignment tapes, they will provide a basis for good technical testing. Adherence to these recommendations can reasonably insure a good interchange of tape and film media.

Section XII: MONITORING AND ACOUSTICS

Monitoring systems are intended to accommodate accurate and consistent judgment when auditioning audio materials. If the requirements for a good monitoring environment are optimized, the user can be confident that what is heard is what is recorded. When certain requirements cannot be met, the user should be aware that those weaknesses will limit the type of judgments that can be made.

Recommendations:

1) Signal to Noise—a) Room noise should be under NC 25. b) Maximum output should reach at least 110 dB SPL without clipping.

2) Acoustics—a) Speakers and listeners should be away from reflective surfaces. b) Speakers should be flush mounted (if designed that way). c) Listener should be at least 5 feet from back wall.

3) Electrical—a) Use short-run heavy gauge wire to connect amps to speakers. b) Use equalization cautiously. Try to treat problems acoustically. c) If using SMPTE curve, make it switch-defeatable. SMPTE curve falls at 1.5 dB/octave above 2 kHz and rolls off 6 dB/octave below 100 Hz.

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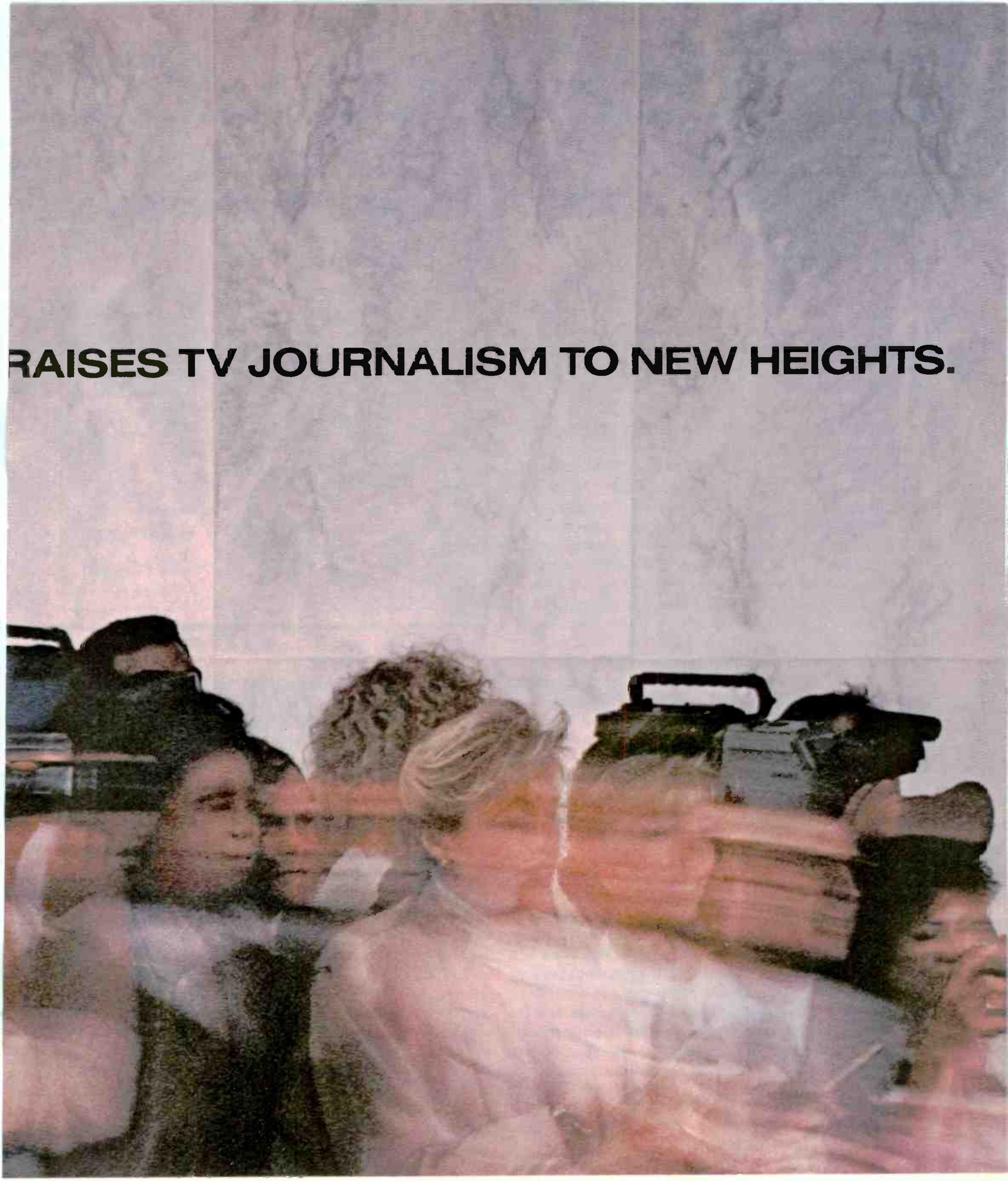

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4) Stereo—a) Speakers should be maximum of 60 degrees apart. b) Room should be symmetrical.
5) Monitoring Practices—a) Check mixes on big and small speakers at loud and soft levels. b) Check stereo material in mono and stereo over two speakers. c) Check mono material over one speaker.

Part A: SIGNAL TO NOISE

The signal-to-noise ratio of a listening room needs to exceed that of the recording medium used. The power amps should also provide more signal than will ever be required during a session.

A noise level of NC 25 is a practical level. This can be measured on meters made by Ivie, GenRad, Bruel & Kjaer and others. As a quick noise level test, if you cannot hear your fingers rubbing together while your arm is at your side, the noise level in the room is at least 10 dB too high.

At NC 25, with 0 VU set to be approximately 85 dB SPL, noises recorded at -60 VU will be audible. To achieve this environment, noisy equipment (with spinning heads or fans) should be removed from the listening environment. Audio monitoring in a machine room should be restricted to confirmation of program content, not audio quality.

A sound system should be able to achieve at least 110 dB SPL without clipping or other unwanted sounds, thus allowing material to be played reasonably loud without transients being clipped off. This measurement should be made with C weighting and the meter set to "fast" speed. The meters mentioned above, or an inexpensive SPL meter (such as can be obtained from Radio Shack), will provide this measurement. The clipping point can be determined by observing indicators on the power amp (if available), closely watching for flat tops or bottoms of the power amp output waveform on an oscilloscope, or by listening for harshness in the sound that is level dependent.

Part B: FREQUENCY RESPONSE

Several factors determine the frequency response of a room. Unfortunately, there is no real agreed-upon way to measure this response. There are three primary groups of interacting sounds that must be measured: direct sound from the loudspeaker(s), a few early reflections and the general diffuse or reverberant sound. Equipment that separates these sounds is relatively expensive and complex to interpret. Due to the complexity of the response and its measurement, the committee did not make specific recommendations on what room responses are appropriate. There are, however, several ways to control frequency response: speaker selection, room treatment and electrical treatment.

Part C: LOUDSPEAKER SELECTION

Loudspeakers should have reasonably flat on-axis frequency response and be free of resonances. They should also have adequate power handling and reliability. Several popular monitors are listed in Table 6.

There are also two categories of speakers listed: main monitors and near field monitors. Near field monitors are useful because they remove most of the effects of the room acoustics. Near field monitors also serve as an alternative reference. Due to their often limited bass response and power handling, however, they should not be counted on to completely replace the main monitors.

Some Popular Professional Loudspeakers Main Monitors

COMPANY	MODEL NUMBER	COMMENTS
B&W	808	Not appropriate for all applications.
JBL	4400	4300 series no longer series recommended.
Tannoy	S.G.M. series	New, not thoroughly tested.
UREI	800 series	In many music rooms.
	Near Field Monitors	
Auratone	SC	Standard limited fidelity reference.
Electro-Voice	EV100EL	Self-powered version.
MDM	TA2, TA3	
Yamaha	NS10	Popular in music studios.

Part D: ACOUSTIC TREATMENT

The position of the loudspeaker strongly affects its sound. Most large monitors are designed to be flush-mounted in the wall. Failure to do this can cause two problems: 1) the lack of acoustic loading from the wall will cause roughly a 3 dB drop in the bass response, and 2) there will also be a series of dips in the frequency response due to the sound reflecting off the wall behind the speaker. These notches will be at 282.5/(D N) in Hz, where D = distance to wall (feet) and N = 1, 3, 5...

Large objects close to the speaker will also cause reflections that will interfere with the frequency response. These reflections will cause a series of dips in the frequency response (known as comb filtering) just as reflections in a video cable do. Controlling these reflections can be an economical way of improving the sound of a room.

The following test will locate interfering surfaces. While playing pink noise over a speaker, have an assistant cover up possible troublesome surfaces with Sonex or equivalent sound absorbing material. If the sound at the listening position changes, the speaker or surface should be moved. Otherwise, the surface should be treated with sound absorbing material (preferably not carpeting). Owens-Corning 703 insulation is an effective absorber, but it is not as effective as Sonex at grazing angles of sound incidence. To aim the speakers, point the tweeter towards the listening position. This will provide maximum high frequency response.

The listening position should not be too close to objects that will reflect sound back to the listener. Troublesome surfaces can be treated as described above. The listening position should be at least five feet from the back wall. This will prevent sound reflecting from the wall from causing serious notches in the bass response.

If the listening position is less than five feet away from the wall, the wall should be made as sound absorbent as possible. This is difficult since most acoustic materials absorb poorly in the bass region. If Reflection Free Zone monitoring is desired, the listener should be closer to the speaker than any untreated reflective surfaces.

In general, the larger a room and the more diffusing surfaces, the smoother the frequency response of the decaying reverberant sound, especially in the bass region. The room should also be tested for flutter echoes. This can be done by walking around the room, clapping one's hands, and listening for a buzzy type of echo. These echoes not only color the sound, but will also affect speech intelligibility.

Since a comprehensive overall room treatment is beyond the scope of this paper, an acoustic specialist should be consulted if serious changes are being made to a room.

Part E: ELECTRICAL TREATMENT

There are two aspects to electrical treatment; preserving the signal and intentionally altering it. Make sure that all speakers are wired with the correct polarity. Failure to do this will result in reduced bass and lack of any phantom center in the stereo image.

The wiring between the amplifier and the speaker should be kept short and of the heaviest gauge practical. If the wire is undersized, the damping factor of the power amplifier is defeated. This results in flabby bass and increased overshoot in the speaker cones. Good speaker wire is an inexpensive way to improve the performance of a sound system.

Wire with a large number of strands is more flexible and makes better contact with connectors. To connect heavy gauge wire to equipment, it is suggested that spade lugs be soldered to the cable. This provides a reliable low resistance connection that fits all amplifiers and most speakers. Below is a table that shows the different lengths of cable that have the same resistance.

Gauge and Length Equivalents

CABLE LENGTH (FT)	WIRE GAUGE
20.0	10
14.5	12
8.5	14
5.5	16

Length and guage combinations which preserve an amplifier damping factor of 100 with 4 Ohm speakers.

After speakers are mounted and the room treated, electrical equalization may be desired. The abilities of equalizers have been widely oversold. Equalization does not fix: comb filters, deep notches in frequency response, poor sound diffusion, room reverb time, stereo imaging, sharp resonances in the room or speaker, and many other problems. EQ does control the total energy put into the room by a speaker and can be used to adjust the frequency response in one area of the room, with the risk of misadjusting the response in another area.

If an omnidirectional microphone is used in conjunction with a ⅓-octave analyzer, the loudspeaker response should not be adjusted to measure flat. Some roll-off should be expected at high frequencies. The microphone is responding to indirect sounds, as well as the direct sound. These sounds will have a high frequency rolloff dependent on the wall construction.

SMPTE has a standard for monitor system electro-acoustic response in television control rooms (SMPTE 222M). It consists of a 1.5 dB/octave rolloff starting at 2 kHz. There is also a bass rolloff of 6 dB/octave below 100 Hz. There is an overall tolerance of roughly +/- 3 dB. It was the opinion of some members of the committee that this curve included too large a rolloff. The -3 dB points of 63 Hz and 8 kHz do not reflect the response of high-quality consumer listening rooms. If such a curve is used to equalize a room, it is recommended that the equalizer be defeatable by the use of a switch.

Part F: STEREO IMAGING

The maximum recommended angle for speaker separation is 60 degrees. Angles much smaller than this will make it difficult to judge the stability of the phantom center image. Angles any larger than this may destroy the center image in the monitoring room. The 60 degree angle means that the listener and the speakers are equally spaced from each other. The speaker placement should be chosen so that the room will be acoustically symmetrical from left to right. This will ensure that the sound will not change as it is panned from one speaker to the other.

Part G: MONITORING PRACTICES

All mono material should be listened to using just one speaker at a time. An additional speaker only detracts from the sound quality. All stereo material should be checked in mono (L + R) mode. Since 90 percent of the audience is listening in mono, it is imperative that material be checked for mono compatibility. Problems such as cancellations due to polarity or phase errors, or center channel build up can be detected using this technique. When switching back and forth between mono and stereo mode, it is less distracting if two speakers are used in both modes. If a center speaker is used for mono compatibility checks, it should be the same model as the stereo speakers. All mixes should be checked on the main monitors and on a limited fidelity speaker such as the Auratone. Mixes should also be checked at a variety of listening levels. This procedure will better assure compatibility with a variety of home listening systems.

GLOSSARY OF TERMS

ALIGNMENT TAPE: A tape recorded with calibrated signals made under laboratory conditions, and checked against a standard for the purpose of maintaining equipment.

ASYNCHRONOUS: Not having the exact same rate as other units; "Wild".

AZIMUTH: The rotation of the tape or film head which adjusts the head gap to be perpendicular to the direction of the tape/film travel. This gives the best high frequency response, as well as the correct timing and phase relationships between the channels in the head (see HEAD

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WRAP).

BLANKING LEVEL: The zero signal level in a composite video signal. Below this is sync information, above this is visible picture.

CAVEAT: Concerned Audio and Video Engineers and Technicians: A Chicago-based group of professionals working to provide recommended procedures and engineering guidelines to improve the quality of audio for the visual medium (c/o 770 N. LaSalle, Chicago, IL 60610).

COUNTDOWN: A special leader, where the time remaining to program start is displayed. This has been standard practice with film, and is recommended for video as well. The film "Academy Leader" has an 8 sec. countdown, but 5 sec. is appropriate for video.

