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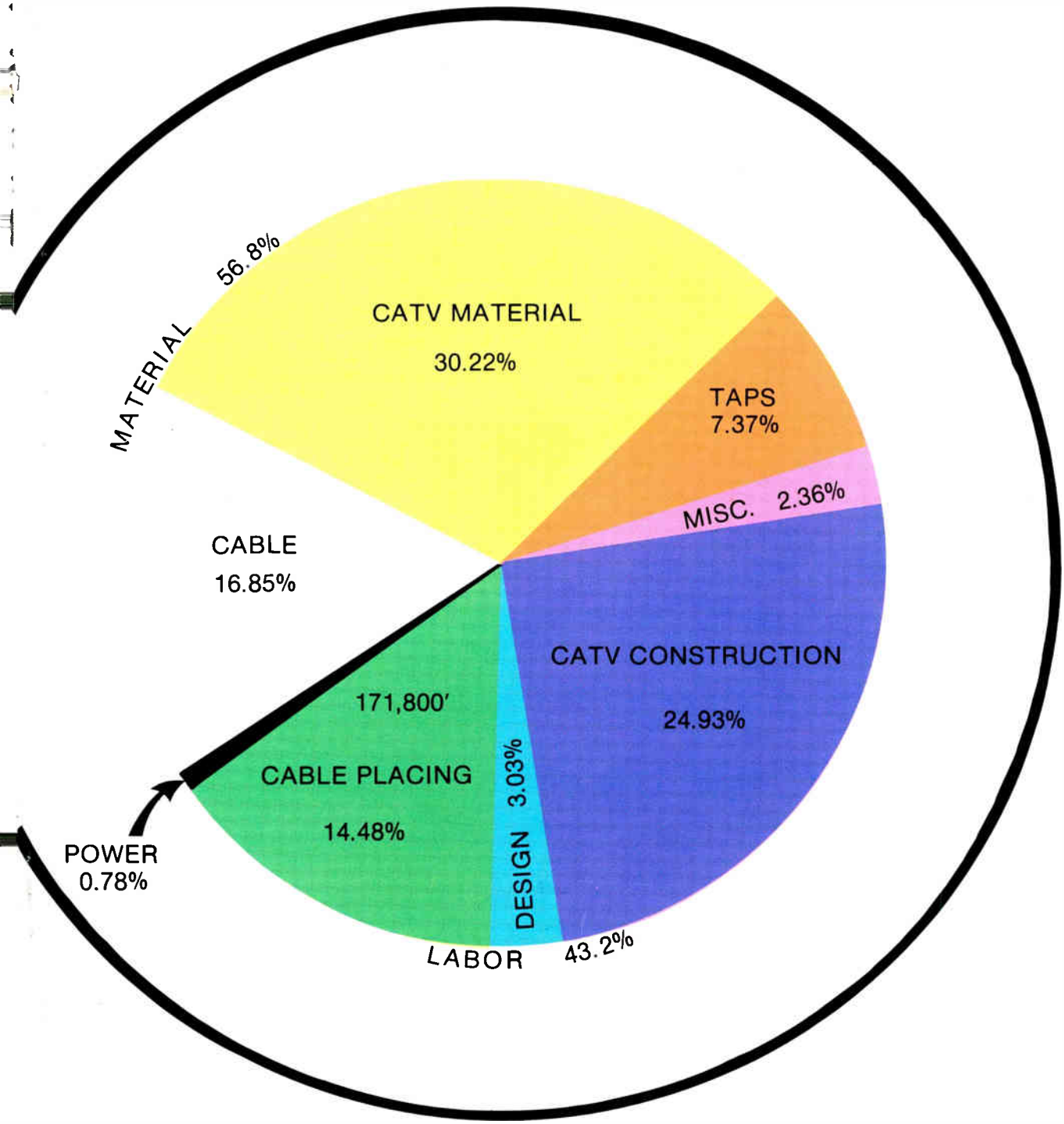

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COVER: This month's colorful cover illustrates the allocation of construction costs as determined by Vancouver Cablevision. See page 18.

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Sixteen Operating and Supplier Companies Join SCTE

WASHINGTON, D.C.—The Society of Cable Television Engineers has welcomed thirteen industry suppliers and three system operators as 1977 Sustaining Members over the past 45 days.

They are Oak Industries, Sadelco, Home Box Office, UA-Columbia Cablevision, Comm/Scope Company, Wheeling Antenna Co., Eastern Microwave, Toner Cable Equipment Co., Belden Corporation, Times Wire & Cable Co., Scientific-Atlanta, Hughes Microwave Communications, Cerro Communications, Magnavox CATV, Vitek Electronics and Gamco.

Robert Bilodeau, president of SCTE, welcomes the companies and thanked them for their support, saying, "These Sustaning Memberships are what allow SCTE to look to the future and continue to provide better membership services without having to increase individual members' dues in the foreseeable future."

As part of a continuing campaign to encourage more Sustaining Memberships and additional industry support for SCTE, thirty letters have been mailed to manufacturing and operating companies requesting their participation and assistance by becoming Sustaining Members.

The letter, outlining SCTE's various programs and accomplishments, has been directed to people who have taken part in SCTE programming, both at a national and a local level over the past two years.

"In some cases, SCTE has provided a great deal of exposure and marketing for companies and has received no income, either locally or nationally," says Judith Baer, the Society's executive director. "There are companies who've contributed support in other manners, such as postage, printing, mailings or advertising support in *The Interval*," she continued, "but we must consider that it takes a great deal of money to promote every SCTE chapter meeting, in addition to our willingness to promote every industry event where technical programming is offered."

According to Baer, additional Sustaining Memberships will ensure that SCTE can stave off a possible increase in individual membership dues for at least another 18 months. "That alone makes it worthwhile for us to tell it like it is, and be aggressive in asking for additional support from these companies," she concluded.

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SCTE **comments**

Judith Baer, Executive Director

Out of the Blocks

On June 22, thirty U.S. and Canadian SCTE members met in Washington, D.C. for an all-day meeting addressing our organization's future. We had operators, engineers, technicians, manufacturers, distributors, marketing personnel, regulators and management included in the group.

The topic of the meeting was "re-organization," but if we are honest with outself, it was more an "organization" meeting since we've never really addressed where we're headed over the years, let alone how we're going to get there!

The prevailing question during the entire day boiled down to our SCTE member's "return on investment" for payment of dues. Are we programming meetings that our members can learn from and are we addressing the average member's needs? What is a representative picture of an SCTE member? What does this member need in order to develop professionally and personally and how can we help provide tools that will benefit the member and our industry? Almost every discussion came full circle back to these basic questions, and truthfully, nobody in the room—individually or collectively—had all the answers. But, we did at least get out of the blocks, and we're going to answer these questions over the next few months.

Many business and administrative matters also were discussed and assignments were made on a lot of areas, including better and more complete reporting techniques on organization funds; additional programming assistance to local chapters from the Washington office; increased involvement with state and regional CATV associations; re-districting of SCTE's chapters; increased participation in local college, university and trade school educational programs; plus other more "mundane" subjects like reviewing the by-laws, and developing an effective membership campaign to continue our growth.

Everyone at the meeting came away with a feeling that something important had happened—whether it was just the interchange of ideas, the airing of opinion, or the actual assignment of a task. Everyone also agreed that the meeting was a normal requirement of an organization that's reached the size and importance of SCTE's membership. It was a natural need and one that, hopefully, will not ever be ignored again in the future of SCTE.

Judith Baer

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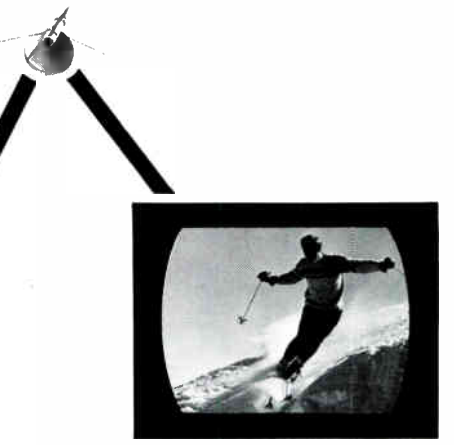

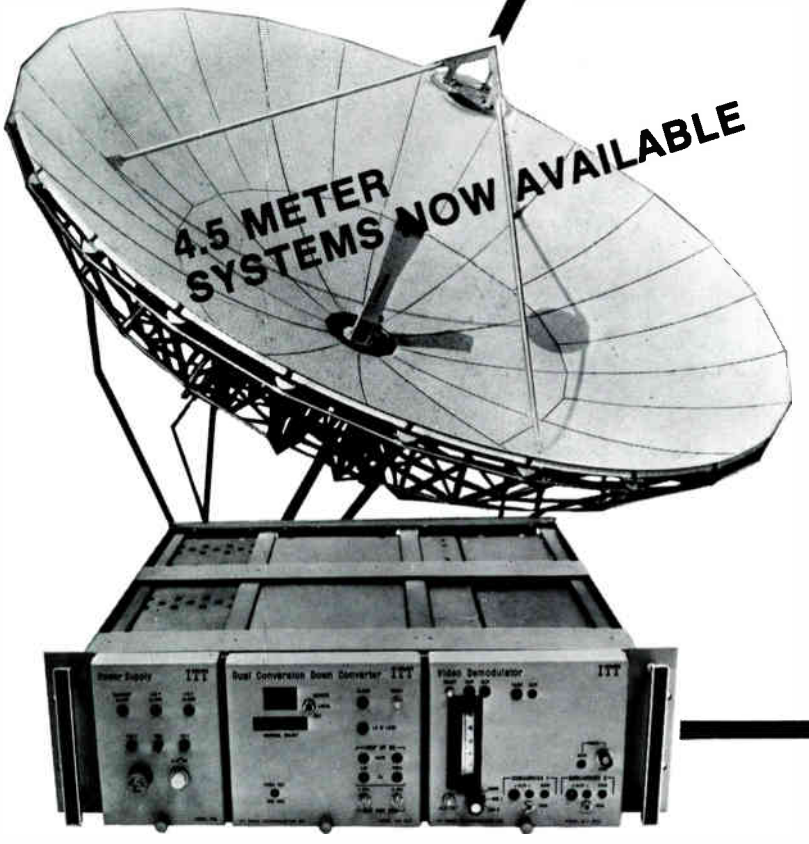

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Technical News at a Glance

. . . **Irving Kahn is at it again.** *He has announced the formation of a new company, General Optronics Corp., for the production of* **optoelectronic components and systems.** *Kahn is serving as chairman of the board of the new firm. Dr. C.J. Hwang, of Hewlett-Packard Labs, has been named president. The company will manufacture and sell gallium arsenide lasers, light emitting diodes, and related systems.*

. . . *The* **National Cable Television Association has named Bob Luff,** *presently engineering assistant to FCC Chairman Richard Wiley,* **as the association's new vice president of engineering.** *Luff will assume his new duties at NCTA this month. Luff joined the FCC in 1970 and has been with the chairman's office since 1976.*

