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Radio on Wheels

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Programming away from the main studio has become a way of life for many broadcasters both large and small. It is a method whereby the audience meets the air personalities, a device for the sponsor to assemble large crowds at his place of business, and a method whereby the station can add substantial income and program material not otherwise available. In planning such facilities, the broadcast engineer is faced with a myriad of problems and decisions. When considering the purchase of a permanent type remote broadcast facility, one must consider many possibilities both in choosing the equipment and the mobile unit in order to provide optimum performance. This article will provide the reader with an insight into what the prospective user needs to know in order to successfully carry out remote broadcasts on a continuing basis, and so far as practical, independent of telephone line circuitry. The more self-contained and independent the remote broadcast unit is for the job to be done, the greater will be its value to the station.

TYPES OF REMOTES

There are many types of remote broadcasts. However, they can be broken down into the following categories:

1. Disc jockey plus record spinning (commercials inserted at main studio);
2. Disc jockey plus record spinning plus commercial origination at remote;
3. All of No. 2 plus local live interviews;
4. All of No. 2 plus local pretaped interviews;
5. All of No. 2 plus local live music (band, orchestra, etc.);
6. All of No. 2 plus interviews or presentations by wireless microphone;
7. Sports events (continuous or short report type);
8. Public affair (fairs, speeches, conventions, etc.).

Most remote broadcasts fall into one of the above categories, and each one requires its own special type of hookup. Successful remote broadcasting requires equipment so arranged that it will handle all probabilities with little or no changes. Of course, if program requirements call for only one particular type of remote, extras need not be included. For example, if the programming calls for just a local appearance by an air personality at some location, a microphone and amplifier to feed a telephone line may be all that is needed. However, as the complexity of the remote grows, more equipment will be needed. If the programming calls for a disc jockey, an operating console with turntables will be required.

If commercials are to be inserted from the remote location, cartridge machines will be necessary, and the console must have additional inputs. Live interviews from the remote location will require additional microphone inputs for the console. Locally recorded interviews on cassette recorders, etc., also must have a feed into the console. When broadcasting live music, a microphone mixer is recommended for the proper audio-mix. Wireless microphones may be desirable when working in crowds since this eliminates the possibility of cables being pulled loose, or of tripping a passerby.

The broadcasting of sports events may range from simple to complex, depending on how many announcers are used and where, the cue involvement, and the commercial origination. On a local level, though, a microphone and an amplifier may be all that is necessary. Public affair events are perhaps the most challenging of all remote broadcasts due to their unpredictability. Preplanning is an absolute essential.

CHOOSING A LOCATION AT THE REMOTE SITE

When a remote broadcast has been scheduled, it is necessary for a member of the engineering department to visit the site. If it is to be a sponsored event, check with the manager or other person in charge, and, if possible, before the day of the event. The greater the knowledge of what can be expected to happen, the less the chance of

errors during the actual program. Ask such questions as: preference of equipment and mobile unit location but do not hesitate to raise questions if the location is not the best. For instance, note the layout of the sponsor's location. Is he on a busy highway? Is the parking lot large enough? These questions are very important for obvious reasons; a good view of the remote from the highway is always an advantage so that it will catch the attention of those who pass by. Large crowds can create a hazard to passing automobile traffic, or even worse, restrict ready public access to the sponsor's place of business. In many cases, one must choose the best compromise. Some of the more simple but obvious questions are the most important. Are electrical outlets conveniently available for the equipment? If so, determine what else is on the circuit. Are high current appliances on the circuit and will the addition of your remote facilities perhaps cause an electrical failure in the middle of the program? Where is the fuse panel location just in case such happens. Are spare fuses available? Is the area served by adequate telephone facilities? Will additional personnel be needed for crowd control or to give cues, etc., during the show? Choosing the remote location is important, and it must be carefully checked prior to program time if trouble is to be avoided.

WHAT TO USE FOR YOUR REMOTE UNIT

This is obviously based on the programming needs. If the remotes are occasional with only an announcer, a microphone and line amplifier is adequate. However, as the scope of the stations' remote activities increases, more permanent facilities are required. This can run the gamete from a converted station wagon all the way up to a completely self-contained motor home. Experience dictates a medium to large trailer, or motor home, is highly desirable.