DIGITAL (AUDIO): A signal where the audio waveform is encoded into binary numbers for processing or storage. This is a robust signal that can be copied repeatedly without degradation.

DISTORTION: An unwanted change in signal. It can be classified as frequency, phase or non-linear, although usually non-linear is meant. Non-linear distortion is usually measured as harmonic or intermodulation. Non-linear distortion has an "edgy" or "grungy" sound.

DOUBLE SYSTEM RECORDING: A production method where the picture and the sound are recorded on separate machinery by separate people on separate media. This allows a higher quality recording of the sound, at higher expense. Great care must be taken to see that sound and picture remain synchronous.

DROP FRAME: (see TIME CODE)

DROPOUT: A momentary reduction or loss of signal. Usually used in reference to tape or film.

DUAL CHANNEL MONO: (see MONO)

DUBBING: 1) Making an identical copy of a recording. 2) Lip-syncing.

DYNAMIC RANGE: 1) The difference (in dB) between the loudest and softest portions of the program. 2) The difference (in dB) between the maximum permissible level and the noise floor of a piece of equipment (see HEADROOM and SIGNAL-TO-NOISE).

ELEMENT: A recording that is only one piece contributing to a finished product.

ELEMENT, N-CHANNEL: An unmixed multi-channel recording, or a submaster.

EQ—EQUALIZATION: The action of modifying a signal by amplifying with a different gain or loss at different frequencies. Equalization is also used in tape machines to overcome losses in the recording processes.

FIELD (VIDEO): One half (every other line) of a single NTSC television frame.

FLUX DENSITY: The strength of a magnetic field. In tape recording, the standard units are expressed in nanoWebers per meter (nWb/m). The standard units, however, are defined slightly differently by the ANSI and the IEC. The ANSI definition yields level readings that are .8 dB lower than the IEC definition for a given recording. The ANSI units are used by CAVEAT and SMPTE.

FRINGING: A magnetic phenomenon where the multi-channel audio head picks up signal beyond the track edges at low frequencies. Test tapes are usually made with a signal spanning the entire width of the tape, including the area between tracks. When these tapes are played back on a multi-channel head, the low frequency tones will appear to be louder than they actually are.

FULL COAT/STRIPE: Film magnetic recording stock comes in two types. Full coat stock has oxide coated across the entire width of the film. Stripe stock has oxide just in the area where the monophonic recording takes place, and a narrower stripe called the balance stripe towards the opposite edge of the film. The balance stripe provides uniform thickness, and should not be used for recording; the rest of the film is transparent.

HEADER: The leader at the beginning of a recording, before the program starts.

HEADROOM: The difference in dB, between the maximum permissible level and the reference level. In tape recording, the difference between 0 VU and the 3 percent harmonic distortion point. Headroom is roughly 8 dB with 1-inch videotape, and 12 dB with audio tape at 15 or 30 ips or 35mm film.

HEAD HEIGHT: An adjustment of a magnetic head to center a channel of the head on a track of a tape. Improper height will lead to level loss and incomplete erasure when exchanging materials on other machines.

HEAD WRAP: A rotation of a magnetic head to ensure intimate contact of the head gap with the tape recording. Improper wrap will cause a higher incidence of dropouts, and high frequency loss. When wrap is set correctly, the head wear pattern will be symmetrical on both sides of the head gap.

HEADS OUT: The tape is positioned on the reel so that the program plays without rewinding; recommended for videotape storage.

HUB IMPRESSIONS: 1) Tape damage caused by irregularities in the tape reels. 2) A physical impression made in tape which will cause recording and/or playability problems due to the irregular tape to head contact.

IRE: Institute of Radio Engineers; also, a unit of video signal amplitude. One hundred IRE equals approximately .714 V.

ITS: International Teleproduction Society headquarters are at 900 Avenue of the Americas, Suite 21E, New York, NY 10018

LEVELS (AVERAGE): A number numerically or physically arrived at by summing a number of level readings together and then dividing by the number of readings. Averaging meters will not reflect the true level of short peaks, but will respond higher than a VU meter. Averaging to sort-of-peak responding meters are often found in the audio section of VTRs, while true VU meters are often found in audio consoles and professional audio recorders.

LEVELS (PEAK): The maximum instantaneous level (see PEAK).

LINE, HORIZONTAL (VIDEO): 1/525 of a video frame; approximately 63.5 μsec.

MASTER: An original recording. Almost meaningless unless used with a descriptive qualifying term. One person's master is often the next person's element.

MASTER, DUPLICATION OR DUBBING: Can be the Edit Master or a copy of the Edit Master made specifically for the duplication process.

MASTER, EDITED: The first generation of a fully edited

videotape.
MASTER, FILM-TO-TAPE: The first generation tape recording from a film.
MASTER, MULTI-TRACK: 1) Unmixed original multi-channel recording. 2) (see MASTER, N-TRACK/CHANNEL).
MASTER, MUSIC: The mixdown of multi-track music recording or an edited version, such that it becomes a master in its own right.
MASTER, N-TRACK/CHANNEL (2-Trk, 3-Trk, etc.): A multi-channel recording made such that, if all N channels are summed, each with unity gain, the final mix will be obtained.
MASTER, ORIGINAL: A first generation recording.
MASTER, PRODUCTION: The finished recording, ready for duplication.
MASTER, PROTECTION: Preferably called a Safety. A copy of a master to be used if the working master is damaged.
MASTER, SUB: (see SUBMASTER).
MASTER, SYNC OR PULSED: The first generation of an audio tape to receive pulse or time code, which should be used for any future sync transfers.
MONO, DUAL CHANNEL: A recording where a redundant copy of a monophonic signal is placed on another channel. The primary purpose of the second channel is as a backup copy. The two tracks should not be summed together, since phase differences normally occurring between the channels might lead to high frequency signal losses.
MONO, FULL TRACK: A monophonic recording made on a monophonic ¼-inch tape recorder across the full width of the tape.
MONO, HALF TRACK: A monophonic recording made on one channel of a 2-channel ¼-inch recorder. Pulse or time code is usually placed on the other channel.
MTS—Multi-channel Television Sound: A system of stereo audio, compatible with the monophonic NTSC system. It consists of a pair of 15 kHz bandwidth channels for stereo (L + R, L-R), an 8 kHz bandwidth separate audio program channel (SAP), and a narrow bandwidth professional usage channel. A dbx-licensed noise reduction system is used to improve perceived signal to noise ratio.
NC—Noise Contour: A set of criteria used to assess the quietness of a room. Measurements of acoustic noise are made using octave-wide filters. These are then compared with the NC curves to an NC rating for the room. For a given NC rating, higher levels of noise are allowed at lower frequencies. This is to match the lower sensitivity of the ear at low frequencies, especially for audio at low loudness.
NEOPILOT: Trademark of Kudelski (see PULSED TAPE).
NEAR FIELD MONITORS: A speaker developed to be used in close proximity to the user so that room acoustics have little effect on the sound.
NON-DROP FRAME: (see TIME CODE).
NR—Noise Reduction: A system where the noise is reduced, usually through a complementary encoding and decoding process. The signal is encoded through the use of varying gain boost and equalization, in order to put the maximum allowable energy onto tape. The decoder then attempts to return the signal to its original form, thereby hiding the noise. Available types of NR include Dolby A, B, C and SR; dbx Types I and II; Telecom C4 and others.
nWb/m—NanoWebers per Meter: (see FLUX DENSITY)
OCTAVE: A musical interval spanning eight full tones. This is a 2:1 span of frequencies. Human hearing spans ten octaves. One-third octave is a ratio of 1.26:1.
OMNIDIRECTIONAL MICROPHONE: A microphone that is equally sensitive to sounds coming from all directions. A test microphone should have a maximum diameter of ½-inch to be truly omnidirectional.
PEAK METER: A meter that is of the instant recording type. An ideal meter would have an instantaneous rise time, with a much slower fall time, in order to give the eye time to read the peaks.
PEAK PROGRAM METER: A meter as defined by the IEC that has a peak response designed to match human hearing. Its response is 1 dB down with a 10 millisecond burst compared to that with a steady state tone. The response is lower with shorter peaks. This is designed to match the time it takes the ear to detect distortion.
PHASE: Used to indicate a time delay of one signal relative to another. Pure time delay will cause a phase shift that is linearly increasing with frequency. Phase shifts that are not linear are called phase distortion. Summing a delayed signal with the original one will result in a filtered version, referred to as phasing or flanging. The term phase reversal is often improperly used to mean polarity reversal (see POLARITY).
PHASE SCOPE: Form of oscilloscope having the ability to show phase relationships between the audio signals.
PINK NOISE: A random signal with equal energy in each octave. The energy distribution makes it a very useful audio test signal for checking frequency and phase response. Its random nature also makes it representative of actual program conditions. Pink noise is often generated by filtering white noise with a filter that has a slope falling at 3 dB/Octave (see WHITE NOISE).
POLARITY: The property of a signal describing whether its waveform is upright, or inverted (flipped) about its axis. Correct polarity is defined such that positive air pressure towards the microphone will create a positive voltage on pin 2 of the 3 pin XLR connector or the tip of a ¼-inch phone plug. This will in turn be amplified and become a positive signal to the speaker which will cause the cone to move towards the listener. There is also a new SMPTE recommended practice (RP 134) describing polarity on magnetic recordings.
POLARITY, RELATIVE: Polarity of one channel with respect to the other. An inverted relative polarity will destroy stereo imaging and perceived bass response.
PRE-ROLL: The time or tape allowed before the start of program for equipment to come up to play speed or to synchronize.
PRINT-THROUGH: The inadvertent magnetization of adjacent tape layers causing pre-echo in tapes stored heads out, and post-echo in tapes stored tails out.
PULSED TAPE: An audio tape with a speed reference signal consisting of a reference tone. A pulsed mono ¼-inch tape has a 60 Hz tone recorded on two narrow tracks

of opposite polarity such that the pulse is inaudible when played on a Full-Track mono audio head. A 60 Hz tone can be recorded on an audio channel on multi-channel machines. The speed reference signal can be used to dub or transfer the tape onto sprocketed film or time coded tape for editing.

RMS—ROOT MEAN SQUARE: A method of measuring level where the true power of a signal is calculated. It is usually used to specify noise signals. Short spikes or peaks in the signal have only a small effect on long-term readings. The signal is squared, the average taken, and the square root is taken (see LEVELS).

RUN-UP/RUN-OUT: The blank tape or film used for threading at the beginning and end, respectively, of a recording. No test signals or program should be recorded on it.

SAFETY (ALSO PROTECTION MASTER): A copy of an original recording. Since the quality is usually inferior to the original recording, this is not the recording that should be used in the process of finishing a project.

SATURATION (AUDIO): The recording level on analog tape where the third harmonic distortion reaches 3 percent. At high frequencies, the third harmonic would be outside the bandwidth of the recorder, so it is the level where the sensitivity of the recorder drops ½ dB (the level compression effect).

SIGNAL TO NOISE—S/N: 1) (preferred) The difference, in dB, between the maximum permissible signal level and the noise that is present while the maximum signal is present. 2) The difference, in dB, between the maximum permissible signal level and the residual noise. 3) The difference, in dB, between a given signal level and the residual noise.

SMPTE: Society of Motion Picture and Television Engineers, 595 West Hartsdale Avenue, White Plains, NY 10607-1824

SMPTE TIME CODE: (see TIME CODE).

SPL—Sound Pressure Level: A measure of the loudness of an acoustic sound, expressed in dB. 0 dB SPL is near the threshold of hearing. 65-80 dB is normal conversation level, 120 dB peaks are reached in live music, and 130 dB is the threshold of pain.

SPLIT TRACK(S): (see N-TRACK/CHANNEL MASTER).

STEREO IMAGING: The ability to create stable and believable illusionary sound sources using a stereo audio system.

SUBMASTER: A partially mixed or edited recording used to create a master.

SUMMING (OF CHANNELS): A simple electrical addition of channels, usually a unity gain, with no further processing; differs from a mix in that no gain adjustments are made during the summing process.

TAILS OUT: The tape is positioned on the reel so that rewinding is necessary prior to playing; often recommended for audio tape storage.

TAKE NUMBER: A sequential numbering of the attempts to record a given scene or segment; not necessarily the same as a track number on a specific tape reel.

TIME CODE, ASCENDING: A code where the numbering increases with time, and no numbers are repeated within a reel of tape or film.

TIME CODE, CONTINUOUS: A time code that has not been edited. The frame numbering counts in simple fashion with no jumps in numbering (except those allowed by Drop Frame) and no pauses, repeats or interruptions.

TIME CODE, DROP FRAME: A SMPTE Time Code which drops frames ":00" and ":01" each minute, except every tenth minute, to allow a 29.97 frame/sec (NTSC) frame rate code to keep a count matching real clock time.

TIME CODE, LONGITUDINAL: A code that is recorded on an audio channel; although difficult to read at slow speeds, it can be read at very high wind speeds. It can also be recorded at any time, since it is independent of the picture and audio channels. Its disadvantage is that it ties up one of the audio channels and is prone to dropouts at low tape speeds; it must be processed before it is copied to another tape.

TIME CODE, NON-DROP FRAME: A SMPTE Time Code where the frame numbering is sequential, with no dropped frames.

TIME CODE (VITC), VERTICAL INTERVAL: A SMPTE Time Code that is recorded in the non-display portion of the video picture. This code has the advantages of being readable at still frames and very low speeds, and is readable as long as the picture quality is good. It has the disadvantage that it cannot be added after the picture is recorded.

TIME CODE, WINDOW: A recording where frame numbering is visible in the television picture. This is not machine-readable code, and cannot be used by an electronic editor or synchronizer; also called Visible Time Code.

TIME COMPRESSION: A technique where the play speed of a recording is increased above the recorded speed to shorten the duration of a recording. Normally, a pitch changing device is used to lower the resultant pitch back to normal, in order to prevent a "chipmunk" effect on voices.

TWO BEEP/2 BEEP: A one frame long tone burst, using a tone of 1 kHz. It should occur 2 sec. before program start; is used to mark synchronization between audio and visual portions of a program.

V DRIVE: Vertical Drive: A pure tone with a frequency equal to the field rate. It is 59.94 Hz with the NTSC signal.

VITC: Vertical Interval Time Code (see TIME CODE).