. . . *The debate over how best to bring* **telecommunications services to rural areas** *continues with the latest forum a House subcommittee on communications informal panel session. Points for discussion included* **cost effectiveness of translator-cable-telephone cross-ownership and the regulatory barriers** *preventing their use. Strongly recommended by several participants were certain types of cooperatives backed by REA funds.*

. . . *The Federal Communications Commission has released* **CATV industry financial data for November 1975 to October 1976** *reflecting information from 80 percent of all systems. The average financial entity had approximately 4,000 subscribers with revenues of $376,000. The average pre-tax net income per financial entity was $15,000. The operating margin before depreciation and interest expenses, ranged in most states between 25 and 50 percent.*

. . . *The Federal Communications Commission has finally issued notice of the* **inquiry into the economic relationship between cable and broadcasting** *promised by Chairman Wiley in April. The inquiry is intended to be a basis for the Commission's reassessment of cable policies and rules, and will focus on cable demand and penetration, audience diversion, the audience-revenue relationship and service to the public. Comments will be accepted until December 1.*

. . . *On the Senate agenda this past month was proposed* **pole attachment and forfeiture legislation** *examined in hearings conducted by Senator Hollngs' subcommittee on communications. Senate staffers reportedly found testimony inconclusive; but, as opposed to House sentiments, are more interested in penetrating arguments about fractions used to allocate costs of useable pole space.*

. . . *The Federal Communications Commission has instituted a pair of* **inquiries on AM stereo and FM quadraphonic broadcasting.** *At question are standards for the development of technology and their subsequent impact on the public interest and marketplace.*

news

General Optronics Corp. Debuts As New Laser Manufacturer

NEW YORK, NY—The formation of a new company, General Optronics Corp., for the production of optoelectronic components and systems, was recently announced by Irving B. Kahn, communications entrepreneur and consultant who becomes chairman of the board of the new firm. Mr. Kahn also announced that Dr. C. J. Hwang, a foremost expert in the development of long-life gallium arsenide lasers, has been named president and chief operating officer of the company.

General Optronics, a privately held company organized by a group of scientists and venture capitalists, will be engaged initially in the manufacture and

Kahn

Hwang

sale of gallium arsenide lasers, light emitting diodes, and related systems and devices with advanced state-of-the-art operating characteristics. The company expects to produce lasers with a projected lifespan in excess of 100,000 hours, representing a breakthrough in existing technology.

According to Kahn, "General Optronics has been formed to take advantage of the immediate need for compatible light sources for low-loss optical fiber systems and optical-based data handling systems. Gallium arsenide lasers are the most desirable light source for these and related applications, but their widespread use has been limited by the relatively short lifespan, substantially less than 10,000 hours, of available devices. The production of lasers with projected lifetimes in excess of 100,000 hours requires extreme technological sophistication to grow the wafer and fabricate the device. Dr. Hwang, president of General Optronics, is acknowledged as one of less than a dozen people worldwide who presently possess this level of sophistication. His contributions to General Optronics will guarantee our early leadership position in this new market."

C. J. Hwang, 39, joins General Optronics from Hewlett-Packard Laboratories, Palo Alto, California, where he was a key member of the technical staff responsible for development of long-life gallim arsenide double heterostructure lasers and their application to optical communications. From 1966 to 1973, Dr. Hwang was a member of the technical staff of Bell Telephone Laboratories, Murray Hill, New Jersey, involved in the development, growth and fabrication of gallium arsenide lasers. From 1962 to 1966, he was research assistant and than a research associate in the Semiconductor Laboratories at the University of Washington in Seattle. He currently serves as a visiting consultant to the Instituto de Fisica of the Universidade Estadual de Campinas in Brazil, where he coordinates a group of faculty members and graduate students in gallium arsenide laser and optical communications research, sponsored by Telebras, the Telephone Company of Brazil.

Dr. Hwang, an electrical engineer, received his Bachelor's degree from National Taiwan University and his Master's and Ph.D. degrees from the University of Washington. He was the recipient of a Fellowship from the Bureau of Telecommunications of Taiwan in 1959-60, and of a grant from the U.S. National Science Foundation in 1962-66. Dr. Hwang holds a patent in Gain Asymmetry in Heterostructure Lasers Operating in a Fundamental Transverse Mode. In addition, he is the author of close to 50 published technical articles in his field.

Also joining General Optronics in key posts are Robert E. Albano, who becomes senior production executive; Joseph F. Svacek III, who will be in charge of device testing and automation; and Thomas F. Moscarello, who becomes controller.

Moscarello, 51, controller of General Optronics, began his financial career with H. K. Porter Co., Inc., Trenton, New Jersey, where he held a series of managerial, accounting and controlling posts for 12 years. In 1963, he joined TelePrompTer Corp., New York City, as controller of the Group Communications Division, moved to the post of general manager of the Master Antenna Division, and in 1967, became division controller and assistant to the group vice president of the CATV Division. In 1973, he joined Video Techniques, Inc.,

Irving B. Kahn, in addition to his post as chairman of the board of General Optronics, is also chairman and president of BroadBand Communications Inc., a communications consulting firm, and a director and consultant for Times Fiber Communications Inc., which manufactures optical fiber cables and systems.

Bob Luff Named NCTA Vice President For Engineering

WASHINGTON, D.C.—Bob Luff, engineering assistant to FCC chairman Richard E. Wiley, has been named vice president for engineering for the National Cable Television Association.

Luff's selection was announced by NCTA president Robert L. Schmidt at the June 9 meeeting of the association's board of directors. He will join NCTA in mid-July.

"NCTA is indeed fortunate to have found in Bob Luff an engineer with a breadth of both technical and administrative experience. His intimate knowledge of the Commission will be of great value to NCTA and the cable industry," Schmidt said.

Luff joined the FCC in July 1970 as an electrical engineer in the frequency allocations analysis branch of the office of the chief engineer. In 1973, he was appointed to the staff of the office of

Bob Luff

plans and policy and in July 1976, he became the chairman's engineering assistant.

Luff was born in Dover, Delaware. He holds a Bachelor of Electrical Engineering from the University of Delaware, and has done graduate work in telecommunications policy at George Washington University.

Luff holds First Class Radio Telephone Operator and Amateur Radio licenses. He is an evening instructor in the adult education program of Montgomery Community College in Rockville, Maryland.

Inquiry Begun on FM Quadraphonic Broadcasting

WASHINGTON, D.C.—The Federal Communications Commission has begun an inquiry on whether to adopt standards for FM quadraphonic radio broadcasting. The action was in response to petitions by Pacific FM, Inc., the General Electric Company and CBS Inc.

Quadraphonic broadcasting is an extension of current stereophonic broadcasting in that two rear loudspeakers are added to give a listener the effect of hearing the sound from any or all directions.

There are three basic quadraphonic transmission systems: discrete four channels—4-4-4; four channels by combining the audio channel into three signals to be later decoded in the receiver back into four channels—4-3-4, and four channels by an encoding process into two signals transmitted as left and right stereophonic signals, which then are decoded in the receiver back into four channels—4-2-4.

The Commission said the purpose of its inquiry was to determine whether there was sufficient public and industry interest to warrant adoption of standards for quadraphonic broadcasting and, if so, to develop a record that would assist the FCC in formulating standards. Some of the issues to be resolved before the FCC can propose to adopt specific standards, if any, for quadraphonc broadcasting, and on which it asked for comment, include:

The merits of the 4-4-4, 4-3-4 and 4-2-4 systems as compared to each other, and the evaluation of several system designs proposed by various manufacturers.

Also, on the compatibility of proposed quadraphonic systems with current monophonic and stereophonic receivers, the impact on subsidiary communications authorizations (SCAs), changes in station coverage, studio transmitter interconnections and transmission equipment.

Also, whether the broadcast industry is interested and willing to spend the money necessary to transmit quadraphonic sound, whether there are sufficient listeners interested in quadraphonic sound willing to spend funds to purchase new equipment or adapt existing equipment, and whether sufficient software (program material) would be available for discrete quadraphonic broadcasting.

In addition to determining the ability of monophonic and stereophonic receivers to function normally in the presence of quadraphonic broadcasting, the FCC also said it was interested in determining whether these receivers could be modified or adopted, through practical means, for quadraphonic and, compared with current stereophonic receivers, how much more quadraphonic receivers for 4-4-4, 4-3-4, or 4-2-4 systems would cost.

The FCC said the adoption of standards for each of the quadraphonic systems might create problems or produce less than optimum sound reproduction or station coverage. Therefore, it said it was important that broadcasters consider the effects on station coverage, protection ratios, increased occupied bandwidth and multipath that are characteristics of 4-4-4, 4-3-4 and 4-2-4 systems.

The Commission noted that U.S.-licensed broadcast stations were subject to international radio agreements to which the United States is a party, and that any proposed use of a new type of FM signal transmission must conform to these agreements, which the United States cannot unilaterally modify. Accordingly, it said, any proposed transmission for FM quadraphonic broadcasting not in accordance with these provisions would require negotiations on modifications.

The Commission urged radio equipment manufacturers, broadcasters and the listening public to make known their interests and to contribute relevant information to assist in this proceeding. Comments are due by September 15, replies October 17.

Canadian SCTE Membership Growing

WASHINGTON, D.C.—The Society of Cable Television Engineers welcomed nearly 75 members from Canada during May, 1977. Fifty-six affiliate members joined from the Ontario region of Canada and 15 individual members joined from the Province of Quebec, bringng the Quebec membership over 50 and eastern Canadian membership to an all time high. Members in the Ontario region are affiliated under the Society of Cable Television Engineering.

"This enthusiastic support from Canada further proves that both CATV and SCTE are international in nature," said Robert Bilodeau, president of SCTE. "Canada has long been respected for its sense of professionalism and proneering spirit with technology in the cable television industry. We welcome this participation in SCTE," he concluded.

AM Stereophonic Inquiry Instituted

WASHINGTON, D.C.—The Federal Communications Commission has opened an inquiry to determine whether there is an interest and need for AM stereophonic broadcasting and, if so, to

develop a record to assist the FCC in proposing standards for such a service. AM stereophinic broadcasting is defined as the transmission of a stereophonic program by a single AM broadcast station utilizing complex modulation of the carrier wave within the authorized bandwidth.

The inquiry was begun in response to rulemaking pettions by Kahn Communications, Inc., and the Association for AM Stereo, Inc. (AAMSI). Kahn is a New York corporation engaged in research and manufacturing of electronic communications, telephone and broadcasting equipment, that has developed a system for transmitting stereophonic signals for the AM broadcast service. AAMSI, a nonprofit corporation of 26 broadcast station licensees and one equipment manufacturer, was founded for the purpose of encouraging the adoption of AM stereo standards.

Kahn contended that use of its technology for compatible stereophonic transmission by AM stations would allow listeners to enjoy stereophonic reception with little or no additional investment in receiving equipment. It asserted that its system was completely compatible with existing transmitting equipment and with monophonic receivers, would cause no additional interference to other stations, would provide stereo reception using two conventional receivers and could provide high quality stereo with receivers designed for AM stereo reception.