The following questions will help to determine what will be needed:

1. What type of remotes will be performed and what equipment will be needed?
2. How much room will be required and what type of vehicle will provide it?
3. Will the vehicle selected accommodate the modifications needed to best suit the programming requirements?
4. Is the vehicle approved for driving on state or secondary roads?
5. Will the unit be adequately soundproof?
6. Can the unit provide its own AC power?
7. Does the vehicle have provisions for announcer comfort such as air conditioning, water cooler, etc.?

Fig. 1. WDON mobile studio on location for coverage of a golf tournament. Unit is self-contained with raised antenna.

8. Can the vehicle be locked and secured easily?
9. Can the unit be painted so that it can be recognized as an extension studio?
10. Does the vehicle have adequate storage space?

In the case of station WDON, a motor home was chosen. Since a wide variety of remote programs are engaged in, a large self-propelled unit with built-in soundproofing, power generator, air-conditioning, refrigerator, etc., was selected that would require a minimum of modification.

A console and turntable package were purchased from a commercial manufacturer complete with cueing and monitoring facilities built into one unit. An auxiliary microphone mixer was purchased for mixing additional microphones for live programming external to the unit. Two seats were removed from the vehicle and the console was installed adjacent to the side window so that the equipment and the control operator could easily be observed from the outside.

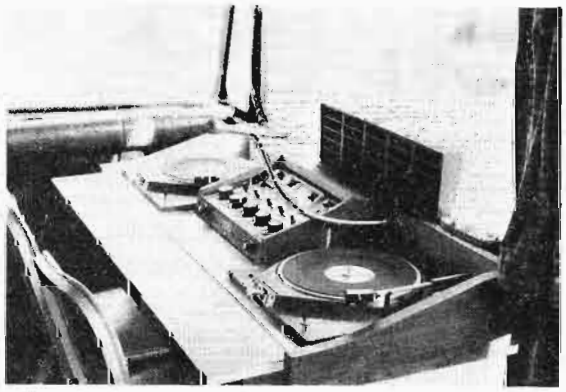

Fig. 2. A commercially available console was utilized with plug-in provisions for cartridge tape equipment. Two chairs are provided for side-by-side interviews.

CHOOSING A METHOD FOR RELAYING THE AUDIO SIGNAL BACK TO THE STATION

There are several choices of relaying the audio signal back to the studio; the simplest method is with an ordinary telephone line. The phone company provides an audio coupler so that the output of a mixer or console may be fed directly into the telephone dial system. At the station end, the same device can be used to couple directly into a console input from the station telephone. A check with the local telephone company should be made to determine rates and installation. This type of interconnection is most handy and convenient for local remotes when the dial telephone lines do not traverse through more than one or two exchanges. The fidelity is quite good for speech or music and minor frequency discrepancies may be compensated for by an inline equalizer at the station. If a bad or noisy line is encountered merely hang up and dial again. This type of interconnection is satisfactory for AM stations, but it lacks the wide dynamic frequency range for FM requirements. One arrangement is to get an extra station telephone line with an audio coupler attached, including a plug and jack arrangement. The telephone can then be taken to remote locations and the only installation at the remote site is to plug-in the unit. If remotes are performed frequently at the same sponsor's location, the jack can be left in permanently for this purpose.

Another type of phone service generally used is the direct metallic nonequalized pair. This again is suitable for local remote use. The frequency response attenuates rapidly with distance as does signal level. The advantage, though it costs more, is the fact that the line is solely for the station's use and removes the possibility of having "dialed-up" phone line problems such as someone accidentally picking up an extension on the same line used for broadcasting. Phone companies also restrict signal levels that are fed into their lines to fixed maximums. It is therefore best to check with the phone company for their particular requirements.