VU METER—(VOLUME UNIT): A metering system that is intended to indicate the perceived loudness of a signal. The meter should reach 99 percent of the steady tone reading when a 300 millisecond tone burst is applied. An overshoot of 1.5 percent is allowed. There are many meters marked in VU units that do not meet the above criteria; they are often too fast and too bouncy. When in doubt, ask the manufacturer.

WOW AND FLUTTER: The speed variation of a recorder or reproducer expressed in percent. Slow changes of speed, such as an off-center record, are called wow. Faster changes are called flutter. Quad videotape-based cartridge players are notorious for having quite audible flutter if not maintained properly.

WHITE NOISE: A random signal with equal energy per unit bandwidth. This form of noise occurs naturally in transistors and resistors. ■

RADIO ENGINEERING

NUMBER SIX | SPECIAL SECTION | MARCH 1989

RDS Radio Comes On-Stream in Europe

A consortium of European radio broadcasters mounted a major demonstration of RDS (Radio Data System) capabilities at the international MIDEM Radio Conference held in January in Cannes, France. First generation RDS radios are now becoming available throughout Europe, according to the EBU RDS Program Experts Group, which made the presentation.

RDS is the result of a 15-year European research and development program to formulate a standardized system to add data to VHF/FM radio transmissions. The system was initially devised as a method for displaying the name of stations being received in order to make it easier to locate them on Europe's increasingly crowded FM waveband.

Current applications for RDS include station identification and transmission signal locking, format coding and an automatic travel information alert which also interrupts in-car cassette listening. RDS can also provide supplemental text to radio listeners via a home computer.

The standardized RDS system was developed by a group of broadcasters appointed by the European Broadcasters Union. Participants were the British Broadcasting Corp., IRT (Germany) and Swedish Telecom Radio.

MIT Professor Slams FM Stereo, FMX

The results of a joint research project between the Massachusetts Institute of Technology and the Bose Corp. call into serious question the quality of FM stereo, FMX and SCA broadcast signals in the presence of multipath distortion.

Based on a mathematical model and a field test at MIT college radio station WMBR-MIT, the results are contained in a paper called "A Theoretical and Experimental Study of Noise and Distortion in the Reception of FM Signals." It was released at a "semi-public gathering" January 25 at MIT's Media Lab in Boston, MA.

The study analyzed the effects of multipath on any analog modulation of an FM carrier. Based on a study of both FM stereo and FMX, a method of FM stereo broadcasting designed to minimize the stereo noise penalty in fringe areas, it concludes that broadcast station area coverage is decreased by the FMX system. It further concludes that FMX transmission degrades reception on existing FM stereo receivers. The study also states that FMX receivers are inferior to existing FM stereo receivers for receiving FMX transmissions.

"The FMX system was originally designed to improve a second order problem of the existing FM stereo system," said Dr. Amar Bose, who is a professor at MIT. Bose is also chairman of the privately held Bose Corp., a manufacturer of consumer high-fidelity products. The Bose Corp. is also an OEM joint-venture partner with car stereo manufacturer Delco Electronics. The partnership supplies car stereo systems to General Motors Inc., and to Nissan, Audi and Honda. The FMX system was not "singled out" for special examination but offered merely as "an example," Bose said.

"Nothing in their mathematics reflects the FMX equation," said Emil Torick, president of Broadcast Technology Partners, Greenwich, Co. "Lord Kelvin had a mathematical model that proved heavier-than-air machines couldn't fly." BTP was formed to license and develop the FMX system when the CBS Technology Center, which originally developed it, was closed in 1986. Executives of BTP were granted special permission from the Office of the President of MIT to attend the presentation and participated in a bitter Q&A session. "This is an impediment and a distraction to our efforts," Torick said, "but there is so much merit in FMX that we believe it will succeed regardless of what Dr. Bose says."

Over 100 commercial and educational FM stations are currently committed to broadcasting in FMX. Both JVC and car stereo maker Alpine launched FMX products at the Winter Consumer Electronics Show early in January; FMX ICs are made by Sprague and Sanyo. Motorola recently announced manufacturing plans.

The timing and content of the presentation has aroused industry speculation that new receiver products incompatible with the FMX system may be in development. "If FMX doesn't work, it will die on its own," said one industry analyst. "It's SCA that needs to be throttled—why didn't they examine that?"

BTP says it is developing its own data and will rebut the Bose/MIT study shortly. ■

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IMPROVED R-ENG USING DIAL-UP LINES

The economics of R-ENG and other radio remotes has changed dramatically since the AT&T divestiture. Using frequency shifters to improve the fidelity of dial-up lines can save time, money and audio quality.

BY SKIP PIZZI

The changes to the broadcast industry brought about by the divestiture of AT&T caught many by surprise. Immediate program circuit rate increases of 300 percent or more were common. Installation charges soared as much as 1000 percent. Subsequent hikes made matters even worse.

It didn't take long for the effects of this cost-spiral to reach the airwaves. Fewer remotes (or "outside broadcasts" [OB]) and more dial-up audio were its symptoms at most stations. More RPUs were put into use by broadcasters able to license and afford such an investment, primarily in locations where terrain wouldn't preclude their use. In many markets, however, RPU frequencies are shared. This reduces their flexibility, especially at breaking news events.

Compromise resulted in greater reliance on the dial-up system for audio feeds. Service area was almost universal, no lead time was required in most cases and costs were minimal. But audio quality suffered terribly due to reduced bandwidths, higher distortion and greatly increased noise.

The recent development of the cellular telephone and bandwidth extension systems reduce the various compromises broadcasters must make in the R-ENG/OB matrix. But these have also increased choices which must be made. (Table I)

Bandwidth extension systems are an interesting and elegant method of squeezing the most audio quality out of the dial-up network. Three manufacturers currently make up the marketplace, which is an area that is still developing. All three share relatively similar techniques in accomplishing their objective, to wit, wider frequency response and in some cases lower noise levels than dial-up transmission. Add to this quality improvement AT&T's recent decision to cut back inter-city terrestrial service drastically and these devices become even more valuable.

Bandwidth extension systems utilize an encode/decode approach, shifting frequency bands on the transmit side and unshifting them on receive, via a single-sideband suppressed-carrier heterodyning process. This is set up so that the actual frequencies that pass through dial-up phone lines can extend beyond their typical one decade (300 to 3000 Hz) response. Of course, the lines' response isn't really changed. Rather, their cutoff frequencies are, in effect, moved, thereby widening frequency response subjectively when perceived by the human ear. A typical single-line system will upshift audio by 250 Hz on transmit and downshift by the same amount on receive, so that the effective bandpass of the line is 50 to 2750 Hz. Note that although the bandpass is still 2700 Hz wide, the low frequency cutoff has been extended by nearly three octaves, at the expense of a one-sixth octave loss on the high end.

For applications that don't require real-time feeding or live airing, a single-line frequency shifter can be of even more value when used with "half-speed transmission." Here, a recording is made in the field, then played back through a frequency shifter at half its original recording speed. At the receive end, this half-speed audio is shift-decoded and recorded, then played back at double-speed. This provides a single octave tradeoff in the bandpass of the line, gaining an octave on the high end while losing one on the low end. Trying this without a frequency shifter on a dial-up line provides unacceptable results, due to the low-frequency cutoff of 600 Hz. With the additional octaves on the low end that frequency shifting provides, however, there is more than enough energy to spare an octave there in order to gain one at the high end.

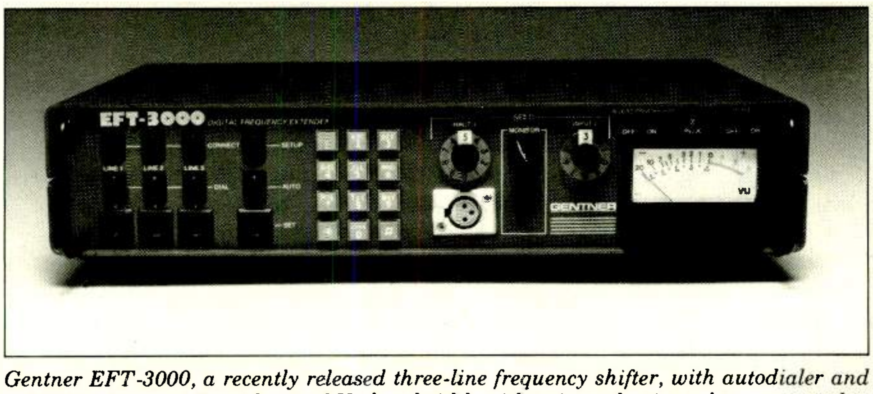
Remember that the more subjectively important high end is not extended by a single-line frequency shifter. With half-speed transmission, the 50-to-2750 Hz bandwidth of the frequency-shifted line translates to 100 to 5500 Hz. Note that this approximates the response of a 5 kHz program circuit and provides a much better tonal "balance" to voice transmissions than does the real-time frequency-shifted approach. Since adding low end to a dial-up line without proportional high end increase may in fact do more harm than good, some users will only use single-line shifters when half-speed transmission is also possible. (An old guideline from the early days of telco is the "Rule of 400,000," which states that in bandlimited conditions, to maintain the proper tonal balance required for optimum intelligibility, any two cutoff frequencies selected should provide a constant product of approximately 400,000, just as the 20-to-20,000 Hz bandpass of human hearing does.)

Of course, feeding at half-speed requires twice the call-time, which will increase costs for time-sensitive long-distance feeds. Technical personnel time is also increased, both by the longer length of the call, and by the additional listening/audio processing required as a separate second step, when the tape is played back at normal (i.e. double) speed. A useful tip for half-speed transmissions is to do a quick trial recording and double-speed playback of the first few seconds of the feed to determine what the audio quality will really be like before spending the entire half-speed feed time potentially for naught. Also advisable is some low-pass filtering of the final product before airing, since phone-line noise (the only thing recorded at "real-time" in these feeds) always sounds worse when played back an octave higher. Since such noise is not Gaussian ("white") in distribution but rather exhibits a parabolically rising function, it can be of serious consequence to these feeds. It must therefore be carefully monitored and filtered as necessary on playback.

	Hardware Cost	Usage	Service Availability	Audio Quality	Comments
Dial-Up	minimal	low	high	poor	1
Cellular	moderate	moderate	very high	poor	2
RPU	high	moderate	very high	high	3
Telco Ckt.	minimal	high	moderate	high	4
Freq. Ext. Dial-Up	moderate	low	high	mod./high	1,5
Satellite	very high	high	low	high	6

Comments:
1) Remote site must be on dial-up network.
2) Remote site must be within cellular operator's service area.
3) Remote site must be in line-of-sight from receive antenna. Usage cost typically includes technical—staff and may include vehicle maintenance and operating expenses.
4) Usage costs vary widely with class of service and installation fees; advance notice required.
5) Multiple dial-up line access must be available at remote site for high- quality real-time transmissions.
6) Remote site must be connected to earth station or a portable uplink. U/L must be capable of illuminating proper satellite, using proper xmsn. format.

Table 1: *R-ENG/OB transmission methods: a comparison.*

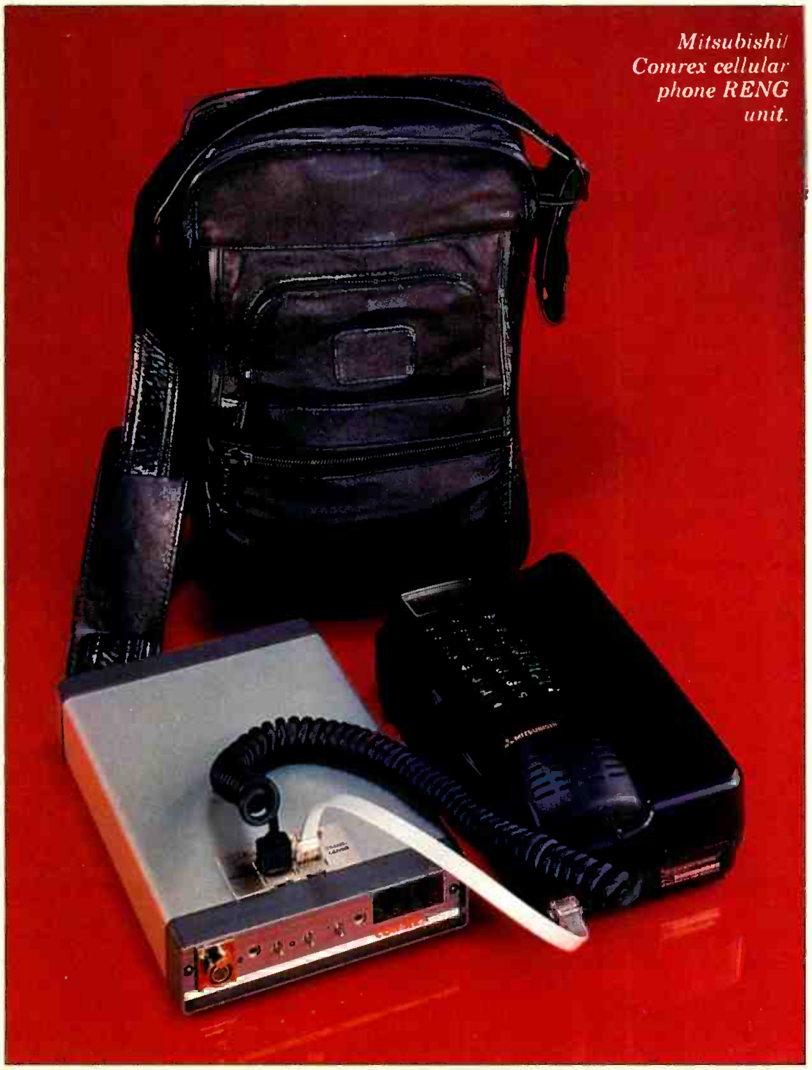


Gentner EFT-3000, a recently released three-line frequency shifter, with autodialer and autosetup features. Provides 7.5 kHz bandwidth with noise reduction when connected to another EFT-3000 by three dial-up phone lines.

Steeply bandlimiting (18 dB/oct.) the incoming feed at 300 to 3000 Hz ahead of the decoder can provide a major improvement as well.

Record and playback equalization anomalies on tape recorders are encountered when recording at one speed and playing back at another, but with telephone audio and at these bandwidths, it is a fairly negligible problem.

More recently, dual-line frequency shifters have been developed. These devices use two phone lines, one operating as in the single-line system, with the second used to downshift higher frequency audio on the transmit end, upshifting it on receive. In this case the "upper line's" 2700 Hz of bandwidth are used to pass audio extending above the lower line's cutoff, typically by downshifting it by 2000 Hz. This means that the upper line will effectively pass 2300 to 5000 Hz.