The Commission requested the public, broadcasters and manufacturers of both broadcasting and receiving equipment to comment on Kahn's recommendations, to respond to specific questions concerning the economic, operational and technical aspects of establishing AM stereo and to submit any additional information they believe should be considered.

If sufficient interest and need should be shown, the Commission said that in addition to technical matters, it must also consider administrative procedures for implementing the service. These, it said, would depend on the degree of technical changes in the transmitter or antenna system that might be required in converting stations for stereophonic broadcasting.

The Commission said it must be recognized that AM stereo might have both an operational and technical impact on existing AM in such areas as signal coverage and monophonic signal quality. Therefore, it stressed that the information requested would be needed in attempting to balance this potential impact on AM radio and the public interest and need for AM stereo. Comments may be filed by October 15, and replies by November 15.

Emerson Wins SCTE Membership Contest

WASHINGTON, D.C.—Jim Emerson of Northern CATV Distributors in Manlius, N.Y. and president of the Upstate New York Chapter of the Society of Cable Television Engineers, is the winner of SCTE's Sustaining Membership Drive, according to Robert Bilodeau, president of the Society. Emerson received a check for $250 last month.

"These memberships afford SCTE the opportunity to offer more membership and industry services," Bilodeau said. "They succeed in placing SCTE in a more sound financial position and allow us to plan further ahead in our everyday business affairs."

June 15 SCTE began an all-out campaign to recruit additional Sustaining Members. Directed from the D.C., SCTE Sustaining Members are both industry operating companies and suppliers, some are regional and state CATV associations which have worked with the Society in staging technical sessions and meetings.

The memberships are $100 per year and that amount is tax deductible. Each member receives an attractive wall plaque for display.

Southern Show To Feature Hands-On, Basic Technician Training

ATLANTA, GA—The Southern Cable Television Association will host its 17th Annual Meeting August 21-23, 1977, featuring reduced registration rates, in-depth "hands-on" sessions, exhibits, representatives from more than fifty manufacturing companies, and the Federal Communications Commission Field Enforcement Testing Van, all for engineers and technicians in the southeast Development and staging of the technical programming for the meeting has been done by the Society of Cable Television Engineers, and the Southeast Chapter of SCTE, through the leadership of Guy Lee of Georgia Cablevision.

"It's simple," says Lee, "we're developing programming that the average system technician can take back and make immediate use of, around our theme of 'Tech Topics to Take Back to Work." Included as part of the three day meeting will be a major session Monday morning on Basic CATV System Headend Operations that will last four hours and feature a working systm headend.

Discussions will be presented on signal processors, de-modulators, modulators, video-FM, automatic switching techniques, UHF fades, CB interference, power outages and testing techniques for the system. "We've left Monday afternoon unstructured," says Lee, "with the hope that participants will fell free to visit the exhibits, tour the FCC Field Enforcement Van or talk further with the instructors of the Headend Operations session."

Registration for the Southern Cable Television Association's technical sessions has been discounted to $18 for the entire program, including Sunday evening's Social-Buffet opening of the show. Low cost housing is available by an inquiry with Judith Williams of Cox Cable at 404-393-0480. Other information about registration is available from Otto Miller at 205-758-2157.

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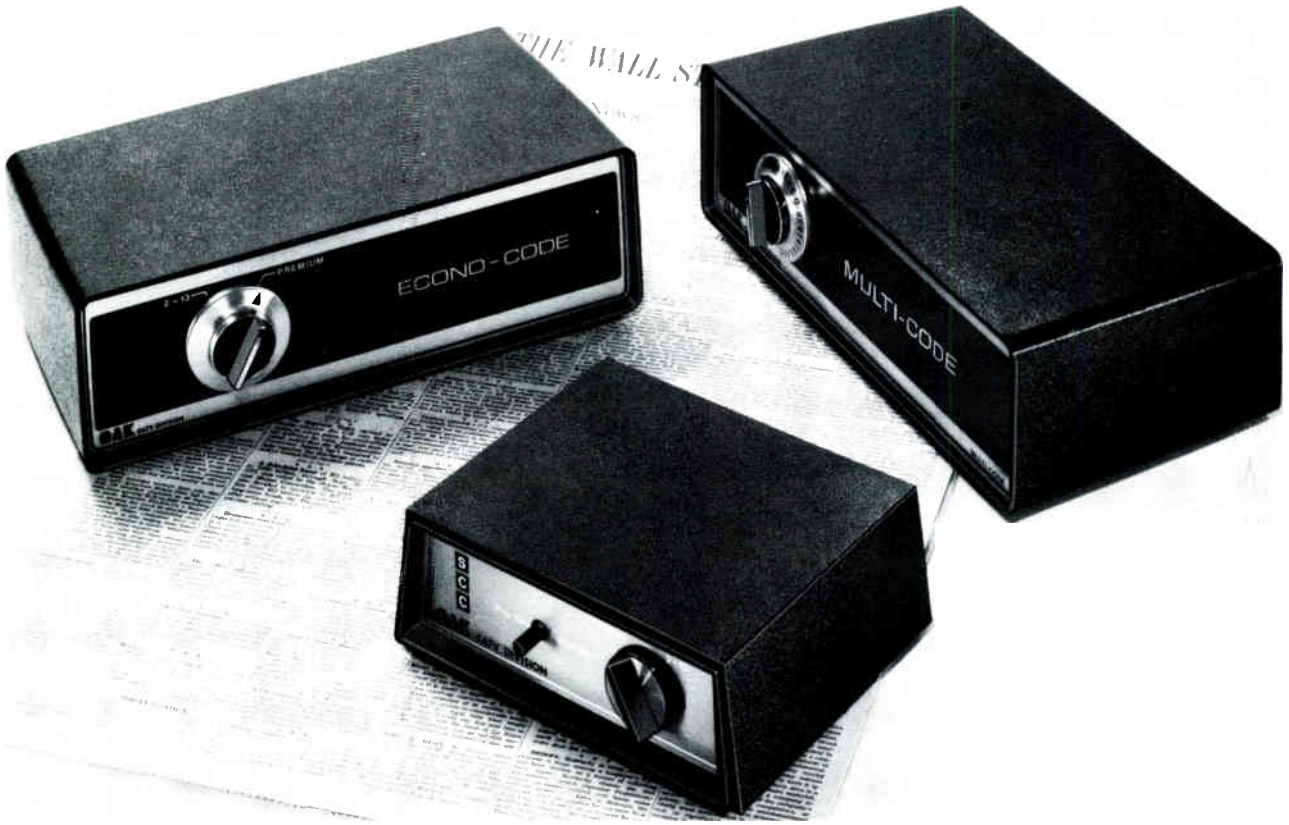

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Earth Station Symposium '77

Scientific-Atlanta welcomed over 200 to its three day earth station seminar held June 13, 14 and 15 in Atlanta, Georgia. A well planned program of speakers and panelists ran the gamut from programming to polar mount geometry complete with charts, diagrams, photographs and equations. The sessions were supplemented with a two hundred pound blue notebook filled with all the technical papers in case attendants couldn't take notes fast enough.

Jay Levergood, vice president of marketing, moderated the first day's introductory sessions with S-A's Ken Leddick delivering an overview of video earth station equipment. Harry Stemple of Comsearch, Dan Yost of Compucon and Pat Marr of SAFE participated in the frequency coordination panel providing information on "How to Start an Earth Station Project."

A surprising turnout of broadcasters prompted much discussion on the first day regarding the use of earth station technology in that industry. Don Cavell of NBC questioned the panel (RCA's Harold Rice, Western Union's John Norcutt, Southern Satellite's Skip Farmer and Mark Foster of Satellite Networks, Inc.) on the problem of security. He asked how carriers expected to deliver only to those stations authorized to receive. He was assured by the panel that several different techniques were in developmental stages and there would be no real security problem.

In answer to a question posed as to why broadcasters have been relatively slow in accepting satellite communications, one CBS affiliate in the audience expressed his opinion that networks were afraid of pre-emption of their programming. Cavell cited the difficulty in doing pick-ups from as many as 200 different locations. "You can't do pick-ups with dishes." There are companies, however, who are presently providing programming via satellite to network affiliates. Tuesday's luncheon speakers included representatives from the Christian Broadcasting Network, Spanish International Network and the Independent Television News Association. All make programming available to affiliates via satellite.

FCC Applications for Earth Stations was the final topic of discussion on Monday. Bill Reynor, attorney with Hogan and Hartson, addressed the subject. Question from the audience: "What would you charge for your services in helping a cable system complete the paperwork and file application with the FCC?" Reynor's reply: "It could be as little as $200 or as much as you can imagine (laughter from the audience), depending on how many problems are

encountered." Reynor indicated that the FCC has plans for adopting specific rules for filing earth station applications within the next three or four weeks. That should simplify this beginning step.

A very detailed program of earth station technology began Tuesday morning with S-A's Ken Leddick moderating. Subjects included *Satellite Link Analysis, Earth Station Design Criteria and Equipment Layout Considerations* and discussion of both the 10 and 5 meter antennas. Panelists included Tom Williams, Jim Cook, Robert White and Marvin Shoemake, all Scientific-Atlanta engineers.

A question from the audience regarding construction and design of antennas; "Why not design a 5 × 10 meter antenna using the same configuration as some radar antennas - just a section of a parabola with the bottom and top of the dish lopped off?" Answer: "Not significantly more economical in terms of production costs."

Sessions reconvened Tuesday afternoon with Fred Fonda addressing *antenna structural design* followed by Heinz Wegener's in depth coverage of video receiver and exciter performance and design, video threshold extension for the small aperture earth station and FDM/FM message receivers and exciters. Barry Sharp brought the Tuesday sessions to a close with his paper on *Downlink Video Protection.*

Wednesday's program covered *Transmitting Earth Station Equipment, Earth Station Equipment for Additional Services, Performance Comparison of 5 and 10 Meter Earth Stations, Technical Requirements for FCC Filing, Remote Control and Monitoring Considerations* and *Earth Station Installation and Peformance Verification.* Panelists included Clifford Searles, Bob Placek, Jim Hart, Patrick Bohana, Tom Williams, Larry Lawson and Richard Barnes, all of Scientific Atlanta.

A tour of the S-A plant and one of the WTCG-TV earth station facility were included in the 3 day program.

Note: Scientific Atlanta is in the process of developing the design for a transportable earth station. A number of requests for this type of antenna have been received by the company. The hold up has been in standardizing specifications. Each request received has had different spec requirements. Questions like "What do you define as transportable?" and "How large a crew will you use for erecting?" must be answered in order to determine a common base from which to begin. You might let the engineering staff at S-A know what you feel is necessary along these lines and speed development. □

Construction Cost Estimate Procedure

By Bing Quon Mui,
Plant Manager, Vancouver Cablevision Ltd.

The success of a cable television distribution system depends on the effective control of a number of elements. Some of which are predictable and some are nebulous. One important element one should attempt to control is cable plant construction cost.