A third type of basic line is the equalized loop. This is a dedicated pair from one site to the other. The line is equalized for frequency response, and line amplifiers are used to make up for line losses. At the main studio termination point, facilities should be provided so that a proper match is affected between the audio equipment and the telephone company line, thus, providing the best utilization of the incoming audio. Usually at the receiving point a 600-ohm repeater coil is provided by the phone company to work directly into the station equipment. An additional note on nonequalized circuits is to provide a 150-ohm to 600-ohm transformer for a better match. At the remote end on nonequalized circuits, the phone company merely provides the termination point of the pair.

If a station's studio is outside the major center from which future remote broadcasting may take place, quite often the phone company will install a permanent equalized single pair from the telephone exchange nearest to the sources of occasional remote to the station. Then, as the equalized circuits are ordered, the telephone company will connect to the permanent terminal into their exchange office, for the ordered period of use. This saves longer run lines, with resultant savings in installation time, with the knowledge that the permanent line from the exchange to your station can be frequently checked and corrected if noise or distortion should develop. The only disadvantage is that back-to-back programs from different points may not be cleared through the phone company exchange as fast as it may be necessary.

At the remote location prior to telephone line installation, make sure that the termination site is labeled for the telephone installer. Since the appearance of an installer is not predictable, a tag saying "Put line here" makes things run much smoother. Telephone lines are usually quite reliable, however, the longer the lead-time (within reason) that you can provide, the better. There can be a substantial time lag between placing your order and installation, as time is required by the company to choose good lines, setup amplifiers, equalization, etc. Also in some locations there are areas where no facilities for having an equalized line exist, and other arrangements will have to be made.

Another method of interconnection between the remote and studio location is via radio. The Federal Communications Commission has allocated the following frequencies for remote pickup purposes:

(1)

Group A (kHz)
[1]1606
1622
1646

(2)

Group D (MHz)	*Group E (MHz)*	*Group F (MHz)*	*Group G (MHz)*	*Group H (MHz)*
[2]25.87	[2]25.91	[2]25.95	[2]25.99	[2]26.03
26.15	26.17	26.19	26.21	26.23
26.25	26.27	26.29	26.31	26.33
26.35	26.37	26.39	26.41	26.43

(3)

Group I (MHz)	*Group J (MHz)*
[2]26.07	[2]26.09
26.11	26.13
26.45	26.47

(4)

Group K (MHz)		
[3]152.87	[3]153.17	[5]161.64
[3]152.93	[3]153.23	[5]161.67
[3]152.99	[3]153.29	[5]161.70
[3]153.05	[3]153.35	[5]161.73
[3]153.11		[5]161.76

(5)

Group L (MHz)	Group M (MHz)
[4]166.25	[4]170.15

(6)

Group N (MHz)			
450.05	450.55	455.05	455.55
450.15	450.65	455.15	455.65
450.25	450.75	455.25	455.75
450.35	450.85	455.35	455.85
450.45	450.95	455.45	455.95

[1]Subject to the condition that no harmful interference is caused to the reception of standard broadcast stations.

[2]Subject to the condition that no harmful interference is caused to the reception of broadcasting stations.

[3]Subject to the condition that no harmful interference is caused to stations operating in accordance with the Table of Frequency Allocations.

[4]Operation on the frequencies 166.25 MHz and 170.15 MHz is not authorized (i) within the area bounded on the west by the Mississippi River, on the north by the parallel of latitude 37°30' N., and on the east and south by that arc of the circle with center at Springfield, Ill., and radius equal to the airline distance between Springfield, Ill., and Montgomery, Alabama, subtended between the foregoing west and north boundaries; (ii) within 150 miles of New York City; and (iii) in Alaska or outside the continental United States; and is subject to the condition that no harmful interference is caused to government radio stations in the band 162-174 MHz.

[5]These frequencies may not be used by remote pickup stations in Puerto Rico or the Virgin Islands. In other areas, certain existing stations in the Public Safety and Land Transportation Radio Services have been permitted to continue operation on these frequencies on condition that no harmful interference is caused to remote pickup broadcast stations.

[a]The following frequencies are allocated for assignment to remote pickup base and mobile stations in Puerto Rico and the Virgin Islands only:

(MHz)	(MHz)	(MHz)
160.89	161.07	161.25
160.95	161.13	161.31
161.01	161.19	161.37

Note 1: These frequencies are shared with the Land Transportation Radio Service.