Mitsubishi/ Comrex cellular phone RENG unit.

CELLULAR R-ENG

The cellular telephone provides another powerful tool for R-ENG. Recently interfaces have been developed specifically for feeding audio via cellular phones. They are essentially breakout boxes or adapters that allow audio inputs from external devices for transmission; they also provide an audio output from the receive side of the cellular phone. Since the cellular system is "four-wire" end to end, hybrids are not necessary in these interfaces. These units are typically installed between the handset and the transceiver of a transportable cellular phone, where a modular connection is commonly used. Phones without modular connectors here may also be adapted. The typical interface also mutes the handset microphone, so that its output is not mixed with the audio feed during transmission.

There are a few caveats regarding cellular R-ENG. First, audio quality may not be as high as on the dial-up network, especially near cell edges. Although noise may be a problem, dropouts are the more common offenders. Level and noise variations may also occur. These level changes can occur whenever a cell changes, and for this reason cellular phones are unsuited for the very level-critical multi-line bandwidth extension systems. Cell changes can occur even from a stationary source due to reflections caused by large moving objects nearby, such as trucks, buses, trains and aircraft. Single-line frequency shifting, both with and without half-speed transmission is quite feasible, but noise and dropouts may still occasionally interfere; in the half-speed case, such problems may not be evident until after the fact, when the receive-end recording is played back at full speed.

In this way, dual-line systems can provide bandwidth equivalent to a 5kHz line on two dial-ups in real time.

Careful design and steep filtering is required to insure that little or no common energy is carried on both lines, since significant phase differences between lines is routine in the dial-up network.

Typical time differences between dial-up lines are 50 ms or less, as long as they are both either terrestrial or satellite-delivered calls. Such differences are of no great audible consequence in a timing sense but they could cause phase cancellation among commonly carried frequencies. Thus the nature of the crossover network here is critical. In the case of dialing two lines and coming up with one satellite delivery and one land-line (an increasingly rare occurrence), redialing will eventually provide an appropriate pairing.

Use of the 10XXX alternate long-distance carrier code before dialing can help in this case. Every long distance service (LDS) has been assigned a three-digit code [XXX]; using it enables the caller to replace the default LDS on a phone line with his choice of service for that call only. Dialing 10XXX-1-[AC]-###-#### routes the call via the LDS selected, and billing is automatic regardless of whether the calling location has an account with the carrier. Although it may take some time, a station will eventually receive a bill, either included with the local phone bill or directly from the LDS. Common LDS

For More Information

For cellular interfacing equipment, contact:

Neal Davis, Broadcast Services Co.
Four Oaks, NC (919) 934-6869
Lynn Distler, Comrex Corp.
Acton, MA (800) 237-1776

codes are AT&T = 288, MCI = 222, US Sprint = 777.

Level matching between lines is important in two-line systems. Each manufacturer has devised a set-up to deal with level matching. Popular methods usually involve test tones generated by the transmit unit augmented by trim pots and metering for alignments on the receiver. Because of the wider bandwidths involved in two-line systems, line noise becomes even more of a problem. For this reason, these systems typically employ some form of multiband companding for noise reduction. The level setup mentioned above is also used to align the compander system. Dual-line systems may also be used at half-speed, again gaining an octave on the high end at the expense of one at the bottom, thus providing a 100-to-10,000 Hz response. On very noisy lines, however, and especially with program audio that has low ambient noise levels, half-speed transmission can reveal companding artifacts (noise pumping) that would typically be masked at real time. Caution must be excercised in these cases. And at these bandwidths, the record/playback equalization differences of the two different tape speeds can become more audible, as well. Again, bandlimiting both lines to 300 to 3000 Hz ahead of the decoder is highly recommended.

A new generation of three-line frequency shifters is also becoming available. These operate in a similar manner to the two-line units but offer bandwidths of 7.5 to 10 kHz according to their various manufacturers. Again, multiband companding is used to reduce line noise. The complexity of dealing with three lines has given rise to the need for some automation.

For live-to-air remotes, a communications circuit, "backfeed" or IFB (interruptable foldback) is usually required. Generally, this just involves the use of a dial-up line at the remote location, which is not too much of a problem when using traditional methods for feeding audio to the station. But when two or even three dial-ups are used for the audio feed, incoming phone circuits and hardware at the remote site can quickly become scarce. Some bandwidth extension hardware solves this problem by allowing the use of one line bidirectionally through the use of hybrids on both ends. But even in these cases a separate backfeed line is still more convenient if the remote site equipment can accommodate it. ■

For More Information

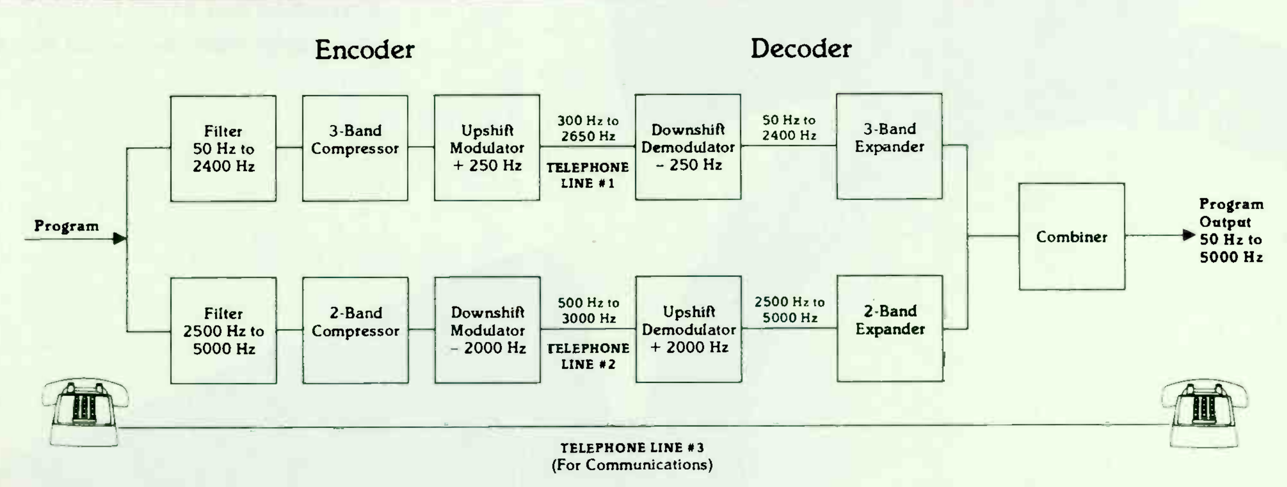
Contact the following people for details on bandwidth extension:

John Cheney
Comrex Corp.
Acton, MA
(800) 237-1776/(617) 263-1800

Gary Crowder
Gentner Electronics
Salt Lake City, UT
(801) 975-7200

Marty Jackson
Rood Megatronics, B.V.
c/o Marcom, Inc.
Scotts Valley, CA
(408)438-4273

For more information on wideband linear frequency shifters, see: "A Five-Band Companded Technique for Converting Telephone-Quality to Broadcast-Quality Using Two Voice-Grade Phone Lines," by Daniel B. Talbot and John F. Cheney, *Journal of the Audio Engineering Society*, Vol. 34, No. 10, October 1986.



Typical two-line bandwidth extension system block diagram (courtesy Comrex Corp.).

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DESIGNING EFFICIENT MEDIUM-WAVE TRANSMITTERS

RF efficiency is an important component of cost-effective station operation. Digital modulation techniques can improve operating efficiency by one-third.

Overall AC to RF efficiency of a high-power medium-wave broadcast transmitter contributes significantly to—or detracts from—a radio station's profitability. Depending on a station's electricity rate and the power level of its transmitter, an efficiency increase of even a few percentage points can easily trim thousands of dollars a year from a station's power bill.

Since 1967, pulse duration modulation (PDM) has become the standard technology in virtually all medium-wave transmitters. Typically a PDM tube-type transmitter has offered top overall efficiency of about 65 percent. A PDM solid-state transmitter will generate about 73 per cent.

When combined with other design considerations, a new digital modulation technique developed by Harris Corporation can result in typical overall AC to RF efficiency of 86 per cent. Called Digital (Quantized) Amplitude Modulation, the proprietary technology renders the transmission system nearly transparent to input audio. The new transmitter designs also greatly improve frequency response, harmonic and intermodulation distortion, squarewave response as well as IQM.

The technology has been employed in the Harris DX series of 10, 25 and 50 kW medium-wave transmitters.

Why do digital modulation and other design considerations so significantly increase overall efficiency? We will address this question by comparing a typical 50 kW PDM solid-state transmitter with a 50 kW digitally modulated model.

First, a number of factors determine the efficiency of any device, which is defined as the output power divided by the input power: N = Po/Pin. The input power is equal to the output power plus losses in the device: [N = Po/(Po + Pd)] where Po = power out, Pd = power dissipated in the device, and N = efficiency.

In a transmitter where power flows through many devices in series, net efficiency is the product of each device's efficiency, i.e.: N net = N1 x N2 x N3...Nn. Devices normally found in an AM transmitter include:

a. High-voltage power transformer
b. Rectifiers
c. Filter choke
d. Wiring to the modulator and RF amplifiers
e. Modulator, including modulation transformer, or PDM filter components, PDM damper diodes, etc.
f. RF power amplifiers
g. Combiner (losses may be repeated several times in some transmitters)
h. Output filter/matching network.

Still other efficiency losses in a transmitter occur in the control circuits, drivers and cooling system. For example, the efficiency of motors in the cooling system can vary between 60 percent and 90 percent depending on whether they are a shaded pole single phase or high-efficiency three phase design.

In the case of a typical solid-state PDM transmitter (Figure 1), overall efficiency—the product of each device's efficiency—is: (transformer N) (rectifier N) (filter choke N) (modulator N) (PA N) (first combiner N) (second combiner N) (output N) = N, or: (.95) (.98) (.99) (.94) (.92) (.98) (.98) (.98) = 75 per cent.

Additional power loss in the control circuits, drivers, cooling, etc. can be expected to reduce overall efficiency by about two percent, resulting in a net overall efficiency of approximately 73 percent.

A modulator typically exhibits 94 percent efficiency in 50 kW PDM transmitters; a digital transmitter increases efficiency by eliminating the

BY NICHOLAS G. RICHARDS AND HILMER I. SWANSON

TYPICAL SOLID-STATE PDM TRANSMITTER EFFICIENCIES

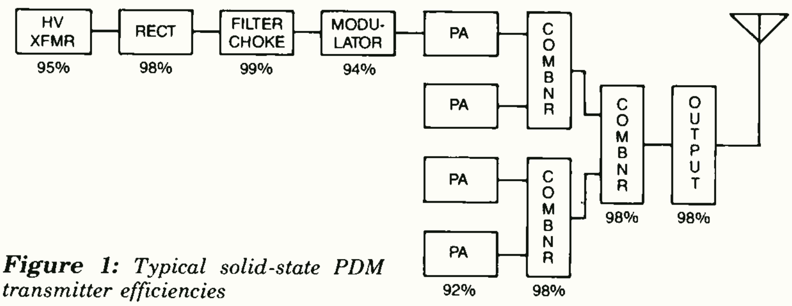

Figure 1: *Typical solid-state PDM transmitter efficiencies*

modulator (see Figure 2).

In brief, digital amplitude modulation design replaces the modulator with a high-speed 12-bit analog-to-digital (A/D) converter, a digital modulation encoder and a powerful digital-to-analog converter. This produces an amplitude-modulated carrier with a quantized envelope.

As used in radio broadcasting, an AM signal is a constant frequency rf signal whose amplitude varies with the audio input signal. The digital modulation process for this signal takes place in four steps. First, the modulating audio signal is processed to provide an output signal that determines both the carrier power level and the modulation level of the transmitter. Second, the audio signal is converted into a digital data stream sampling the audio at the carrier or submultiple of the rf carrier frequency. Third, the digital data from the converter is encoded to provide digital control signals to 42 of the 48 rf power amplifier modules needed, for example, for a 10 kW transmitter. Finally, the digital output of the modulation encoder switches individual rf power amplifiers on and off.

Amplitude modulation is produced by switching on only the number of rf power amplifiers needed to provide the transmitter rf power required at any instant. In a digitally modulated transmitter, the rf level at the transmitter output is changed by switching on either a larger or smaller number of rf power amplifiers, which are combined to produce total output. A ferrite power splitter provides equal amplitude, equal phase drive to the power amplifiers.

In detail, the rf power amplifier section consists of 48 rf amplifier stages for a 10 kW transmitter. Since 48 equal steps are not enough to reproduce the modulation envelope accurately, binary weighted steps are used to obtain the required resolution. The 42 amplifiers controlled by the modulation encoder are called "big steps" and each contributes an equal voltage to the combined output. The "binary steps" (bits 7, 8, 9, 10, 11, 12) are controlled directly by the A/D converter and contribute 1/2, 1/4, 1/16, 1/32 and 1/64 of the "big steps" respectively. The rf amplifiers are essentially constant voltage sources whose outputs combine in a multiturn primary, single secondary ferrite combiner to form an amplitude modulated carrier with a quantized envelope. This quantized AM waveform is then filtered by a bandpass network to remove unwanted spectral components.

Note that the power output from each amplifier stage is not constant, but depends on the total number of amplifiers or "steps" that are turned on at any given time. The maximum power output (for a given number of rf amplifiers) is limited by the current rating of the rf transistors.

Each of the identical and interchangeable RF power amplifier stages in the digitally modulated 50 kW transmitter is a Class D switching amplifier with four power MOSFETs in a bridge configuration (Figure 3).