The Systems Design Centre of Vancouver Cablevision (formerly Canadian Wirevision) Limited has employed a cost estimate and control procedure which has yielded quite reasonable results since the 1960's. Our procedure was evolved and based on patiently gathered empirical data from the completion of hundreds of miles of wide bandwidth coaxial cable construction projects. The dollars and cents it takes to build a given size of cable television plant does not stand alone (nor should it) as the criterion or even the definition of success. However, knowing the cost range within which a given construction undertaking will fall must provide the system manager or operator with a modicum of confidence in his planning of his system's financial balance sheets.

From almost any vantage point, Vancouver Cablevision must be ranked amongst the largest CATV systems in the world. Besides serving the city of Vancouver, the system also feeds Richmond and the larger portion of Burnaby. We have over 7.6 million lineal feet (or over 2325 kilometres) of cable distribution plant, more than 6100 solid state trunk and secondary amplifiers, close to 500 AC power supply stations (many of them the battery standby type) and tens of thousands of in-line tap-off devices. Subscriber saturation is around 90 percent and currently around 215,000.

The topography of our service areas ranges from over 500 feet at Oakridge and Burnaby to a couple of feet below sea level in Richmond. Portions of the coaxial cable system could be high and dry strung along the telephone messenger wire or else immersed most of the time under water which is frequently salty. Proximity to the Pacific Ocean and a moist climate necessitates jacketed cable throughout the system. Housing density ranges from single detached houses to townhouses to multitenant highrises of the west end.

Over 90 percent of Vancouver Cablevision's plant is attached to pole-line and conduit facilities of the B.C. Telephone Co. The remainder is either in our own conduits or direct buried in joint trenches. Most new expansions are underground and in the township of Richmond. All our subscribers receive excellent reception of 12 (soon to be 14) TV channels plus FM service. With the enumerated magnitude of plant and geographic diversity, a systematic and consistant approach to construction cost estimate and control is a prerequisite to the system's operational viability.

Construction Cost Estimate Form

The construction cost estimate and control procedures we have developed are but a section of our step-by-step systems design and construction procedures. Mainly because of the size of our plant and the fact that we attach our cable to telephone facilities, much of our construction is the "forced rearrangement" variety. Another source of necessary construction are new subdivision developments and condominium housings. Our construction program also includes company initiated rebuilds of defective or antiquated plant.

All these accountable reasons result in about 100 to 200 projects in our "to-be-constructed" files at any one period. Of these, our construction forces usually work on 10 to 20 jobs in any one week. It is the large number of projects generated

in our system that makes it necessary to have a methodical approach to our cost estimate and control procedure. Since the actual designing of any project depends on usually local requirements and established technical parameters, we shall bypass that facet of our routine in favor of the cost estimate and control procedures.

The cost estimate procedure form we have is divided into two major divisions, material and labor. These are in turn sub-divided into smaller headings relevant to our operations. Since labor cost and material cost are never constant for long, our cost estimate procedure also undergoes adjustment periodically. The labor productivity rate as well as the cost per man-hour is reviewed every six months and adjusted at least once a year. Material costs are updated whenever new prices are posted (Appendix A).

Materials

Amplifiers, CATV Devices . . . include trunk and distribution amplifiers, directional couplers, line splitters, line splices, amplifier equalizers and flat attenuators as well as 75-ohm terminators for trunk and distribution lines.

Power Supplies . . . refer to the AC power stations that provide the 30 volts (or 60 volts) to power the amplifiers in the system. The whole package consist of the power unit, housing, mounting hardware and the appropriate grounding rod. It could be mounted aerially on a pole or bolted to a concrete pad poured on site.

Cables are listed by nominal sizes . . . our practice is to allow about 5 to 10% more than the designed or measured amount as slacks and wastage before cost extension.

Directional Taps . . . include aerial and pedestal mount housings complete with the right kind of connectors. The directional tap plates are either four or eight spigots modules. Two spigots plates were found to be too restrictive in our urban environment.

Miscellaneous Hardware . . . would encompass all the little odd items not specifically ordered for any job but carried as truck inventory and charged as they are utilized.

Labor

System Design and Drafting . . . include all man-hours required from the opening of the file, through driving, designing, cost estimates, etc. to the recording of the measured levels onto the master file drawing.

Cable Placing . . . includes all costs associated with the placing of the cable onto telephone messenger wires or pulled into the telco conduit system. The B.C. Tel Company is our cable placing contractor as our plant is attached to their facilities almost exclusively. Therefore, all B.C. Tel engineering time, vehicle expenses, tree trimming costs, traffic control services and any other legitimate expenses incurred in the process of placing our cable are charged to us under this heading.

CATV Construction . . . means the installation of all CATV or electronic devices, setting and recording all input and output levels to specified standards.

Power Supply Installation . . . refers to the installation of power supply housing on pole or concrete pad. AC plug and circuit breaker. Batteries if the standby type. Energizing and the final check for proper operation.

The preceding headings or divisions are by no means the only acceptable categorization. We have found that these are few enough to be manageable but broad enough to contain all the

PROJECT NAME _____ W.O. NO. _____

DWELLINGS TO BE PASSED _____

PROJECT TYPE

- ☐ NEW
- ☐ REWORK
- ☐ AERIAL
- ☐ BURIED

CONSTRUCTION PRIORITY

- ☐ 1 - FORCED BY OTHERS
- ☐ 2 - NEW EXPANSION
- ☐ 3 - CO. INITIATED
- ☐ 4 - DISCRETIONARY

FILE OPENED _____

CONSTRUCTION STARTED _____

CONSTRUCTION DONE _____

CONSTRUCTION COST ESTIMATE FORM

		ESTIMATED $	ACTUAL $
MATERIAL	AMPLIFIERS, CATV DEVICES		
	DIRECTIONAL TAPS		
	POWER SUPPLIES, POWER SERVICES		
	MISCELLANEOUS HARDWARE		
	FT. .412" CABLE		
	FT. .500" CABLE		
	FT. .750" CABLE		
	MATERIAL TOTAL		
LABOUR	PLANNING & DRAFTING		
	CABLE PLACING		
	CATV CONSTRUCTION		
	POWER SUPPLY INSTALLATION		
	LABOUR TOTAL		
	TOTAL PROJECT COST		
RATE AVERAGES	PROJECT COST PER FOOT		
	CATV RATE FT. PER MAN-HOUR		
	PLACING RATE FT. PER MAN-HOUR		
	COST PER DWELLING PASSED		

Appendix B

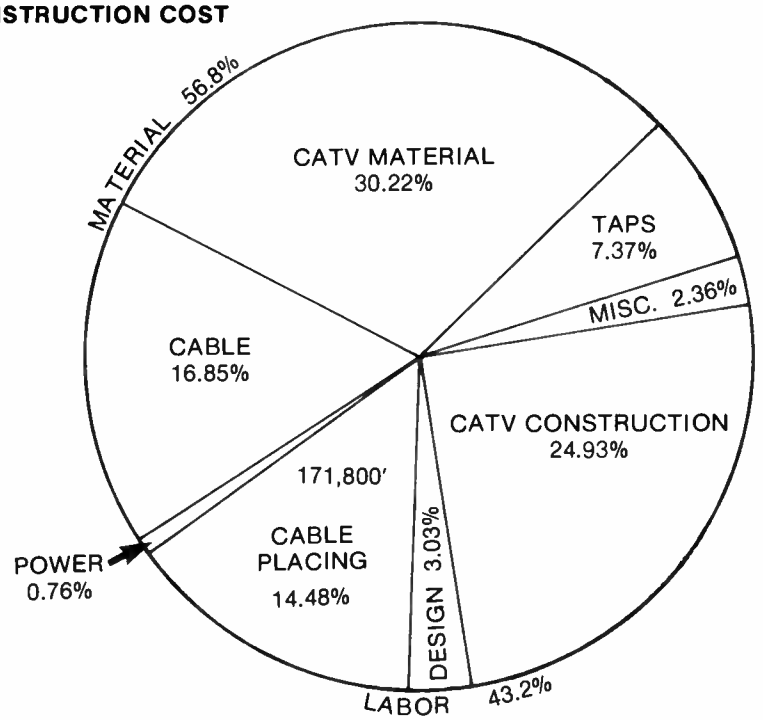
Idealized Rate Chart

		Project Category									
		1		2		3		4		5	
		N	R	N	R	N	R	N	R	N	R
CATV Constr @ hour	Aer	45′	40′	60′	45′	65′	50′	75′	60′	80′	65′
	UG	35′	30′	40′	35′	45′	40′	50′	45′	60′	50′
Rate		$15.00/man-hour									
Design @ ft.		$60 + 10¢	$60 + 12¢	$60 + 5¢	$60 + 10¢	4.9¢	5.5¢	3¢	4¢	2¢	1.5¢
Misc. Hdw.	Aer	1.75¢		1.5¢		1.25¢		1.0¢		0.75¢	
	UG	7.0¢		5.0¢		4.5¢		4.0¢		3.5¢	
Cable @ ft. Place	Aer	55¢		45¢		35¢		25¢		20¢	
	UG	75¢		60¢		45¢		40¢		35¢	
Pwr Stn		16 man-hour per stn. installation 3 m-h design									

This chart is a close approximation of Vancouver Cablevision Ltd. chart.

Appendix C

CANADIAN WIREVISION LTD.
1972 ACTUAL CONSTRUCTION COST



CATEGORY
COMBINED

STRAND FIG. 256,255 FT. or 48.53 MILES

material and functions relevent to our construction projects. Whenever the situation demands it, we have created the extra heading so a special item of cost can be displayed.

The other important feature of the cost estimate form is the provision of a column to record the actual expenditures for each heading. This feature makes it possible to determine at a glance how close the estimate compares with the actual after all the bills and charges are tabulated. The value of the whole cost estimate procedure is that consistant application will yield fairly predictable projections for future projects.

Project Types

We encounter many types of construction in our building of the Vancouver Cablevision Ltd. system. Each type has its own peculiarity and complexity. So that we may be able to compare the cost of similar types of projects, we've developed different classifications of construction.

Aerial . . . indicates projects to be placed on pole line facilities above ground.

Underground . . . indicates projects to be pulled into conduits and man-holes or else direct buried.

New . . . means plant extensions into areas with no previous cable television service.

Rebuild . . . means reworking or rebuilding an existing portion of a system at the request of the municipal authorities or the telephone engineers. The requests usually originate as telephone facility upgrading or to meet some newly pro-claimed municipal bylaw; to relocate overhead utility lines to underground for example. Rebuild could also be initiated by our own corporate policy to replace antiquated equipment or to expand the system's frequency spectrum.

By selecting the right combination of the preceding classifications one should be able to represent most types of construction encountered on a broad basis. On occasions we have had a class for conduit construction. We had to prepare trenching detail drawings, develop acceptable digging and backfilling specifications, apply for and obtain all the necessary permits from the city authority, maintain good public relations with property owners along the construction route and to complete the project within reasonable limits.

All the above were made easier because we approach every one of our projects with a systematic design and cost estimate procedure. Sometimes, to be more specific we have sub-classifications of our project types. We distinguish between different types of rebuilds such as "street to lane" or just a "strand (messenger wire) replacement" along the same pole line. However, one need not be so specific in a small system or a relatively constrained construction program.