Equipment may be purchased which, when fed remote audio signals, will transmit them back to a studio receiver. Using this method requires a different setup from a telephone line and naturally has a few problems of its own. The use of radio does provide the instant remote possibility therefore, it is best to purchase equipment made by a reputable manufacturer. Using homemade equipment can reduce the reliability of your system. Remember, this equipment will be carrying your programming. Most remote pickup equipment uses FM modulation thus providing all the inherent features, with its resultant high quality signal. Since such a system is portable, a remote broadcast can be performed anywhere within signal range of the system.

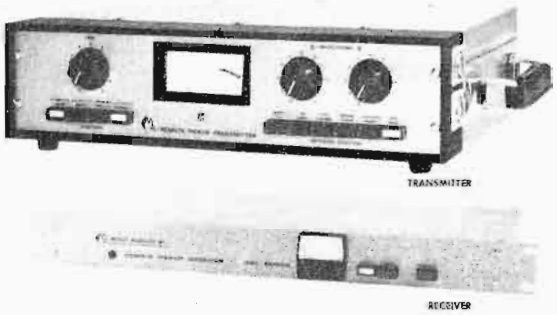

Fig. 3. Typical radio remote equipment. (Photo courtesy of Moseley Associates, Inc.)

It is usually necessary to utilize a directional antenna at the remote unit in order to provide maximum signal-to-noise at the receiving end. Since the remote unit's transmitting antenna (usually a Yagi, with high directivity) must be aimed accurately at the station (assuming that the receiving antenna is mounted on the station's tower), one simple method of determining direction is by using a small portable AM receiver with a loop antenna. Since the general direction of the main station from the remote site is always known, i.e., whether north, west, south, etc. The exact "direction-of-aim" of the Yagi (or dish, or other directional antenna) at the remote site can be obtained by utilizing the loop characteristics of the receiver, namely, to

Fig. 4. View is left front side behind the driver. A short rack has been installed containing the remote pickup transmitter mounted on a shock absorbing pad. The rack also contains a small patch panel and public address amplifier.

Fig. 5. The transmitting antenna is mounted to rotate 360 degrees and can be raised 10 ft. above the vehicle. The transmission line is attached to a reel inside the van to provide the additional length.

null out the AM signal, having in mind that the exact direction of the station is at 90° from the nulled direction of the receiver's loop antenna. The null process provides a much sharper and more precise orientation of direction than working with signal maximums which are quite broad in response.

Of course, when the station's tower(s) or other receiving location can be clearly seen, the remote transmitting antenna can be aimed visually toward the receiving point. At the station, the relay receiver antenna may be made directional for maximum pickup from the remote unit, and at the frequencies employed can be easily rotated from the ground by the more common TV antenna rotators.

To go to the opposite extreme, when distances are short and the path unobstructed, a remote may be carried out with just a remote transmitter, a microphone, and a beam or simple ring type antenna mounted on a floor type mike stand.

Relay broadcast frequencies are fast being used up and are not granted on an exclusive basis to any station. The use of the channels must be shared.

Cooperation between station licensees solves many problems, but in and near large communities, the use of these relay frequencies have become so extensive that the unexpected can happen more often than the expected. For this reason remote broadcast relay frequencies should be carefully chosen. Also, a station may be assigned more than one frequency in the band in which it operates. To have at least two crystals and ready capability to immediately use either channel in the case of unexpected interference on the frequency normally being used is both prudent and good insurance for uninterrupted program transmissions.

CUEING

In order to coordinate the remote broadcast, adequate communication between the studio and the remote unit is necessary. This may be carried out by a number of methods.

1. *By Radio.* A separate transmitter at the main station and a receiver at the mobile unit can be used for cueing. However, if the frequencies are close to each other, care must be taken to avoid interference which may occur when transmitting from the van and receiving instructions at the same time.

2. *By Telephone.* An ordinary telephone can be installed at the remote unit for cues and instructions.