Transistors Q1 and Q4 are driven 180-degrees out of phase to transistors Q2 and Q3. The amplifier output is coupled to the output combiner via transformer T3. During one-half of the RF cycle, transistors Q1 and Q4 are driven into saturation (on) while Q3 and Q4 are in cutoff (off), and dur-

DX SERIES SIMPLIFIED BLOCK DIAGRAM

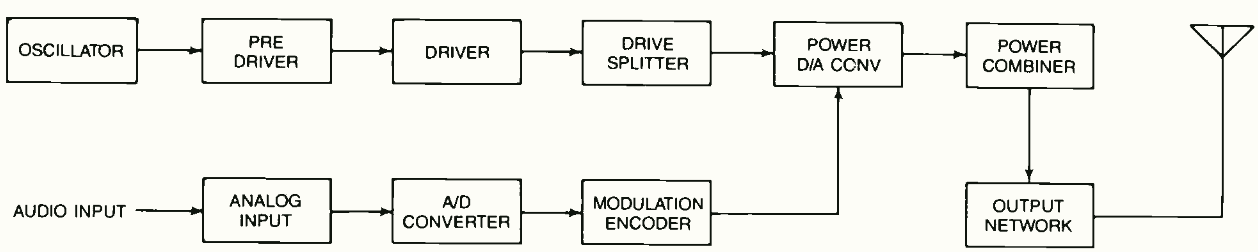

Figure 2: *Digitally modulated DX series simplified block diagram*

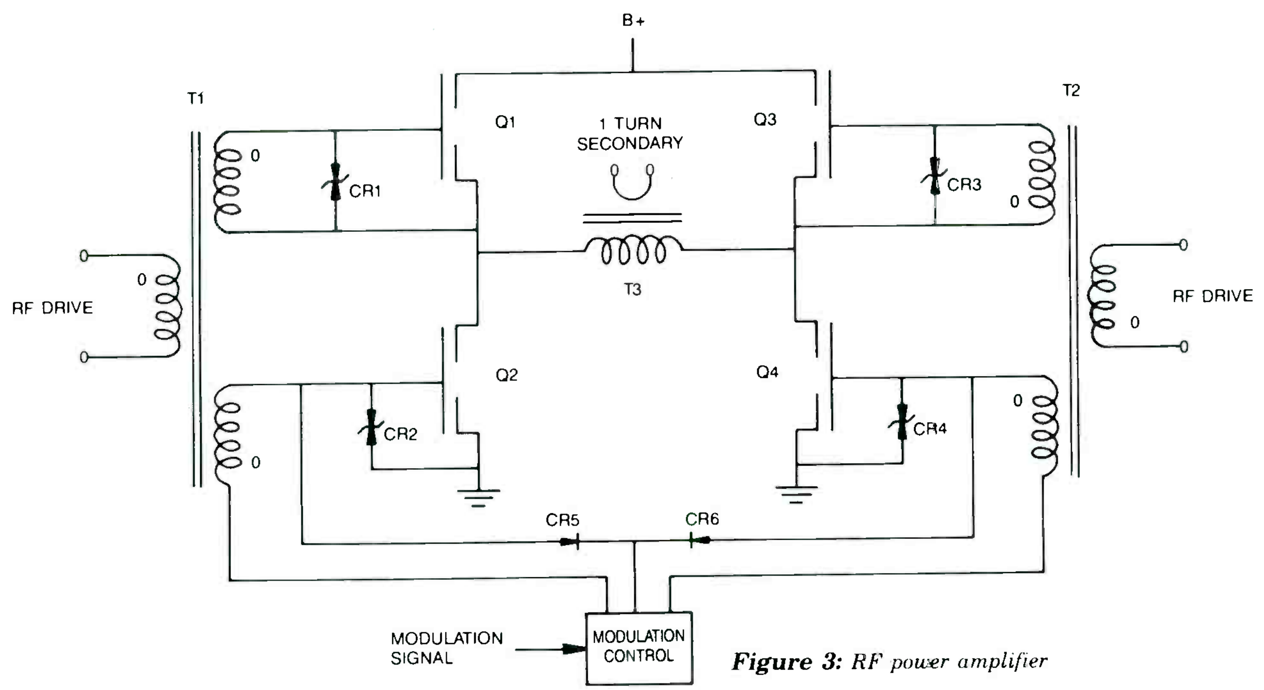

Figure 3: *RF power amplifier*

ing the second half of the cycle, transistors Q2 and Q3 are driven to saturation while Q1 and Q4 are in cutoff. The result is a squarewave peak-to-peak voltage of twice the bridge (DC supply) voltage across the output primary.

In a Class D amplifier, there are two main components to loss of power: conduction loss and commutation loss. Conduction loss is equal to I(Square)Rds (Rds = drain to source resistance or MOSFET). It can be minimized by making the total Rds (on) as small as possible. This can be accomplished by using a large number of large transistors.

For a given power output, the transmitter with the largest amount of silicon in the PA will have the lowest conduction loss. Total PA silicon area can be obtained by multiplying the silicon area in one PA transistor by the total number of PA transistors, assuming similar Class D amplifiers, similar transistor construction and the use of MOSFET transistors with ratings between 100 and 500 volts.

Commutation (switching) losses in most Class D amplifiers operating in the broadcast band are usually about equal to conduction losses. Typically commutation loss is ordinarily about three watts per transistor. The Harris DX design uses an output network circuit which reduces commutation loss to about one watt per transistor.

Transistor efficiency in digitally modulated designs measures about 96 percent. As a result of efficient cooling and very little dissipation, the transistor temperatures are close to ambient, which results in little thermal cycling of the transistor. Combiner loss, outwork network loss and losses in the "off" power amplifiers reduce overall PA efficiency to 92 percent, however.

High voltage transformer and rectifier designs also improve efficiency in a digital solid-state transmitter.

Rectifier efficiency is a function of the DC out and rectifier drop: N = (DC -2Vfm/DC) where Vfm is the diode voltage drop while it is conducting. Efficiency will be very high if the DC voltage for the diode is high and the voltage drop is low. A 50 kW digitally modulated transmitter uses a 230 VDC supply; oversized diodes are employed to keep the diode voltage drop low. Therefore efficiency of the rectifiers in a 50 kW digitally modulated transmitter is approximately 99 percent, where N = (230-2.2)/230. In a typical 50 kW PDM transmitter, rectifier efficiency is about 98 percent.

Overall efficiency in a digitally modulated 50 kW transmitter is: (transformer N) (rectifier N) (PA N) = N or: (.975) (.99) (.92) = 88.8 percent.

Power consumed by other circuits including cooling, control and driver cause typical overall efficiency to be about 86 percent. ■

Richards is project manager for the Harris Corporation, Broadcast Division engineering team which developed the DX digitally modulated transmitter series. Swanson is senior scientist for Harris Corporation, Broadcast Division. He holds U.S. patents for the development of pulse duration modulation, polyphase pulse duration modulation and digital (quantized) amplitude modulation technologies.

Monitoring Point Vector Analysis for Directional Antennas

By Ronald F. Balonis

In the world of the broadcast engineer the applications and the uses for a PC can range from the eclectic to the mundane. With programs stored in a computer, there's no need to memorize complex procedures and equations; these things a PC does with ease.

About half of the AM radio stations use directional antennas to either provide interference protection to other stations or to provide the best possible coverage for themselves. This, of course, means that the ability to maintain a directional antenna can be a required skill in a broadcast engineer's toolkit.

But the theory behind the design and the operation of directional antennas is mathematically complex and quite abstract. And the knowledge problem they pose is compounded because directional antennas are custom designed for each particular station ... no two are truly alike in all ways, they come in all shapes and sizes.

While the initial design and adjustment is properly the domain of expert consultant engineers, the maintenance and day-to-day operation of them seldom is. The day-to-day operation and maintenance is the domain of the broadcast engineer.

This month's Compute application program is called MPVECTOR.BAS. It performs vector analysis on the monitor points of a directional antenna. Vector analysis is the calculation of the resultant vector fields produced by each tower at monitoring points. The purpose of the analysis is to determine the effect that changing tower parameters has on the monitoring point fields. It makes for intelligent and systematic, rather than trial and error, adjustment of directional broadcast antennas.

Modeling the directional antenna with MPVECTOR.BAS lets you twist and tweak the controls to determine what control does what and by how much. This program's designed to enhance your ability to maintain a directional array: to debug minor operational problems, to keep it adjusted to its licensed parameters, and to recognize when it needs, and you need, the services of an "expert" consultant engineer to implement the changes properly.

MPVECTOR.BAS is an interactive application program. First you input the data, the directional antenna's parameters. Then you adjust tower phases and field ratios until a sequence of adjustment is found, assuming there are no component failures or system defects, that gives "in tolerance" parameter values: loop currents, phases, and monitoring points.

The first part is for inputting data, extends from line 100 to 625, and consists of seven modules: The Number of Towers and the Field Ratio, Phase, Azimuth from true north, and the Spacing from the reference center of the array (a tower or a point) for each tower. Then the Number of Monitoring Points and their Azimuths from true north for vector analysis. Each data input module is coded alike: Data input as a string variable and converted to a numeric value then tested for a valid value ... an error causes a top of the program restart and reentry of all the data.

```
+ Incremental DA Monitoring Point Vectors +

NUMBER OF TOWERS (2 to 6): ? 4
TOWER # +> ++  1   ++ ++  2   ++ ++  3   ++ ++  4   ++
FIELD   :    1.000      2.090     1.770      1.160
PHASE   :      0.0     -175.0      41.0     -109.0
AZMTH   :    295.0      295.0     115.0      115.0
SPACE   :    172.5       57.5      57.5      172.5

NUMBER OF MP (1 to 10): ? 5
MP# +> + 1 + + 2 + + 3 + + 4 + + 5 +
MP AZ:  36.8 193.2 265.7 295.0 324.33

VCTR%:  +0.0  +0.0  +0.0  +0.0  +0.0 <REF FLD PH>
VCTR%: +13.3 +13.3  +1.4  -0.2  +1.4 <FLD 1 +2%  >
VCTR%:  +0.0  +0.0  +0.0  +0.0  +0.0 <FLD 1 -2%  >
VCTR%:  +4.9  +4.9  +2.4  +1.6  +2.4 <PH  1 +1deg>
VCTR%:  +0.0  +0.0  +0.0  +0.0  +0.0 <PH  1 -1deg>
VCTR%: -29.1 -29.1  +6.1  +3.5  +6.1 <FLD 2 +2%  >
VCTR%:  +0.0  +0.0  +0.0  +0.0  +0.0 <FLD 2 -2%  >

INCREMENT TOWER <1 to 4 > : ?
```

Demo screen for MPVECTOR.BAS

The second part does the actual vector analysis, it extends from lines 600 to 1030: Lines 600 to 625 compute the reference vectors for the input data fields and phases. The interactive part loops through lines 640 and 840: Lines 640 to 680 display each MP vector as a percent change for each monitoring point. Lines 700 to 840 prompt for the Tower, then Field or Phase to change and increment: Field up or down by 2 percent and Phase up or down by 1 degree (Set in line 25, DF=.02 and DP=1.0). At the bottom of the program, lines 1000 to 1030 make up the subroutine that calculates the directional antenna fields. For hardcopy of a vector analysis sequence, use the PC's Print Screen key. You can do 10 calculations before the results roll off the screen.

That's probably the easy part. Just follow the example screen and sequentially enter the data for the directional antenna to analyze. The hard part is to effectively interpret and then to apply the analysis to the real-world directional antenna. To succeed at that, you've got to: 1) Document the system and it's components. 2) Thoroughly checkout the antenna system. Be as sure as you can be that there are no faults or defects in the system causing it not to behave as it once did. 3) Make sure that the Monitoring Points are the real ones and are "good" ones. 4) Be meticulous in recording and logging the readings and the adjustments that you make. 5) Make changes one at a time, to some extent they all interact with each other. Finally, 6) know when you need, or it needs, the services of an "expert consultant engineer."

For the theory and practice of directional antenna design, adjustment, and maintenance, *BME* has provided the forum for many of the experts:

In the June 1978 issue, George W. Ing describes the formulas for directional antennas in "The Pocket Calculator and the DA, Part 3," p. 86.

In the March 1980 issue, Ty H. Stites tells how to do "Vector Analysis of Directional Arrays," p. 122. His method is to calculate them by hand; then plot the vector results on a sort of graphical map for each monitoring point. Somewhat like MPVECTOR.BAS does, except that MPVECTOR.BAS builds an on-screen tabulation of the vectors as percent change.

In the September 1983 issue, John H. Battison provides in "Facilities Design and Engineering Part 10: Selecting and Installing an AM antenna," p. 75, an overview and guide on AM antennas.

And finally, in the January 1984 issue, Battison provides a one-page troubleshooting checklist in the Great Idea Notebook: "Troubleshooting Directional Antennas," p. 99. It's a very useful guide for debugging and adjusting any directional antenna system. ■

Balonis is the chief engineer at WILK-AM, Wilkes Barre, PA.

```
495 '++ ENTER TRUE N. MP AZIMUTHS  0 to 360
500 PRINT "MP AZ:";
505  FOR I=1 TO MP:MP$=""
510   INPUT MP$:MP(I)=VAL(MP$)
515    IF MP(I)<0 OR MP(I)>360 THEN RUN 0
520     LOCATE 12,1+I*6:PRINT USING" ###.#";MP(I);
525  NEXT I:PRINT:PRINT:PRINT:PRINT
595 '
600  FOR I=1 TO TWR:'+++++ REF FIELDS & PHASES
605    DF(I)=1!:DP(I)=0!
610  NEXT I:'+++++ COMPUTE REF MP FIELDS
615  FOR II=1 TO MP
620   GOSUB 1000:E(II)=E
625  NEXT II:FP$="REF":T$="FLD":D$="PH"
635 '
640 '+++ DISPLAY THE % CHANGE IN MP VECTORS
650 LOCATE CSRLIN-2,1:PRINT "VCTR%:";
655 FOR II=1 TO MP
665  GOSUB 1000:E=100*(E-E(II))/E(II)
670  IF E>99.9 THEN PRINT " 100+ ";:GOTO 680
675   PRINT USING" +##.#";E;
680 NEXT II:PRINT " <";FP$;" ";T$;" ";D$;DD$">"
690 '
695 '+++ INCREMENT A TOWER'S FIELD OR PHASE
700 PRINT SPACE$(79):PRINT:T$=""
705 LOCATE CSRLIN-1,1
710 PRINT "INCREMENT TOWER <1 to";TWR;"> : ";
715  INPUT T$:T=VAL(T$):IF T$="" THEN RUN 0
720   IF T<1 OR T>TWR THEN 705
725    FP$="":DD$="":D$=""
730 '
740 LOCATE CSRLIN-1,1:'++ BACKUP AND OVERWRITE PROMPT
750 PRINT "TOWER ";T$;"  <F>ield or <P>hase: ";
755  INPUT FP$
760   IF FP$<>"F" AND FP$<>"P" THEN 740:++ NOT F OR P
765    IF FP$="F" THEN FP$="FLD":DD$="2%  "
770    IF FP$="P" THEN FP$="PH ":DD$="1deg"
775 '
800 LOCATE CSRLIN-1,1:PRINT "TOWER ";T$;" ";:D$=""
805 PRINT FP$;"   + UP or - DOWN:  ";
810  INPUT D$
815   IF D$<>"+" AND D$<>"-" THEN 770:++ NOT + OR -
820    IF D$="+" AND FP$="FLD" THEN DF(T)=DF(T)+DF
825    IF D$="-" AND FP$="FLD" THEN DF(T)=DF(T)-DF
830    IF D$="+" AND FP$="PH " THEN DP(T)=DP(T)+DP
835    IF D$="-" AND FP$="PH " THEN DP(T)=DP(T)-DP
840     GOTO 650:+++ AND DISPLAY % CHANGE IN VECTORS
845 '
1000 '++++++ COMPUTE THE MP FIELD VECTOR
1005 E=0:X=0:Y=0:A0=MP(II)
1010 FOR I=1 TO TWR
1015  SP=(PH(I)+DP(I))+SP(I)*COS((AZ(I)-A0)/RD)
1020  X=X+(FLD(I)*DF(I))*COS(SP/RD)
1025  Y=Y+(FLD(I)*DF(I))*SIN(SP/RD)
1030 NEXT I:E=SQR(X*X+Y*Y):RETURN:' PROGRAM END.
```

MPVECTOR.BAS, a vector calculation program.