Project Size

Regardless of the size of a construction project, certain amounts of paper work, office routine and similar start up cost are integral to the final balance. For this reason, projects of similar sizes are grouped together in our cost comparison studies.

Category 1 . . . are projects under **500 meters**
Category 2 . . . are projects between **500 and 1000 meters**
Category 3 . . . are projects between **1000 and 500 meters**
Category 4 . . . are projects between **5000 and 10,000 meters**
Category 5 . . . are projects over **10,000 meters (10 kilometers)**

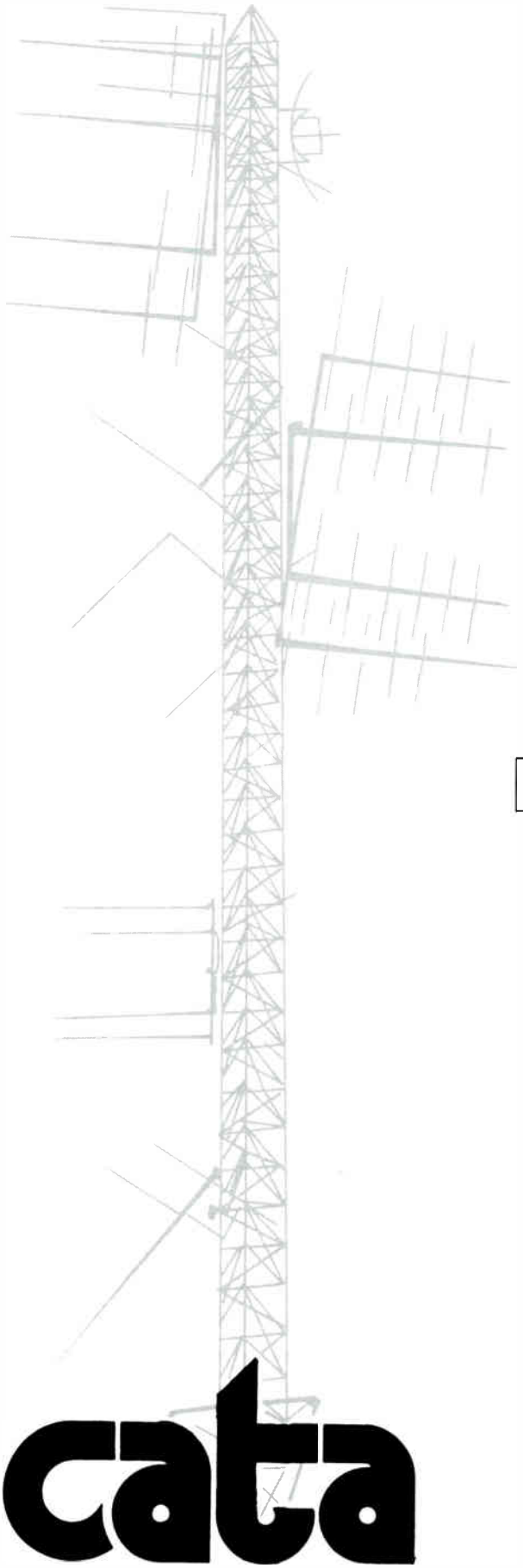
The Manpower

Procedures, project classification, project size and material are intangible without the skilled manpower to put them together. The manpower of our company for the construction program comes from highly trained electronics technicians selected through an apprenticeship training curriculum and on-the-job experience. Although every man can perform every function of any construction job, we tend to group the men into teams that specialize in certain aspects of each project. For example, we have trucks equipped especially to install power supply housings. Again this type of specialization is possible mainly because of the size of the construction program.

RATE FACTORS

The key to our construction cost estimate procedure is our construction rate chart (Appendix B). It was developed over a period of years and constantly updated. Since every company in every locality has their own labor pool and different levels of proficiency as well as pay scale, our cost-per-foot for a typical project cannot be adopted across the board. However, it should be possible to use our rate chart as a guide to develop one's own by keeping careful records.

Success in controlling expenditures in a CATV system's plant construction program will contribute to the overall success and viability of a system. By developing and adhering to a dynamic cost estimate and control procedure, keeping consistantly accurate records and having an empirical rate chart, it is possible to predict with a reasonable degree of accuracy the range within which a plant construction project will fall. The Cost Estimate and Control Form of Vancouver Cablevision Ltd. and an idealized Rate Chart are offered as guides. The pie-graph (Appendix C) showing typical cost percentages for our company's 1972 east division construction program is also offered for reference. Subsequent yearly studies using the same methodology have corroborated the 1972 study with one significant trend; the labor components are on the rise. Our latest compilation indicates an almost one-to-one relationship between material and labor. □



microwave mission

Excerpts from the prepared text of comments by Kyle D. Moore before the FCC.

CATA has been, as you are aware from our small earth station docket of this past year, very much involved in technical filings and in exploring new and better ways to provide improved television service to rural Americans. I'd like to touch on just one such area where we believe the Commission can be very responsive to the needs of rural America. That area is low cost microwave for rural communities.

I hold in my hand a modern, solid-state microwave station. Let me turn it around in my hand and pass it around among you. This is a complete 20 milliwatt microwave transmitter and receiver. The funny fan-shaped device on one end is the antenna. All a cable operator has to do is to plug a television picture with its accompanying

sound into this device and aim the fan-shaped antenna across the countryside or over the river. Then five or 10 miles distant another identical device to this is used as a receiver. By connecting a small add on electronics module to the receiver end of the circuit, the cable operator would have the original television picture and sound delivered at the five to 10 mile distant point; without any interconnecting cables.

Now here is the astounding part. The total cost of this package, including the fan or horn-shaped antenna, is $108 per channel. That's one hundred and eight dollars. And that includes a profit for the company that builds these units!

Now let me tell you what a typical CATA member system could do with a microwave package such as this. Based upon a study CATA performed this month, we know that the typical CATA system could . . . with this package . . . serve rural settlements with as few as 10 homes. Using a combination of such units, a typical CATA system could serve several hundred additional homes . . . rural homes . . . in areas that are too thinly populated to support the normal cable trunk and distribution lines it would take to presently reach these homes. And these additional rural homes would be receiving their first, quality service, multiple channel television in the process.

Now this is not an engineering forum and I will not attempt to get technical. However, CATA is planning several practical demonstrations of this approach to low-cost microwave at our CCOS-77 Seminar this summer in Oklahoma. I would like to re-make the point that the total microwave transmitter, with its own antenna, is currently available at the $108 price tag. It is not the figment of some engineer's imagination.

But there's at least one hitch or fly in the ointment.

Under the present FCC rules and regulations as they apply to microwave licensing requirements and equipment type acceptance, we cannot use this little box. In other words, the box is not legal for CATV service. It does not meet the strict FCC technical requirements for microwave. Now, suppose we took this complete transmitter package and did some more engineering work on it . . . to make it legal for CATV CARS band microwave. Then what would we have?

Well, it turns out that this has been done or is being done at this time by the internationally known manufacturer of the equipment. Similar work has been done and is being done by our CATA lab in Oklahoma.

Remember that $108 per channel price tag? To make this piece of equipment meet the technical requirements of the Commission's present-day microwave rules will drive that $108 price tag up to around $2,400 per channel. This is still a significant price reduction from other presently available microwave . . . but it is not good enough. That one hundred and eight dollar figure is much better, and allow me to explain why.

Remember the ten homes I could afford to serve, economically, with the $108 box? Well, at $2,400 per channel per box, that 10 homes has just grown to approximately 150 homes. In other words, where with the 108 dollar unit could afford to serve settlements with as few as ten homes, now with a 2,400 dollar unit I am restricted to settlements or communities of approximately 150 homes. This is a most significant 15 to 1 ratio.

I would like to leave this topic with the following thought. Technology has now reached the stage of development where it can actually help the FCC achieve the goals and dreams of 1952 or 1953; that dream being the reception of quality, multiple channel television by virtually every home in America. This box is proof of that technology. The demonstration of this box and others like it at CCOS-77 this summer will be the living proof that technology has the ability to expand multiple channel television to virtually all of the television deprived areas of this country.

But there is a challenge here which CATA believes the Commission must address itself to. And that challenge is regulation. The present day microwave regulations were drawn up and laid down for the most part in the 1950's. In the ensuing twenty five years the technology has changed many times. But the imposition of 1950 era regulations has not changed; it has not kept pace with the technology.

CATA believes a whole, fresh, new look at the microwave rules and regulations is in order. We believe that if the present day rules that restrict the advance of technology were re-appraised and if the rules were not merely relaxed but totally rewritten from the ground up, that the Commission's 1952 dream of quality television for all Americans would move several steps closer to realization.

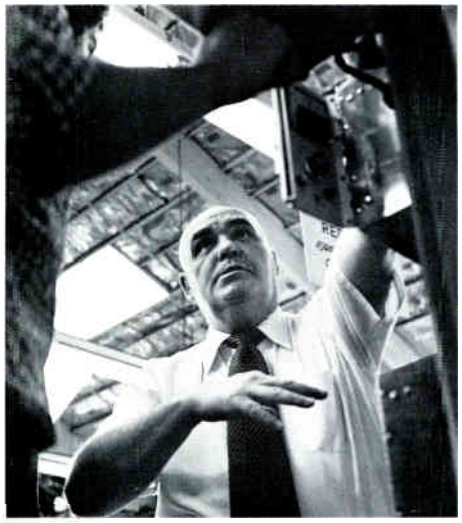
In this specific regard the Community Antenna Television Association will late this summer propose to the Commission, in a formal request for rulemaking, several significant changes in the way microwave regulations are now written. We will suggest that in areas of the United States where existing microwave bands are not occupied as greatly as they are in metropolitan markets that in these rural areas Rural CATV Relays be authorized on a shared, non-interference basis. We will petition the Commission that new microwave services be opened up with as few rules and as few restrictions as possible, to encourage the rapid implementation of American ingenuity and American technology to solve rural American problems with inadequate television service. We will suggest that by starting off with as few rules as humanly possible, that we challenge American technical know-how to solve the problems of distance and reliability for lowest possible cost, without the artificial and often unnecessary expensive refinements which contribute not one bit to microwave system performance; only to its cost.

Positive assessment of this bold, new approach to making quality television possible and practical for rural America will require a bold and innovative Commission. We will suggest that the Commission view this rulemaking not in terms of protecting some existing technology but rather of the public good of providing first-time television to Americans who have been patiently waiting since 1948 for its arrival.

Our proposal will be uncomplicated and that will make it vulnerable to the oftentimes instinctive attempt to complicate or burden new proposals with regulations purely for the sake of regulations. And therein lies our real challenge to the Commission.

We will perform if you will resist inner-inertia drives to make something that is low in cost and simple to apply expensive and difficult to apply with needless regulations.