3. *Via On-Air Cue.* A portable radio at the remote broadcast site can be used to receive cut back cues over the air from the main station, and at the main station from the mobile unit. During such time as the mobile unit is not sending program material it can, of course, keep the main station advised of any necessary changes, although this is not a two-way convenience.

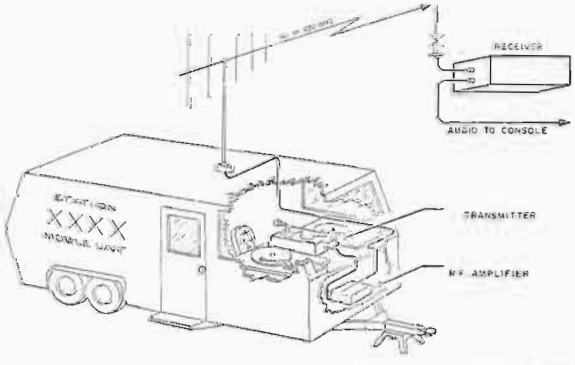

Fig. 6. Another example how the equipment may be installed in a commercial vehicle. (Drawing courtesy of Moseley Associates.)

Fig. 7. Public address speaker is mounted on side of van and is capable of being rotated 180°.

PUBLIC ADDRESS SYSTEM

This is a vital part of the remote system. Before purchasing a system decide what range and what area you need for sound coverage. Then decide what sound reproducers will serve the purpose. In some instances only two outdoor horn type speakers on a rotating mount are adequate.

A high quality audio amplifier should be chosen with power to spare and with a switchable input for being fed from (a) the console, (b) off-the-air monitor, and (c) a local microphone for announcing separately over the public address system without directly interfering with programming from inside the mobile unit. It is advisable to have the speakers mounted so that they could be turned and adjusted up or down to minimize any type of feedback. The volume control should be conveniently mounted so adjustments by the announcer can be quickly made, if necessary.

CART MACHINES AND TAPE RECORDERS AT REMOTE SITES

When the decision is made to insert the commercial spots at the remote site, provision must be made on the console for accommodating the cart machines. Also this means that the cartridges will have to be either duplicated or brought from the station for the event. If taped reel-to-reel shows are to be played, it is usually a good idea to dub them onto a quality cassette tape deck, which can conveniently be used in the remote unit and not take up room, while providing more than adequate fidelity.

AC GENERATING FACILITIES

The installation of a 110-v ac generator in a vehicle is a "must." The noise developed by such a generator does not prove to be a handicap for promotional activities when the vehicle is in motion (Fig. 8). Such a generator also is available in case of failure of commercial power while on semipermanent location.

The size of the generator depends, of course, on the load developed by the equipment and display lighting attached to the studio on wheels. Most commercial generators guarantee one percent frequency accuracy when the generator is operated within load limits. This is particularly important for proper operation of tape recorders or turntables when the generator is used as the power source. In planning a generator installation, manufacturers caution about oversizing. If the load is not sufficient, the engine driving the generator does not work hard enough which could raise the maintenance costs.

Should the station engineer choose to install a 110-v ac generator in the vehicle, care should be taken to allow for sufficient ventilation. If the available space is small, supplemental forced air should be installed to guard against excessive heat building up. A fixed-position 110-v ac fan will work satisfactorily to force out any excessive heat.

Since the generator is a gasoline-driven device, provision should be made to obtain gasoline from the main tank of the vehicle. This permits the personnel to use the gasoline gauge of the vehicle as a guide for sufficient fuel at all times. A separate supplemental tank can be used, but generally there is no gauge for judging the amount of fuel in the supplemental tank.

Normal winter and summer protection for the cooling system must be observed, just as with the vehicle engine.

While the installation of a power-distribution panel will undoubtedly raise the initial cost of installation, the safety factor, particularly for generator protection plus protection of off-air time, should make the cost and effort worthwhile.

WHAT TO DO WHEN THINGS GO WRONG

As with any type of remote broadcast you are out of your controlled environment and away from the convenience of your normal maintenance facilities. You must plan ahead for contingencies. The obvious problem is the interview where an indiscretion may get on the air. This of course can be solved by a tape delay at the station. If the console fails, a backup amplifier at least for the microphone is a good idea. Spare fuses are important items. A general rule-of-thumb is "DO NOT PANIC." Most problems are simple and solved rapidly. If handled properly at the remote site, neither the sponsor nor the listener will be made aware of the problem that developed.