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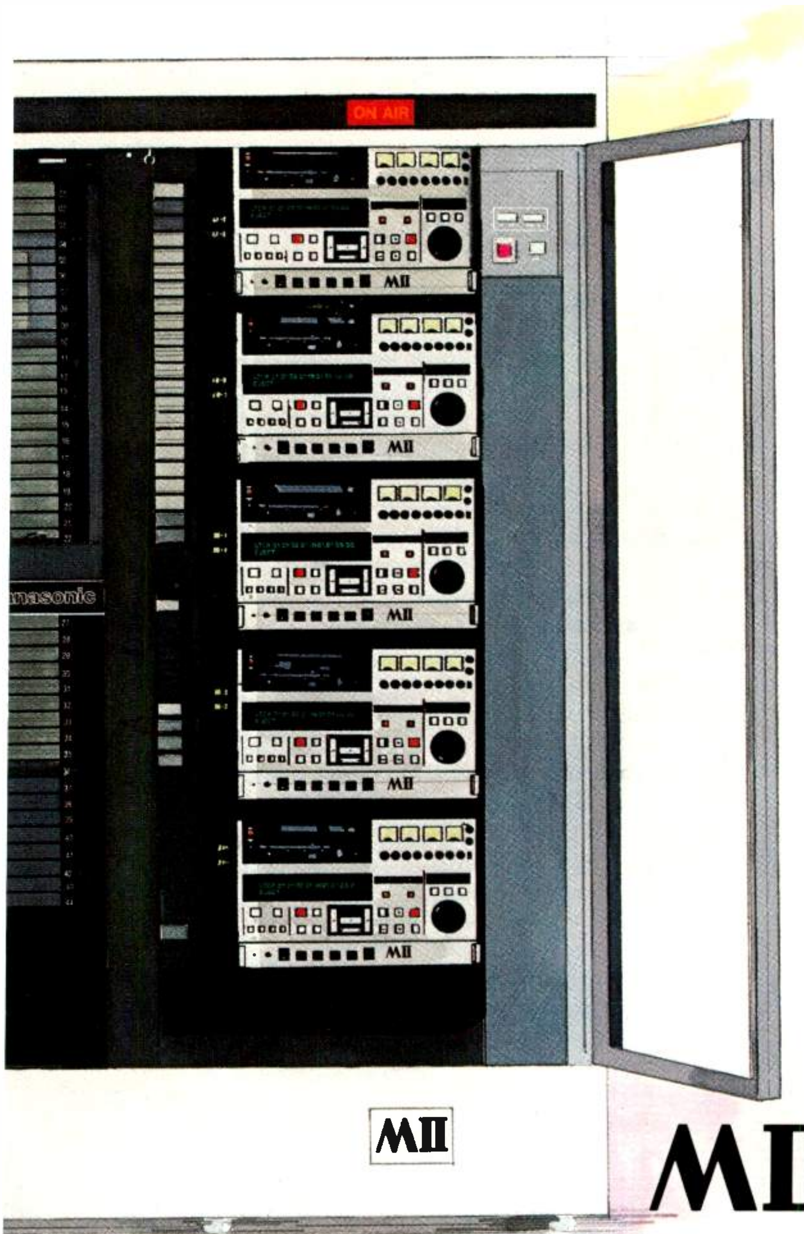

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How to Go Dark

By Harry Cole

At one time or another just about every licensee needs to turn its station off—to "go dark," in the language of the industry, for technical or occasionally financial reasons. Since such instances are the exception rather than the rule, many broadcasters may not be completely familiar with their obligations as far as the FCC is concerned.

The Commission understands that we live in an imperfect world where notwithstanding our best efforts, things sometimes go awry. As a result, the rule on going dark (Section 73.1740) anticipates stations needing to cease operation for a short period. In order not to add unnecessarily to the burden of such situations, the FCC *permits* a station to go off the air, or otherwise "limit" its operation (presumably by operating with reduced power, for instance), for up to thirty days *without* prior authorization from the FCC. That means you can just turn the station off if you feel like it for up to 30 days. More realistically, if a tornado blows your tower over, or if your transmitter explodes, or if your studio burns down, you don't have to worry about getting any kind of approval from the Commission if you are forced off the air for awhile.

There are two things you must keep in mind, however. First, you will be required to adhere to the tower lighting requirements specified in your license at all times. The Commission views tower lighting as an extremely important safety consideration, and it expects all licensees to take all necessary steps to maintain compliance with those requirements.

Second, you must notify the Commission that you have discontinued operation within ten days of the discontinuation. This does not constitute a need to obtain approval—all you need to do is drop the FCC a line to identify the station and its community of license and advise the Commission that the station has discontinued operation. You may include some details about the underlying circumstances, if you wish, and add when you expect to go back on the air.

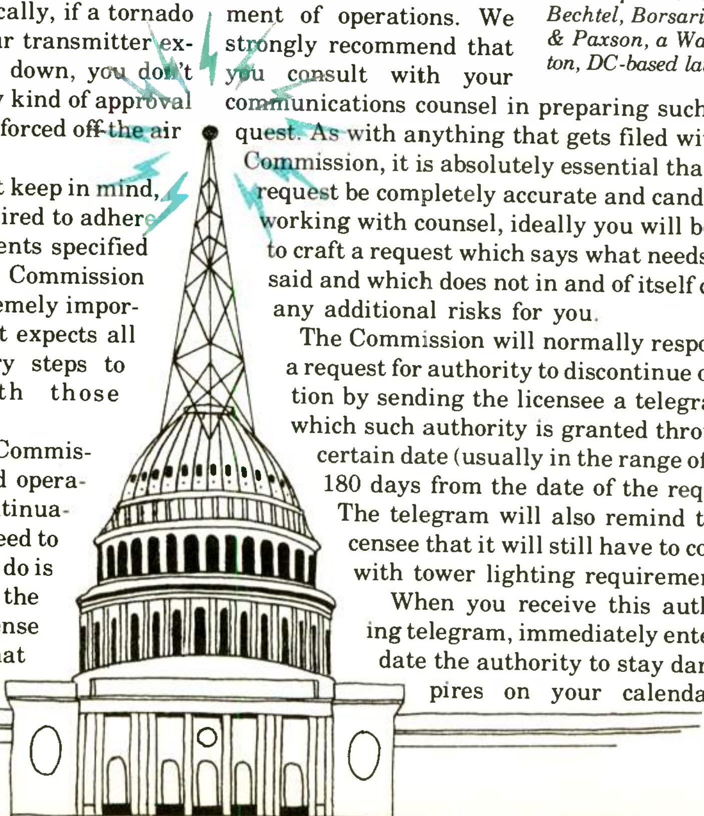
The fact that you don't even have to notify the FCC until the tenth day is important because it can be construed as permitting any station to cease operation for up to ten days without even notifying the Commission. Thus if you blow a tube which keeps your station dark for a day while a replacement is flown in, technically you would not be required to advise the Commission.

If the station is going to be off the air for more than 30 days, you *will* need to file an informal request for authority to keep it off the air no later than the thirtieth day. Such an informal request would normally include a description of the circumstances forcing the discontinuation of service, and at least some projected date for the recommencement of operations. We strongly recommend that you consult with your communications counsel in preparing such a request. As with anything that gets filed with the Commission, it is absolutely essential that your request be completely accurate and candid. By working with counsel, ideally you will be able to craft a request which says what needs to be said and which does not in and of itself create any additional risks for you.

Cole is partner in Bechtel, Borsari, Cole & Paxson, a Washington, DC-based law firm.

The Commission will normally respond to a request for authority to discontinue operation by sending the licensee a telegram in which such authority is granted through a certain date (usually in the range of 90 to 180 days from the date of the request). The telegram will also remind the licensee that it will still have to comply with tower lighting requirements.

When you receive this authorizing telegram, immediately enter the date the authority to stay dark expires on your calendar. If

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you're still not ready to go back on the air by that date, the note will remind you to file a request for extension of the authority to remain silent. Such a request is also an informal matter which normally provides the Commission with a progress report and with an estimate of when the station might be expected to return to service. The FCC will normally respond to an extension request with another telegram which provides a new date by which the station should resume operation.

When the station does resume operation, the licensee is required to notify the Commission. This notification requirement applies with respect to any discontinuation of operation of which the Commission has been advised, whether or not the discontinuation lasted more than 30 days. In other words, if you have told the FCC that you're off the air, you have to tell them when you go back on the air. Your notification should specify the date you actually resumed operation. If you decide you are definitely not going to return the station to the air, you should also notify the Commission. Normally you would send the FCC your instrument of authorization plus a letter indicating that you no longer wish to operate the station and the license should be cancelled.

What is the risk if you don't comply with the rules? Theoretically, the willful and repeated violation of any Commission rule can result in a fine or forfeiture of up to $20,000. In real-life terms, the actual fine may be less than that. Two Commission actions at the end of last year indicate the Commission's attention to such matters isn't the most vigilant.

In the first case, the Commission ordered an AM licensee in Oregon in December 1988 to show cause why his license should not be revoked. The Commission had learned in September 1986—more than two years before the show-cause order—that the station had been off the air since March 1986. Commission personnel inspected the station site in November 1986 and found that the station was indeed off the air, and further, the station had been abandoned. Apparently not convinced that the licensee would not suddenly reappear, the FCC waited until July 1987 (by which time the station had been off the air for more than 15 months) to send a letter to the station "seeking information as to the status of the station." The letter was returned to the FCC stamped "Returned to Sender—Box Closed".

As with anything filed with the Commission, it is essential your request is completely accurate and candid.

Apparently the Commission still didn't believe the station might really be dark for good. In March 1988—two years after it apparently first went dark and 16 months after an on-site inspection revealed it abandoned—the Commission sent field operation personnel back to the site to look around again. They found the station was still off the air and so, nine months later, the Commission issued a show-cause order in an apparent effort finally to cancel the license.

Ironically, the Commission revoked the license of a Washington state AM license the same week it adopted the show-cause order. The Washington station had been off the air since January 1985. It first requested authority to go dark for 90 days in February 1985. Extensions of that authority were requested and granted through mid-August 1986. Apparently the licensee gave up sometime around then, for no further extension requests were forthcoming and a March 1987 inspection of the station site found it to be vacant. Still, in April 1987 the Commission directed the licensee to provide specific plans for the station's return to operation. In response the licensee indicated that it was looking for a buyer for the station. Eleven months later, with no assignment application on file, the Commission ordered the licensee to show cause why its license should not be revoked. The licensee opted not to oppose revocation and finally, in December 1988, the license was revoked.

From these two cases it is apparent that the Commission does not have a hair-trigger when it comes to revoking licenses for failure to operate. Indeed, these two stations were off the air for years before the Commission took any meaningful steps aimed at forcing the licensee itself to take steps. The FCC's willingness to let things slide in this area is probably attributable to a variety of factors, including the infrequency of this type of situation and a desire by the agency not to be too hard-nosed when it comes to a licensee who is having problems.