In this situation, the potential to serve rural, really rural, American homes with quality, multiple channel television depends totally on the cost being kept very, very low. This includes the cost of the equipment and the equally expensive cost of complying with regulations which serve no real purpose except for their own administration. CATA will urge that the Commission move with lightning speed to approve this innovative expansion of rural microwave technology for rural American television service. And we will do so not only on behalf of CATA's 600 member systems, but also on behalf of America's several million rural homes which to this day are still waiting, after 30 years, for their first quality, multiple channel television service. □



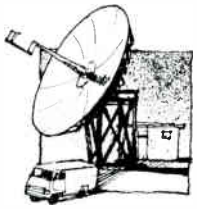
Questions and answers about

Microwave for CATV

Jim Hurd, Farinon's resident expert on the microwave problems of CATV operators, answers a few questions about the use of microwave in the cable television industry.

Q. Where do you see CATV operators using microwave transmission systems, Jim?

A. Earth station backhaul and



CARS are the applications. Our SS12000 remodulating radio is providing operators with a good clean way to bring video information into their headends.

Q. Couldn't most CATV operators use cable for that?

A. Most used to. Many still do. But in the past three years there has been a big move to CARS microwave. Farinon alone has supplied at least 20 Farinon-type SS12000 microwave systems for HBO backhaul. Cable requires constant maintenance—a steadily escalating labor cost that never goes away.

Q. Money! Speaking of which, I've always assumed that microwave radio costs would be out of the question.

A. Again proving you don't want to assume anything. Sure, microwave represents a sizeable investment in plant. May take some financing. But there are offsetting investment tax credits and operating cost reductions that make microwave attractive, even from an economic standpoint. Plus the additional factors of security, independence and *control* that are often decisive in choosing to go to microwave.

Q. What about maintenance of your SS12000 microwave systems? Will I need a lot of exotic gear?

A. No, sir. The same counter you now use to meet proof of performance on your cable system will do for the annual proof. Our built-in metering takes care of all routine maintenance.

Q. What kind of signal will I deliver with microwave?

A. You're well aware that color TV is vulnerable to differential phase and gain problems. System operators tell us that our microwave system is virtually transparent, even over several hops. Of course, our FV13F heterodyne radio is what you would probably use for a multi-hop system.

Q. I've got a couple of special questions about our system, and I would like some names of Farinon users. Mind if I give you a call?

A. Not a bit. Glad to help and give you references. Give me a shout at (415) 592-4120.

Farinon Electric, 1691 Bayport, San Carlos, CA 94070.
Phone (415) 592-4120. Telex: 34-8491.
In Canada: Farinon Electric of Canada, Ltd.
657 Orly Avenue, Dorval, P.Q., H9P 1G1,
Canada. Tel. (514) 636-0974. Telex: 05-82-1893.

Farinon

Reliable Design for Field Installation and Tests

Part II

A. Lochanko
American Electronic Laboratories, Inc. (AEL),
Lansdale, PA

With a primary design objective for the Wilson, North Carolina trunk station being the minimization of performance degradation for the broadband, extremely flat, low distortion hybrids, it is necessary that all circuitry in the station be flat, have good return loss, and minimize loss and distortion. As seen earlier in Part I of this article, not only is the design of the circuit important but also the circuit's location is important in determining the station's performance. Maintaining at least an 18 dB return loss not only ensures a minimum deterioration in flatness of the hybrids but also limits the number of controls necessary to optimize that flatness.

As a result of all these considerations, the number of "pooch" adjustments in the trunk and bridger modules has been held to two. These two controls take corrective action at the extreme ends of the bandpass only, not in the middle of the band.

Some of the station's features which affect the flexibility of the system and its quality are worth restating:

a) Fixed plug-in cable equalization is of a split type: one plug-in equalization is at trunk amplifier input, and the second plug-in equalizer is in the interstage area.

b) The same approach is taken for the fixed plug-in attenuators. These approaches allow the optimization of carrier-to-noise ration and low distortion for a great variety of cable spans; it accommodates a variety of block tilt and slope combinations required in different system designs.

c) The diplexer design approach results in an exceptionally flat frequency response and match, low insertion loss, and a cross-over point attenuation and selectivity which eliminate interaction between the forward (trunk) and return paths. The group delay is kept at very low values.

d) The directional couplers, splitters and rf cabling are of reliable high quality type (low losses, good match and flat overall frequency response).

e) Match at all ports is extremely flat over the frequency band of interest with monotonic rising characteristics at the band edges. This is achieved by careful rf layout and trimming techniques.

f) Low density distribution of the rf circuits and passive devices ensures good isolation between the housing ports.

g) Rf and/or ac test point areas are easily accessible.

h) The housing construction is solid and of high quality. The temperature rise within the housing is rather small when compared with high density packaging concepts.

To eliminate infant mortality and ensure quality performance, all tested modules are subjected to a burn-in process for at least 48 hours. The station with installed modules is retested for all main specification parameters as a final check.

Test Results

The Wilson system represents 116 miles of operational one-way cable television transmission. The system is capable of operating from 54 to 300 MHz, and from 5 to 32 MHz; the actual operating range is from 54 to 270 MHz.

Test results for the longest cascade (phase III, 19 stations) are as follows:

a) Transmission Response: see figure 4.

b) Signal-to-Noise Ratio (system specification, 44 dB):
Ch 2, 47 dB
Ch 7, 47 dB
Ch 13, 46 dB.

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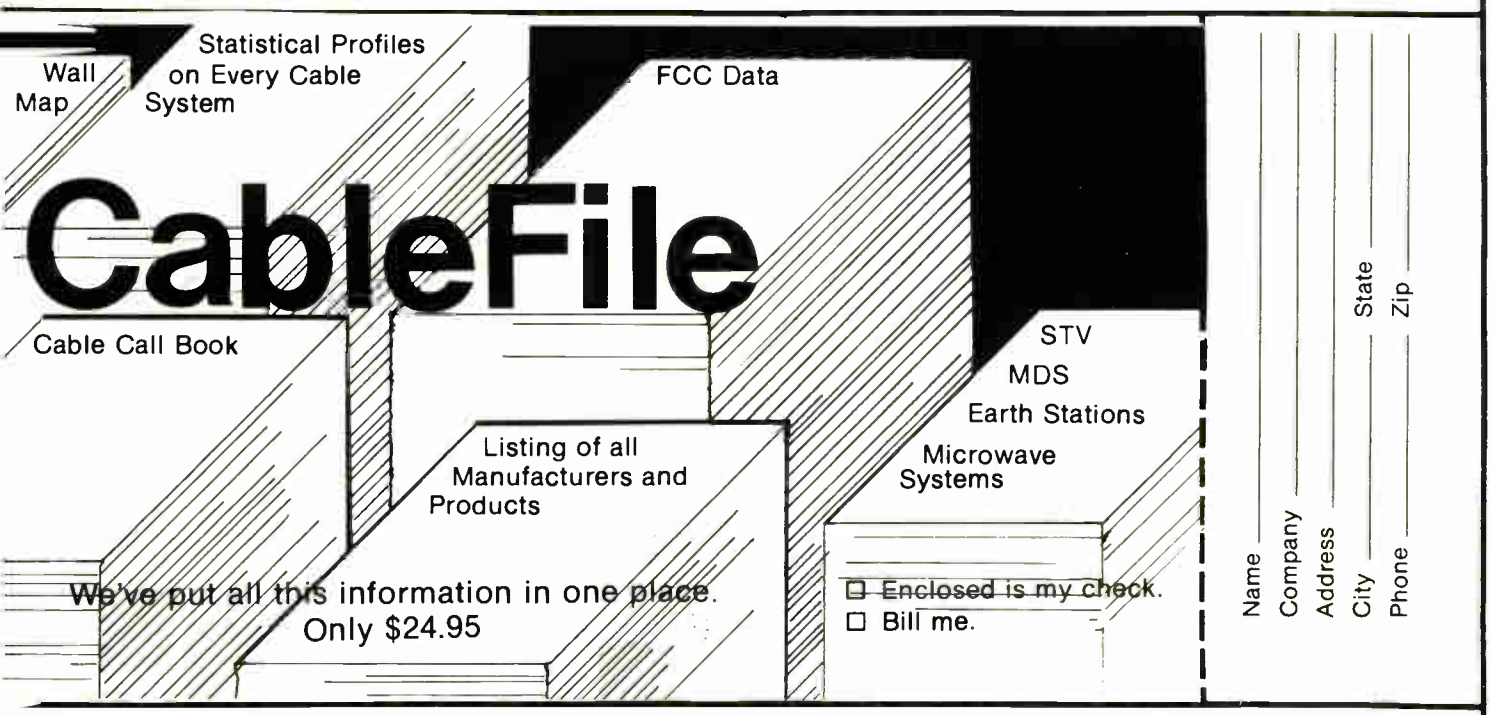

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c) Cross Modulation Distortion (system specification, -58 dB):

Ch 2, -62 dB
Ch 13, -60 dB.

d) Second Order Distortion: -68 dB.

e) Hum Modulation: less than 1 percent.

f) Composite Intermodulation Distortion: -60 dB (worse case).

g) Mark IV Trunk Station Performance Curves: see figures 5 through 14.

h) Mark IV Trunk Station Group Delay Curves: see figures 15 through 19. These tests were made using the GR 1710 RF Analyzer.

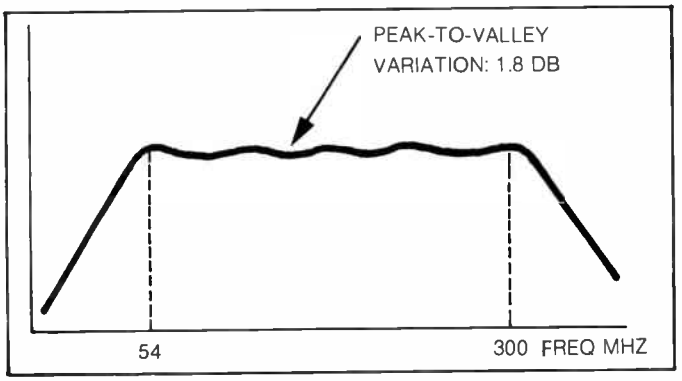

Figure 4. Phase III Simulated Trunk Transmission Response (19 Stations Cascade)

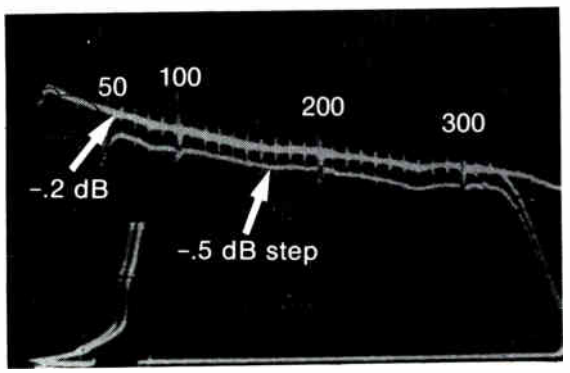

Figure 5. Mark IV Station Frequency Response - Forward Trunk with 22 dB of Cable and 17 dB Plug-in Equalization