SPOT NEWS COVERAGE

In addition to the mobile studio concept, remote pickup equipment can be installed in conventional type automobiles and used extensively

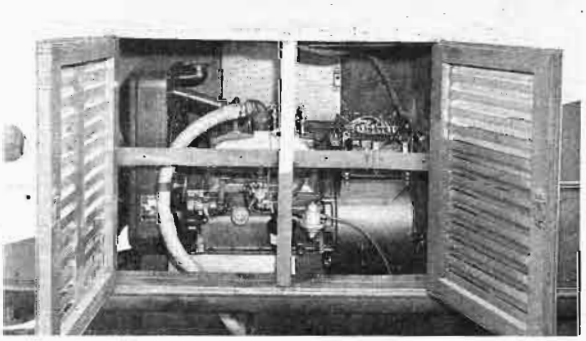

Fig. 8. 110-v ac motor generator. (Photo courtesy of Station WERE.)

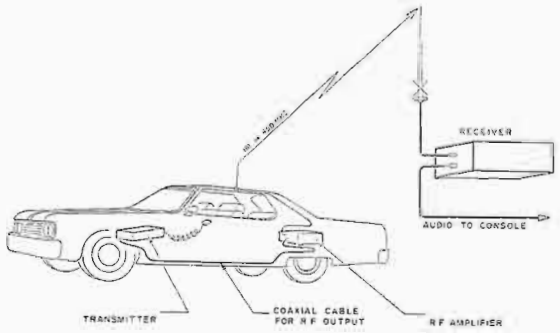

Fig. 9. A typical remote pickup system for the coverage of spot news. (Drawing courtesy of Moseley Associates, Inc.)

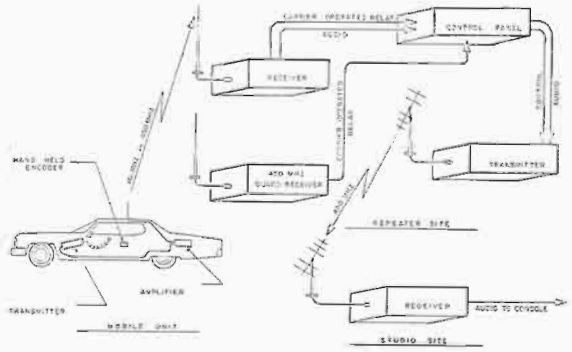

Fig. 10. Remote pickup equipped automobile for unattended automatic relay. (Drawing courtesy of Moseley Associates, Inc.)

for "on-the-spot" news coverage. Fig. 9 shows a mobile unit with direct communications to the studio. The automobile is equipped with a transmitter and optional RF amplifier. Although not shown in this drawing, additional audio sources besides the microphone shown may be fed to the transmitter.

As illustrated in Fig. 10, it is possible to install and use unattended automatic relay systems. Typically, such installations are usually on mountain top locations (or on high towers) to extend the coverage of remote pickup broadcasts. This enables stations located in areas where terrain factors are a hindrance to realize substantial increases in the usable range of the remote pickup system. Note that the relay repeater system, as shown, is activated by a two-tone hand-held encoder. This is accomplished by holding the encoder to the microphone and transmitting the keying tones to the relay receiver, and then to the remote control panel. The remote control panel is used to activate the relay transmitter. To meet FCC requirements, a guard receiver is required to monitor the output frequency of the repeater. If the guard receiver detects another signal on the assigned frequency, it will not activate the repeater transmitter until the channel is clear. Once the repeater is activated with the encoder, it will stay on the air until such time as the remote transmitter removes its carrier from the air. At this time, remote control panel senses the loss of carrier from the remote and removes the relay transmitter from the air.