Nevertheless, you would probably be well-advised to comply with the rules even if you don't think the Commission will penalize you if you don't. As noted above, any decision you make about going dark, staying dark, or notifying the Commission etc., should be made only after consultation with your communications counsel. ■

Neumann New Mic Series....Desktop Audio with Sonic Solutions....ICI Digital Paper....Sony Infrared Camera....And More New Products

Neumann Intros New Microphone Series

Microphones of the Neumann KM 100 series are modular condenser mics with a small diameter capsule. The active capsule which is only 1.5 inches long connects to the output stage either directly or via a thin cable up to 150 feet long. Hybrid, transformerless electronics provide 4 dB less self-noise, a 3 dB higher output level, and a 12 dB wider dynamic range than the KM 83/84/85 series. Dynamic range is 124 dB and RFI rejection is 30 to 40 dB. The KM 140 cardioid is priced at $600 and the KM 150 hyper-percardioid is $725.
Reader Service #200

Sonic Solutions Debuts New Desktop Audio System

Using the Sonic System, recording engineers are able to prepare professional master recordings with the help of a personal computer and applications software. The system provides all-digital editing, mixing, EQ, dynamics and project management functions for professional mastering. It allows the operator to complete all the editing, equalizing, mixing, and CD prep functions with one system and engenders more accurate editing, lessens the hassles of tape shuttling, and creates a finished master more quickly.
Reader Service #201

ICI Launches Digital Paper

Digital paper from ICI Electronics is a completely new form of optical data storage medium. Highly flexible, durable and low in cost, it offers the data density of optical disks and is readable by digital devices. The new medium can be slit into lengths as tape, stamped into disks, inserted into cassettes or cut into strips or tags. Two drives, tape and disk, using digital paper as a medium have been announced and several more drive manufacturers are working on implementations of the new optical data storage medium. A tape designed for a tape drive being developed by Creo Products of Vancouver will have a capacity of one terabyte (one million megabytes).
Reader Service #202

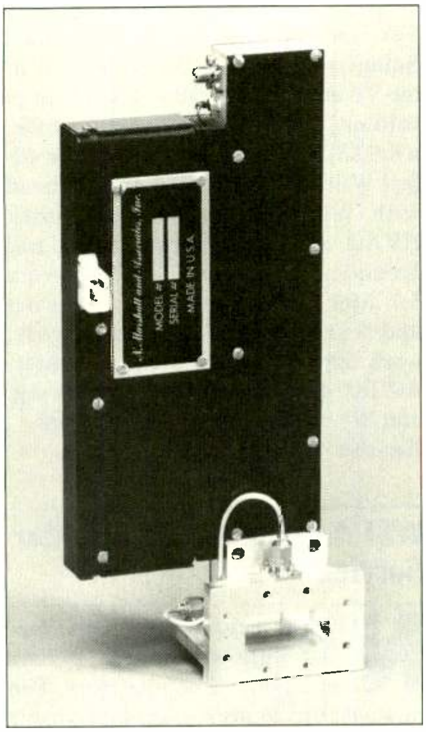
New Sony Camera Works In Infrared Light

Model DXC-3000IR uses CCD technology to capture high quality images in both infrared and normal light settings. Applications range from investigatory work to ENG. The remote controller, which includes both a control unit box and filter drive unit, activates the filter wheel, allowing the user to choose between the various light spectrum modes from a distance of up to 100 meters. A five-meter cable is standard equipment. When the third filter is selected, green and blue signals are automatically turned off and only the red channel is operational. The electric charges generated in the red chip are processed by the circuits for green, including the image enhancer. This contributes to the picture quality in this mode.
Reader Service #203

Lyon Lamb Presents Video Animation System

Lyon Lamb Video Animation Systems has introduced the HR-VASystem, a new system designed specifically for high-resolution

computer graphics animation and conversion to all video formats. The system is comprised of the Lyon Lamb HRC high resolution converter, the MiniVAS animation controller, and all cabling and software for immediate interface with high resolution computer graphics workstations. The HRC converts up to 1280 x 1024 60 Hz non-interlace RGB video to NTSC video or low resolution 525-line RGB with no loss of graphic information. Users of high resolution display devices are able to directly record or display their images in standard video format. The HRC performs complex compression operations and interfaces with a wide range of high resolution formats. The MiniVAS is designed to perform precise single-frame recording and frame grabbing from computer graphics systems to a wide range of videotape recorders. The price is $17,500.
Reader Service #204



N. Marshall Has GaAs FET I.L.A. Retrofit Amplifiers

N. Marshall and Associates introduces another member of their microwave amplifier family. The VR5964-2 and VR6471-2 amplifiers are a drop-in replacement for the Gunn diode injection locked amplifier (I.L.A.) in video broadcast equipment operating at 5.9 to 7.1 GHz. Other configurations are available including an amplifier with 40 dB gain at 2 watts. Predicted power train M.T.B.F. is in excess of 25 years.
Reader Service #205

Centro Unveils Two ENG Vehicles

Centro Corporation has two new ENG's. One is built around the Ford E-350 Econoline Super

Van and the other around the GMC Suburban. The Ford features a 7.5 liter V8 engine, 347 cubic feet of cargo volume, a three-bay equipment rack, a 6.5 kW Onan generator, a 30- or 40-foot Will-Burt mast, pan and tilt head with remote control, work lights, HVAC, a DC to AC converter and roll around seating. The GMC features a 5.7 liter V8 engine, power steering and brakes, two-bay equipment rack, work lights, 4.45 kW Onan generator, AC/DC distribution and monitoring, and 30- or 40-foot Will-Burt mast.
Reader Service #206

WSI Announces New Radar Service

NOWrad From WSI Corp. features improved image quality and advanced compositing. The new system suppresses ground clutter from buildings and vegetation which can appear on the screen as precipitation, but does it in a new way that does not suppress true weather signals. Advanced compositing means that composite national and regional radar images are composited simultaneously. The system works with any WSI-compatible graphics machine and can also be accessed at home on a PC. NOWrad users can specify more than 800 regional images.
Reader Service #207

ISS Engineering Offers Satellite Receiver

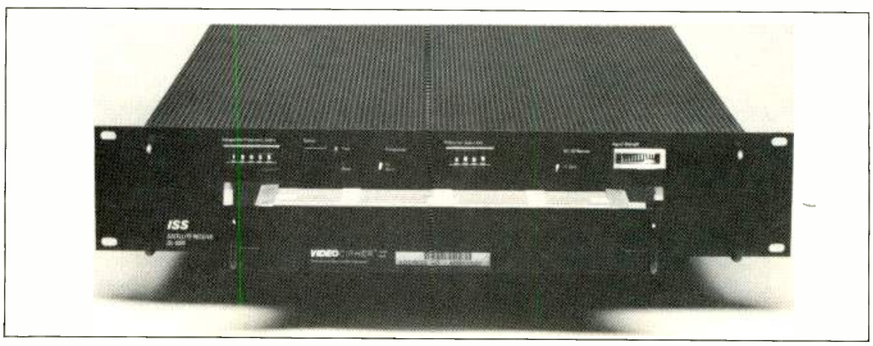
ISS Engineering has announced that it will soon release a new C-KU band IRD satellite receiver, model GL5020, for the TV cable and broadcast industries. The new receiver will feature a videocypher module that can be removed from the front panel by quick release latches. Tuning will be accomplished by either channel or frequency. Audio outputs will be balanced. Provision will be made for remote control.
Reader Service #208

ACE Produces New Routing Switcher

Model VX164 is a 16x4 broadcast quality video router in one rack unit featuring a local control panel with flexible remote control options. The new unit, available in composite or component versions, provides disturbance-free field or frame rate switching and DC restoration. Multiple audio levels, joystick override and software configured serial panels are optional.
Reader Service #209

ACE Markets Color Encoders

ACE color encoders, models 204N and 205N, convert RGB outputs from such sources as character generators or paint systems into composite NTSC. The 204N features six composite outputs, RGB or Y, R-Y, B-Y inputs and a test pattern generator, providing 32 test signals including full field and SMPTE color bars, red field and pluge. The 205N has all the features of the 204N plus Y, R-Y, B-Y outputs, enabling simultaneous feeds to component analog VTRs from



character generators. A TTL input option is available for use with PC generated pictures.
Reader Service #210

MCI Intros UHF 'Hot' Switch

Micro Communications Inc. has designed a small size "hot" switch and switchless combiner. The switchless combiner replaces the standard hybrid combiner or switching combiner in dual transmitter systems. The hot switch allows the broadcaster to switch between either of two transmitter systems, similar to a four-port transfer switch. Should one transmitter fail, the remaining transmitter can be hot switched to the output with no loss of air time, says the manufacturer. The unit operates with a push-button momentary contact and can be remotely operated.
Reader Service #211

Nady VHF Wireless System Designed for ENG

The Nady 501 VR wireless system is designed to provide studio quality sound anywhere, with a compact size and light weight that work well in electronic newsgathering and electronic field production. The 501 VR operates on VHF high-band frequencies, with five channels between 170 and 216 MHz offered standard, and other frequencies optional. Patented companding circuitry gives the 501 VR a dynamic range of 120 dB and full frequency response of 25-20,000 Hz. The receiver is internally powered by a 9V battery, or externally powered from any 12V to 35V power source. A headset output with volume control is designed to make monitoring easy. Other features include a "rubber duck" antenna and removable belt clip. Transmitters are available in a choice of miniature lavalier in a field-proven bodypack or hand-held model.
Reader Service #212

Sony Adds Field-Portable U-Matic SP Recorder

Sony has introduced the VO-8800 field-portable recorder with time code capability. The new model incorporates many of the features of its predecessor, the VO-6800, as well as 330 lines of resolution and a signal-to-noise ratio of 46 dB. Additional features include Y/C interface capability through the 14-pin camera cable, built-in rf modulator, lighted VU meter and C Type Dolby noise reduction for audio signal-to-noise ratio of better than 72 dB. The VO-8800 also incorporates SMPTE longitudinal track time code. The optional BKU-706 time code generator plugs in to the unit and offers selectable free-run/record-run capability, regeneration to external time code and user bits entry.

Reader Service #213

DSC Premieres Collage D-2 Digital Compositor

Digital Services Corp.'s Collage D-2 digital compositor is designed for multi-channel compositing of multi-layered effects and sophisticated program segments. It features a 12-bit video path and can composite directly to D-2 tape machines or disk recorders. The system accepts five video sources and three key signals as external inputs. It composites three foregrounds over the background while controlling the priorities of two of the videos. Internal sources can be provided from optional matte generators, frame memories or DSC's DiSC digital disk system. Input sources can be composited in a single pass with manual or automatic dissolves, fades, keys and cuts. Automatic dissolve durations and levels are fully programmable.

Reader Service #214

Telcom Compander Card Works With Sony BVH Series

Telcom c4 AC-27 audio compander card is designed to improve the audio channels 1 and 2 of the Type C 1-inch video tape recorders in Sony's BVH-2000/2500 series. It is a replacement card for the Sony AU-27 board and plugs directly into the VTR slot requiring no modifications of the VTR. The card improves audio recording in dynamic range and crosstalk performance, offering a quality comparable to 16-bit digital, according to the manufacturer. The signal-to-noise ratio is referred to 250nWb/m, unweighted. The card also corrects

frequency response errors with head bump effects, offering a frequency response of 50Hz-15kHz +/- 1 dB with NR off or on.
Reader Service #215

Philips Digital Oscilloscope Brings Lab Power to Field

A new portable 100-mHz digital storage oscilloscope from John Fluke Mfg. Co., the Philips PM 3308, features an electroluminescent screen, powerful mass storage memory, and a wide range of arithmetic and analysis facilities. The PM 3308's portability is enhanced by its clam shell construction and 14.5-lb. weight. Other features include a shoulder strap, battery-packed 180kB RAM disk with non-volatile memory that can store up to 100 waveforms or setup menus. DSO can display up to four traces simultaneously. Vertical measurements include peak-to-peak and rms voltages, average DC level and mean voltages across trace. Horizontal measurements include cursor to reference, cursor to trigger, rise-time, frequency, period and phase. GPIB and RS 232 interfaces are standard. Delivery schedule is eight weeks; list price is $7500.
Reader Service #216

Ampex Intros Pro Audio Cassettes

Intended for studio, dubs, client copies and other applications, Ampex Corp.'s 472 Studio Audio Cassette is available in both Type I Normal Bias and Type II High Bias configurations, and in 5-, 10-, 15-, 30-, 45-, 60- and 90-minute lengths.
Reader Service #217

Programmable Audio Signal Generator/Analyzer Introduced

Sound Technology's 3100B generator uses digitally controlled analog oscillators to produce sine and square wave signals in addition to SMPTE IMD, tone-burst, and sine/step waveforms. Sine waves range from 1 Hz to 102.39 kHz, with 0.0008 percent distortion, and square waves from 1 Hz to 50 kHz, with a rise time of less than 1 μs, according to the manufacturer. Internal crystals insure frequency accuracy within 0.03 percent for fixed frequency and selected frequency sweeps. The 3200B autoranging audio analyzer measures levels from below 4 μv to 100 V in volts, dBM—referenced to 600 or 150 Ohms—or watts (1 to 99 Ohm reference), in greater than a 300 kHz band-

width. Three high-pass, four low-pass, or a weighting filter can be selected.
Reader Service #218

AMX Shows Off 8-Line Relay Controller

The AMX SX-8+ relay controller is a trim line version of its standard SX-16+. The new unit features eight relays instead of 16, and communicates with other AMX peripherals via the communications buss. Features include front panel controls and rack mount capability.
Reader Service #219

Vinten Has New Pedestal

Vinten's Vision pedestal offers pneumatic technology, traditionally the preserve of heavy-weight camera systems, to users of lightweight equipment. Features include a 16.5 inch on-shot column movement operable anywhere within a height range from 25 to 58 inches, a full 44-lb. carrying capacity, a self-charging system for easy adjustment of payload, detachable base with convenient carrying handle and castored wheels with individual brakes.
Reader Service #220

RF Technology Releases Mini Microwave Transmitter

RF Technology's RF-223B miniature portable microwave transmitter is available in any 250 MHz segment of the band 1.7-2.7 GHz with rf power output switchable (1⅔ watts at 2.0 GHz and 10/3 watts at 2.5 GHz). Standard features include dual high-quality audio channel with line/mic level switching, LPF video input, remote control capability, wideband (10 MHz), narrowband video, baseband switching and 12V DC operation. Available options include AC power supply, disc rod and parabolic antennas with gains up to 25 dBi at 2.0 GHz. The unit measures 4.5 x 5.0 x 7.0 inches and weighs about eight lbs.
Reader Service #221

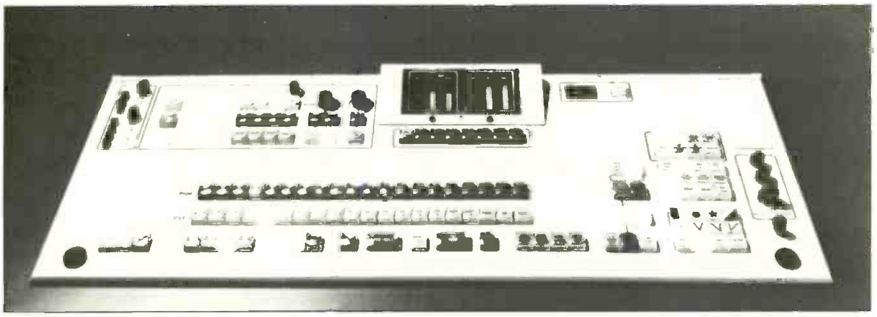
Interface Unit Controls Chyrons

Zaxcom Video's DP800 Data Parrot is a GPI pulse to RS422/232 interface unit. When a GPI pulse is received by the Parrot, a user-programmable data string is generated, simulating keyboard keystrokes. Applications include control of older

Chyrons directly from an editor's GPI output. The Parrot contains eight non-volatile memory buffers, each of which may be up to 14 characters in length.
Reader Service #222

Tec Pro Intros Distribution Amp

This new audio distribution amplifier from Tec Pro Technology, Inc. features a frequency response of +/- .1 dB 10 Hz-22 kHz, S/N 95 dB, distortion 1 kHz <.007, separation >90 DB, input -10 to +10 dBm, output +20 dBm. It also features LED peak indicators, mono/stereo bridge switch, headphone monitor jacks, two unbalanced high-level outputs via RCA jacks, individual output controls, and RF input protection.
Reader Service #223