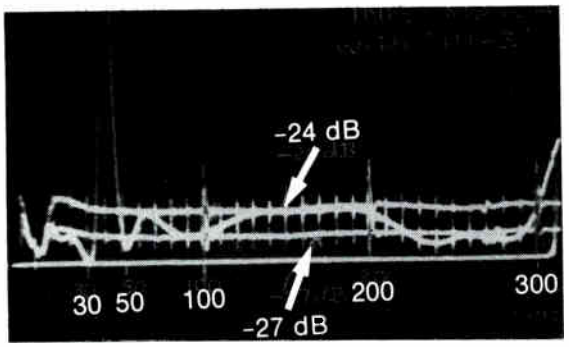

Figure 6. Mark IV Station Return Loss Response at Housing Trunk Input Port

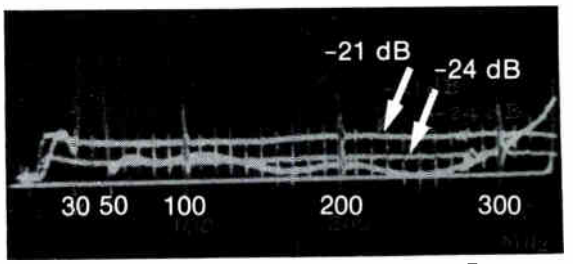

Figure 7. Mark IV Station Return Loss Response at Housing Trunk Output Port

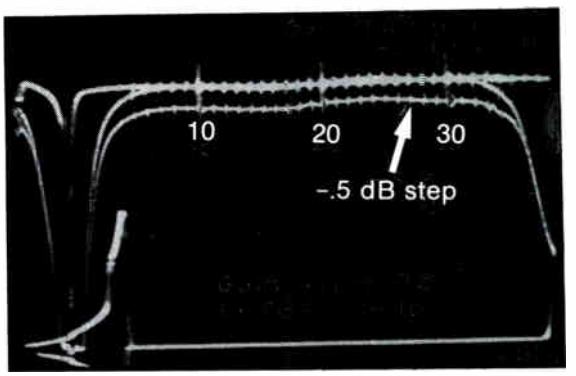

Figure 8. Mark IV Station Sub-band Frequency Response from Housing Output Port to Input Port

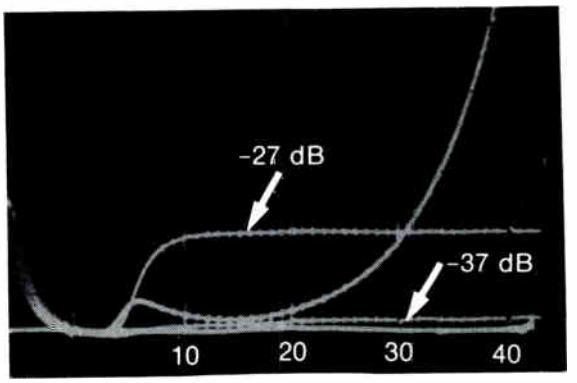

Figure 9. Mark IV Station Return Loss Response at Housing Input Port for Sub-band Frequency Range

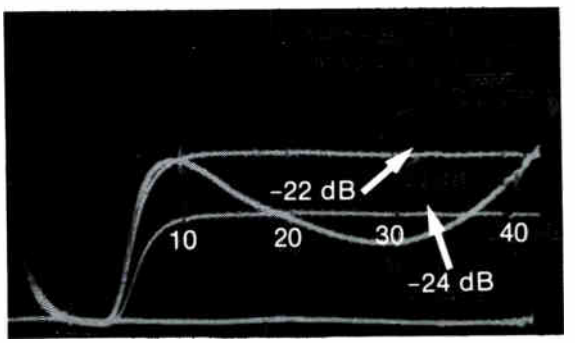

Figure 10. Mark IV Station Return Loss Response at Housing Output Port for Sub-band Frequency Range

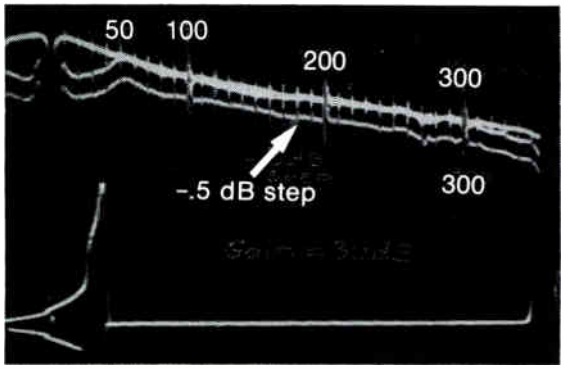

Figure 11. Bridger Amplifier Frequency Response (HB-3)

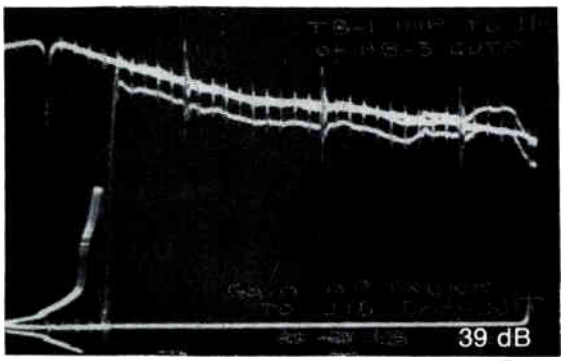

Figure 12. Mark IV Station Bridger Circuits Frequency Response from housing Input Port to J16 Bridger Output

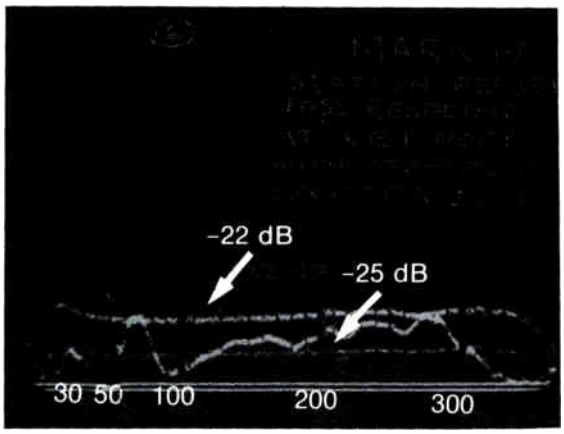

Figure 13. Mark IV Station Return Loss Response at Housing Port CB-1 with SO-4 Off-trunk Splitter

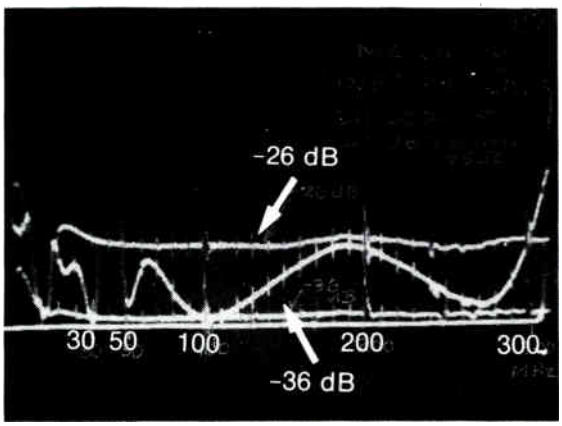

Figure 14. Mark IV Station Input Port Diplexer Return Loss Response with J1 and J1 and J6 Terminated

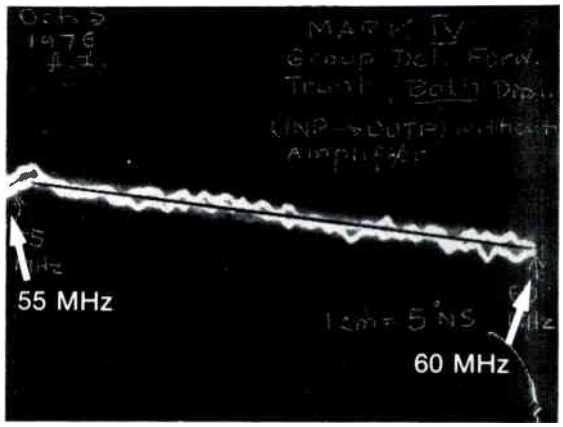

Figure 15. Group Delay from Input to Output (Both Diplexers Combined) from 55 to 60 MHz, 1 cm = 5 ns

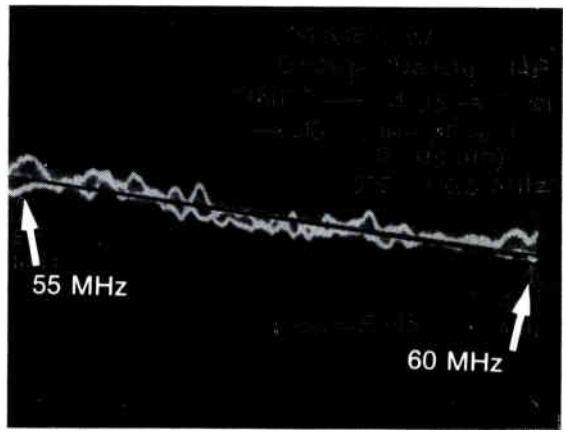

Figure 16. Group Delay from Input to J4, J5 to FL301 J16 (HP Input and HP Bridger Combined) from 55 to 60 MHz, 1 cm = 5 ns

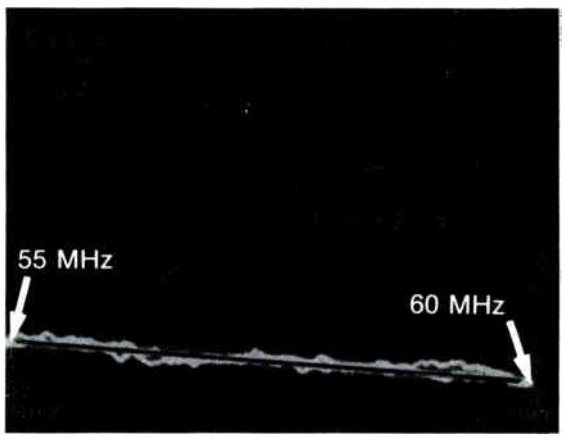

Figure 17. Group Delay for Bridger HP Section (J16 to J5) from 55 to 60 MHz, 1 cm = 5 ns

Conclusions

Reliable design for field installation and test involves a properly designed cable system and reliable equipment which is easy to install and to service.

The CATV system and equipment designs covered in the article give a basic understanding of "how" and "why" such a system functions.