These systems, mobile, repeater or base stations, are licensed under Part 74, Subpart D of the Commission's Rules and Regulations. Such systems can be licensed whether telephone land line service is or is not available. The systems shown are just some of the possible configurations. As an example, mobile repeaters in a mobile studio or news vehicle can extend the usable range of a system on a moment's notice. Also, it can be relocated easily to suit changing requirements. Systems also have been used from helicopters, airplanes, blimps, boats, and even atop flag poles.

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Television Remote Program Originations

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As an independent broadcaster in the City of Chicago, WGN Continental Broadcasting Company relies heavily on remote pickups in its television operation. The following chapter reflects the information that has been acquired by WGN-TV in making television remote program originations.

Our discussion necessarily will be about facilities used at this station and will also include facilities considered for the future. It is to be understood that remote pickups take on many forms. These include sporting events, on-the-site commercial recordings, community affairs public interest programs, closed circuit originations, news events, and even presidential speech originations.

The diversity and frequency of remotes, naturally, is a vital factor in the type of equipment used. If, for example, a station is to provide baseball coverage of two major league teams, it would be wise to have equipment comparable to a normal studio control room, where reliability of facilities for daily operation was present and where comfortable working quarters for the mobile unit crew are provided. For these reasons, the primary color mobile unit, if more than one mobile unit is employed, will handle the day-to-day originations, or those that require the greater facility with the more complex production.

A second color mobile unit can be judiciously employed where a one or two camera on-the-site commercial recording is to be made prior to post-production work at the studio, where coincidence of more than one remote pickup per day is a frequent factor, where a generator need be employed for a self-powered feature, or where equipment utilized in that mobile unit can be disengaged and rolled into the pickup quarters. Other reasons, such as the need for videotape playback equipment, or the involvement of the station in electronic news coverage, may also necessitate the use of two or more mobile facilities.

WGN-TV is currently using two mobile units to satisfy its remote requirements. The station has always stressed versatility in its remote handling capabilities. Features that are built into its remote mobile units emphasize this point.

This discussion can be outlined as follows: (1) principal features of the primary mobile unit, (2) additional features worth considering in a primary unit, (3) a secondary mobile facility, (4) video taping and remotes, (5) lighting and remotes, (6) electronic news, and (7) remote operational considerations.

PRINCIPAL FEATURES OF THE PRIMARY MOBILE UNIT

The primary facility that will be described in great detail is a semitrailer, 40 ft. in length, 8 ft. wide, and 12 ft. 6 in. in height (Fig. 1). 1974 was the first full year of service for this unit, and 200 remote program originations emanated from this vehicle. Of the two mobile units to be discussed, this is the deluxe facility.

The trailer layout shown in Fig. 2 identifies the principal operating areas of the trailer, and will