Master Control Switcher Is Entry-Level Unit

Utah Scientific's MC-501C master control switcher is an entry-level unit offering many of the features of the company's MC-500 family of switchers. The unit has 20 source selectors which can be associated with video only or video plus audio; there is an additional audio-only function machine control system with individual pre-roll times for each source machine.
Reader Service #224

PCO Announces Fiber Optic Data Link

PCO, a subsidiary of Corning Glass Works, has announced the EDL-1300 series of fiber op-

tic data links. The series consists of two data link modules, the EDL-1300-TX transmitter and the EDL-1300-RX receiver. Ideal for first-time users and for upgrading a coaxial or short wavelength fiber system for greater link distance and higher speed, these moderate-speed data link modules transmit serial TTL data over multimode optical fiber for link distances in excess of two kilometers and at data rates up to 50 Mbps. The benefits of high performance and 1300-nanometer wavelength optical communication are combined with the design features of 16-pin DIP housing. Price per set in unit quantities is $320.
Reader Service #225

EEV Premieres Traveling Wave Tube Amplifier

EEV's latest traveling wave tube amplifier for Ku-band SNG applications, type N4290, provides 270 W rf output at from 14.0 to 14.5 GHz in an extremely compact (7 x 19 x 24) and lightweight (66 lbs.) package. Intended for use in ground mobile environments, the N4290 is designed to be compatible with most environmental conditions experienced by SNG terminals. Its operating temperature range is from -20 to + 122 degrees F. Optional items include a weatherproof transport case, remote control and monitoring (including the rf output power), computer interface and phase combiner for combining the outputs of two N4290s.
Reader Service #226

Comtech Premieres L-Band Antenna

Comtech Antenna, in cooperation with Seavey Engineering, has introduced an INMARSAT antenna system. The Model AS33-15 C/U is a 33-inch diameter collapsible antenna designed for L-Band transmit/receive applications. The antenna was designed for airline transport and weighs just 40 pounds. It complies fully with INMARSAT SES sidelobe requirements and can be deployed by one man in approximately one minute, says the company.
Reader Service #227

Alta Improves Celeris Y/C Format Converter

Alta Group has added a luma-chroma delay correction circuit to their Celeris U-matic/S-VHS format converter. The new circuit provides both digital vertical and horizontal correction and solves the chroma delay problem critical to multi-generation copying. Celeris converts programming from the U-matic and U-matic-SP formats to S-VHS or from the new S-VHS format back to U-matic dub mode. Price is $1850.
Reader Service #228

A.F. Associates Presents New Standards Converter

International Signal Interface System (ISIS) is a signal converter from

A.F. Associates that is designed to fill the gap between the Applied Video Systems 6500 and ADAC. Intended for the mid-range post-production market and the high-end corporate market, the new converter features smoothness of motion. ISIS is a three-field unit (expandable to four) offering two-line interpolation. **Reader Service #229**

FOR-A Improves Time Base Corrector

For-A Corp. of America has announced that its FA-740 parallel effects time base corrector for A/B roll editing applications can now be used with S-VHS systems. Operating as two independent time base correctors, the FA-740S integrates both ½-inch and ¾-inch U-matic VTRs with or without external sync input since its full frame correction range allows processing of non-synchronous VTRs. This also permits the combining of a playback VTR with a studio camera in editing applications. Used in combination with the For-A EC-740 editing controller and AS-740 audio switcher, the FA-740S system has the capacity to handle sophisticated A/B roll editing for Super-VHS systems. **Reader Service #230**

Hewlett-Packard Premieres 6.5-GHz Portable Spectrum Analyzer

Model HP 8561A from the Hewlett-Packard Co. extends the performance of its portable spectrum-analyzer series. By using solid-state electronic switching, the HP 8561A spectrum analyzer becomes the first rf analyzer to provide continuous sweep capability from 1 kHz to 6.5 GHz. Tracking preselection extends from 2.75 to 6.5 GHz, eliminating concerns about multiple responses or images when analyzing high-frequency signals. Mean-time-between-failure rate is 10 years (based on 2000 hours per year). **Reader Service #231**


3-Way Lounger

One of these revolutio the world looks at TV w

BTS did not invent the three-way lounge chair. Barcalounger® did.

But you'd be surprised at how many of the most revolutionary ideas in the history of video did come from BTS. In fact, because we look at things differently, the whole world looks at things differently.

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BTS has been a technological innovator in the video industry for six decades. Our cameras,

BUSINESS BRIEFS

The first customer deliveries of **Ampex Corp.**'s VPR-300 D-2 format composite digital studio VTR began on schedule in November. Among the organizations expecting the VPR-300s are AME, Inc., Burbank, CA; the Canadian Broadcasting Corp., Montreal; The Post Group, Hollywood, CA; and Northwest Teleproductions Productions, Inc., Minneapolis and Dallas.

The **Conus Satellite News Cooperative**'s membership reached 81 in December, with the additions of WCMH-TV, Columbus, OH and KWQC-TV, Davenport, IA. "These two new members will add strength to the Conus system," said Conus Communications vice president and general manager Charles H. Dutcher III. "KWQC is in a position to provide outstanding coverage of Iowa and western Illinois. WCMH can cover a lot of ground from its central Ohio location, as well as provide state capitol coverage."...The **Disney-MGM Studios** complex at Lake Buena Vista, FL, has ordered the largest **Solid State Logic** audio console ever manufactured for its post-production facilities. The SL 5000 M Series 96-channel film post-production console will be installed in a new dubbing theatre at the full service facility operated by **The Post Group** for Disney-MGM. The console can perform either film-style or video-style mixing. Among the TV series expected to make use of the console is the syndicated *Superboy*...Five TV stations have recently added **Pinnacle Systems** workstations. **KFBB-TV**, Great Falls, MT; **KTVF**, Fairbanks, AK; **KFFD-TV**, Honolulu; and **KFDX-TV**, Wichita Falls, TX have all added Pinnacle 2000 Series systems. A 1000ES system was installed at **WSMH**, Flint, MI.

The **National Association of Broadcasters** has released the results of new studies which urge the FCC to institute or modify some of its regulations. An NAB survey shows widespread abuse of the FCC license renewal process, according to joint board chairman Wallace Jorgensen. "For too long, those filing competing applications and petitions to deny have been extracting payment in some form from broadcasters in order to drop their challenges," Jorgensen notes. "It is time for the Commission to step in and prohibit this blackmail." The NAB has asked the FCC to make it an abuse of Commission policy to threaten to file with the intent of blackmailing a licensee. It also called for requiring applicants to provide additional ownership and financial information. In a different FCC filing, the NAB called for new must-carry regulations. Based on studies by the FCC and National Cable Television Association, the filing concluded that the studies "provide even more conclusive evidence" that cable has the incentive to drop, refuse to carry, reposition and demand just compensation from local broadcasters when it has been in cable's economic self interest to do so.

Video Park, Inc., a Baton Rouge, LA-based video postproduction firm, has added three staff members. They are: editor Dave Frentz, formerly with Teleproductions, New Orleans; editor Terri Reid, previously with Cinetel productions; and Cathleen Tomeny, who will operate the Aurora 280 Videographics system...**Acrian, Inc.**, San Jose, CA, has named Walt Dorsey director of manufacturing, amplifier division. Dorsey has previously worked with Applied Technology, Hewlett Packard, Atari and GENRAD Semiconductor.

KRTH AM/FM, Los Angeles, received an award recently from the Emergency Preparedness Commission of Los Angeles County. The award, accepted by KRTH chief engineer Robert Kanner, was in recognition of the station's donation of a new computer for the county's Emergency Broadcasting System...**KWHY-TV**, Los Angeles, which bills itself as the Business Channel, has announced that it will schedule Spanish language programming in prime time seven days a week and will extend its Business Channel service through the afternoon to 6 or 7 p.m. ■

The Audio Engineering Society honored Dr. Per V. Bruel with its Silver Medal Award at the society's recent convention in Los Angeles. Bruel, co-founder and director of Bruel & Kjaer Industri A/S, Denmark, received the award in recognition of his contributions to and continued refinement of microphones used for acoustical measurements. Bruel (right) accepted the award from AES president Dan Gravereaux.

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A GUEST EDITORIAL

State-of-the-Month: The Challenge of Staying Current

By Don Lockett

Broadcast managers and broadcast engineers are constantly faced with the challenge of competition. Being competitive is akin to being profitable for commercial broadcasters and to being underwritten for noncommercial broadcasters. The programming as well as the technology that we use to deliver the on-air product are the principle tools of the trade. Therefore, knowledge and application of the latest broadcast technology becomes a basic housekeeping obligation for today's broadcaster.

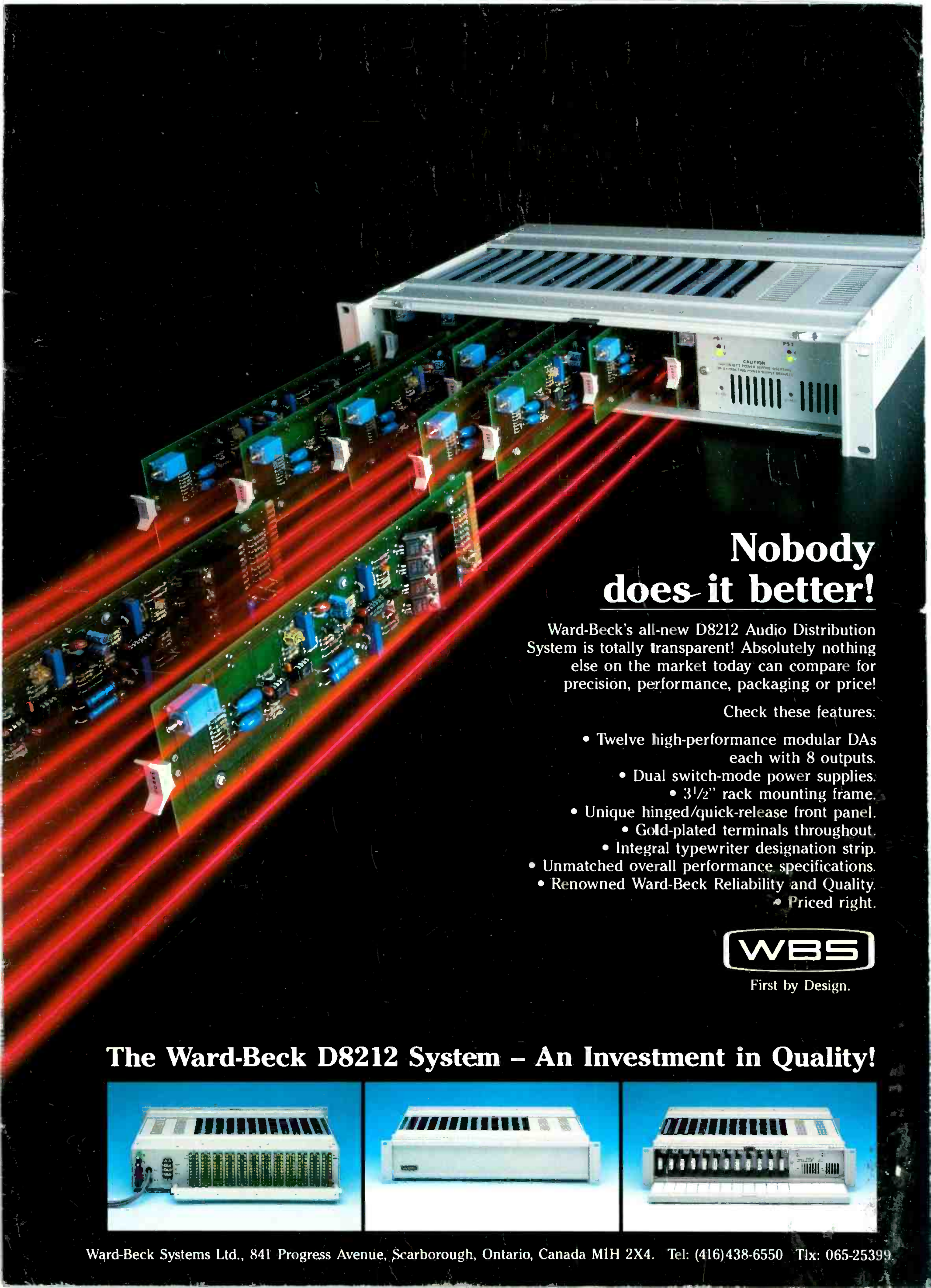
Integrating the best technology involves information gathering and training. Broadcasters must be able to install and maintain the new bells and whistles and deal with compatibilities of old and new equipment over the long term. Unless we are the recipients of large annual budgets or complete rebuild financing, this integration of newer, existing, and older broadcast technology becomes an artful dance. The broadcast engineer must be able to understand the theory of operation of new technology, assess its advantages and disadvantages, and negotiate an equitable purchase.

Then comes the workplace implementation which often involves immediate training expenses for maintenance and operational personnel. Having the latest is of no advantage if it cannot be fully utilized. In most cases, today's union contracts place stringent requirements on employers to provide training for operational personnel when new technology is introduced. The training cost adds an extra, often substantial, cost to the acquisition and should be considered when negotiating.

Don Lockett is the director of engineering and operations, Program Division for National Public Radio.

The manufacturers of equipment have not helped matters any with their rapid fire introduction of new products. However, manufacturers are really not to blame because they too are the victims of the infamous state-of-the-art factor. A heightened competition level has been caused by the proliferation of industry trade shows. Each manufacturer is advantaged by the introduction of state-of-the-art products when its target audience gathers for technical expositions (i.e., SMPTE, AES, and NAB). Consequently, we find ourselves grappling with the introduction of improved digital video formats, more incompatible digital audio workstations, and whatever NAB '89 will bring forth. The pressure of competition at the major trade shows has taken on the semblance of the new car industry. While NAB's Annual Convention originally established the new car year, the frequency and importance of the other broadcast/audio/video events has created a quarterly, if not monthly, barrage of new improved widgets.

Staying current technologically also requires staying current professionally. Continuing education is the only preventative for professional obsolescence and career disasters. Since broadcast engineering as a profession is being challenged on several fronts, it is up to today's broadcast engineer to establish, maintain and prognosticate the legitimacy of the vocation. The broadcast industry must give urgent and immediate attention to the continuity of a broadcast engineering pipeline if competent expertise is to be available in the future. ■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