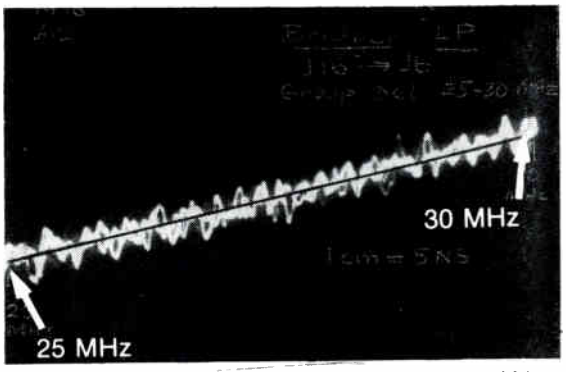

Figure 18. Group Delay for Bridger LP Section (J16 to J6) from 25 to 30 MHz, 1 cm = 5 ns

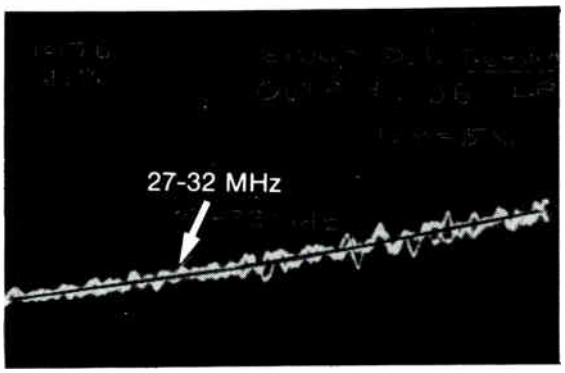

Figure 19. Group Delay for Output Diplexer LP Section (Output to J6) from 27 to 32 MHz, 1 cm = 5 ns

The Wilson, North Carolina CATV system design aspects were discussed. By using an approach which avoids marginal designs, one can produce a high quality reliable system.

It is important, also, that the equipment design criteria require an absolute minimum of external adjustable controls. This eliminates costly errors and wasted rework time, especially during initial installation and test of the system. With modules having many accessible controls, it is easy to obtain an incorrect combination of the control settings with subsequent deterioration in performance.

The minimization of service and test adjustments also pemits the use of persons with limited technical training, thus shortening maintenance efforts and reducing costs.

References

Simons, Ken, "Technical Handbook for CATV Systems," Jerrold Electronics Corporation, Third Edition.

Acknowledgements

The author wishes to acknowledge the contributions to this paper of the following individuals:

1. E.L. Baker of AEL Inc., who performed, during 1976, a major part of the tests and alignments on the Wilson, NC CATV system and supplied data invaluable for the preparation of this paper.
2. A.L. Cavalieri and G.M. Diefes of AEL, Inc., whose valuable advice and encouragement are greatly appreciated.

Appendix
CATV Cascaded Trunk Line Amplifier Systems Concepts

For the purpose of this document we will assume that all cascaded amplifiers are identical, have similar performance characteristics, and are separated by identical cable lengths each of which has a loss equal to an amplifier gain. From this, two basic quantities may be obtained: noise and distortion; these characteristics determine the quality of the resultant TV picture and the final length of the system.

a. Noise Relationships

The noise output of a single amplifier with a terminated input is

$$N_1 = 59 + G_1 + F_1 \text{ (dBmV)} \quad (1)$$

where,

G_1 = operating gain of amplifier in dB

F_1 = noise figure of amplifier corresponding to G_1 gain (in dB)

The lowest allowable signal output is:

$$S_{min(1)} = N_1 + R_{min} = -59 + G_1 + F_1 + R_{min} \text{ (dBmV)} \quad (2)$$

where,

R_{min} = lowest acceptable signal to-noise ratio (S/N) in dB. See Table 1.

Table 1. Acceptable Signal-to-Noise Ratio (S/N) Levels

TASO Picture Rating	S/N
1. Excellent (no perceptible snow)	45 dB
2. Fine (snow just perceptible)	35 dB
3. Passable (snow definitely perceptible but not objectionable)	29 dB
4. Marginal (snow somewhat objectionable)	25 dB

The system noise figure is determined as:

$$F_m = F_1 + C \text{ (dB)} \quad (3)$$

where,

C = 10 log m (cascade factor)

m = number of amplifiers in cascade.

The noise output of the last amplifier is:

$$N_m = N_1 + C = -59 + G_1 + F_1 + C \text{ (dBmV)}. \quad (4)$$

Therefore, the lowest allowable signal output from the last amplifier is:

$$S_{min(m)} = N_m + R_{min} = -59 + G_1 + F_1 + C + R_{min} = S_{min(1)} + C = S_{min(1)} + 10 \log m \text{ (dBmV)}. \quad (5)$$

b. Cross Modulation Relationships

$$XM_m = XM_1 + 2C \quad (6)$$

where,

XM_m = system cross modulation

XM_1 = cross modulation of one amplifier

C = 10 log m (as shown in equation 3).

To determine the system maximum output, with system cross modulation expressed as XM_{max}, use the relationship:

$$S_{max(m)} = S_{max(1)} - 10 \log m = S_{max(1)} - C \quad (7)$$

where,

m = number of amplifiers in cascade

$S_{max(1)}$ = output in dBmV from one amplifier where cross modulation SM_{max} is on the worst channel with the other channels measured at the operating gain.

The system cross modulation $XM_m = XM_1 + 2C = SM_1 + 20 \log m$.

c. System Noise and Cross Modulation Effect

To relate noise and cross modulation on system length, the term tolerance (TS) will be used as the allowable variation in level that does not produce objectionalbe picture degradation. This is expressed as the difference in dB between the lowest permissible output (determined by noise) and the highest permissible level (determined by cross modulation).

For a single amplifier this is expressed as:

$$T_{(1)} = S_{max(1)} - S_{min(1)} = S_{max(1)} + 59 - G - F_1 - R_{min} \text{ (dB)} \quad (8)$$

where,

$S_{max(1)}$ as in (7).

For a cascaded system, the system maximum output is expressed as:

$$S_{max} = S_{max(1)} - C; \quad (9a)$$

system minimum output is expressed as:

$$S_{min} = -59 + G_1 + F_1 + C + R_{min}; \quad (9b)$$

and system tolerance is expressed as:

$$T_S = S_{max(m)} - S_{min(m)} = S_{max(1)} + 59 - G_1 - F_1 - R_{min} - 2C = T_{(1)} - 2C \text{ (dB)}. \quad (9c)$$

d. Maximum Number of Amplifiers

From equations 8 through 9c we may derive the value of tolerance equal to zero as:

$$T_1 = 2C; \; T_1 - 2C = 0 \quad (10)$$

With the value of T_S equal to zero for the maximum number of cascaded amplifiers, the tolerance of a single amplifier approaches the value 2C. During the state of zero tolerance only one operating level is posible.

e. Optimum System Operating Level

The optimum system operating level is defined as the operating level that is halfway between the maximum and

minimum output (i.e., this is the midpoint between the level at which cross modulation becomes objectionable and the level at which noise becomes intolerable).

From equation 7 we have the formula:

$$S_{max(m)} = S_{max(1)} - C$$

where,

$$2C = T_{(1)} \text{ for zero tolerance.}$$

Therefore,

$$S_{max(m)} = S_{max(1)} - \frac{T_{(1)}}{2} \qquad (11)$$

In order to find the optimum operating level for each amplifier in a cascaded chain, subtract one half the single amplifier tolerance from the single amplifier maximum output. At zero tolerance:

$$Smin(m) = Smin(1) + \frac{T_{(1)}}{2} \qquad (12)$$

f. Triple Beat Distortions, Second Order Distortion

The occurrence of composite triple beat distortion is due to the third order distortion in the active devices of the system. The visible threshold level of the triple beat distortion is 46 dB below the peak carrier with 30 channels. However, AEL amplifier performance specifications far exceed these requirements and perform exceptionally well for this criterion.

The second order distortion levels also are very low (-68 dB or better). □

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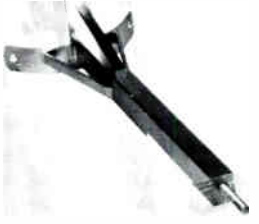

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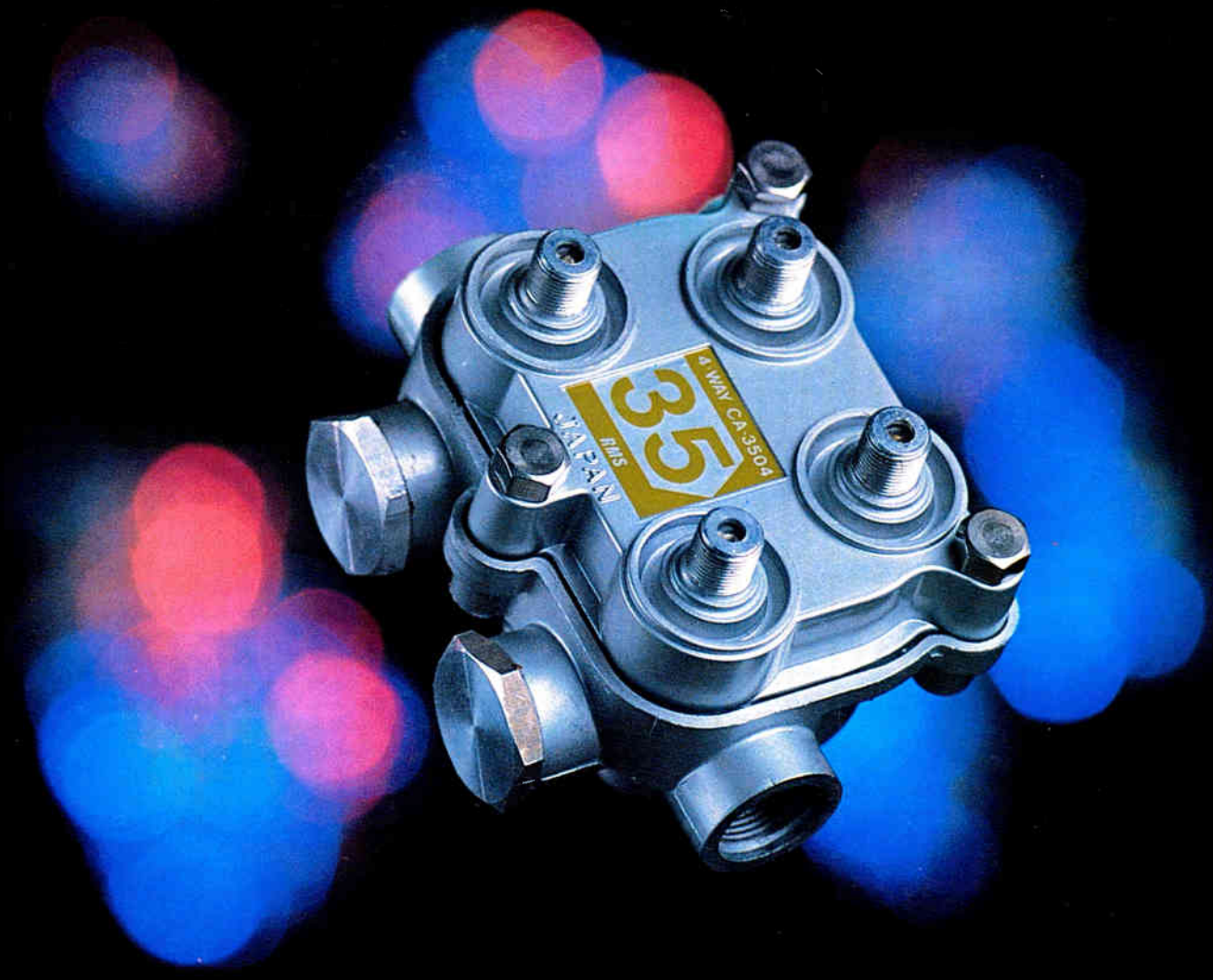

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