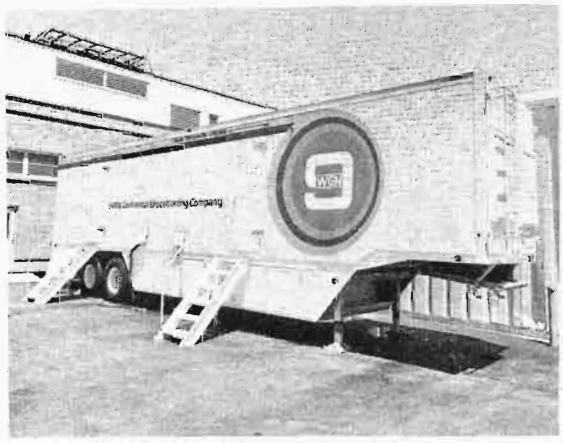
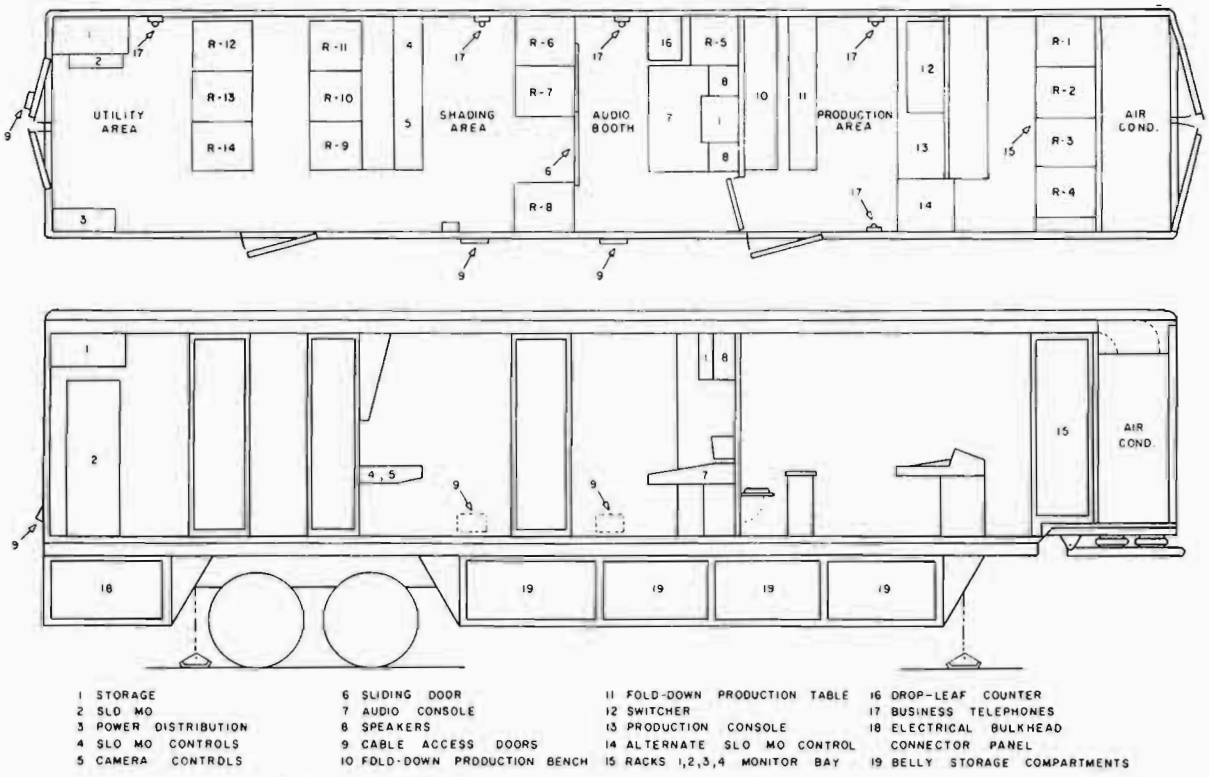


Fig. 1. WGN-TV primary mobile trailer.



1 STORAGE
2 SLO MO
3 POWER DISTRIBUTION
4 SLO MO CONTROLS
5 CAMERA CONTROLS
6 SLIDING DOOR
7 AUDIO CONSOLE
8 SPEAKERS
9 CABLE ACCESS DOORS
10 FOLD-DOWN PRODUCTION BENCH
11 FOLD-DOWN PRODUCTION TABLE
12 SWITCHER
13 PRODUCTION CONSOLE
14 ALTERNATE SLO MO CONTROL
15 RACKS 1,2,3,4 MONITOR BAY
16 DROP-LEAF COUNTER
17 BUSINESS TELEPHONES
18 ELECTRICAL BULKHEAD CONNECTOR PANEL
19 BELLY STORAGE COMPARTMENTS

Fig. 2. WGN-TV color mobile trailer—equipment layout.

be referred to as these areas are further described. All principal equipment racks are accessible from the front and rear. Racks are identified with the "R" designation. Note that personnel can walk through the entire length of the trailer without going outside; this is appreciated by the crew during bad weather.

All cabling for cameras, audio, video, and telephone facilities enter the vehicle by way of the cable access doors (No. 9 of Fig. 2), and terminate on the two bulkhead panels located inside of the unit itself on either side of R-8. This feature, we feel, is very important for two reasons. First, it is more trouble-free because all of the bulkhead chassis connectors are not subject to corrosion due to weather. Secondly, at the remote unit end, any troubleshooting of lines can be done inside the comfortable quarters of the mobile unit.

Fig. 3. Production control area.

Fig. 4. Audio control booth.

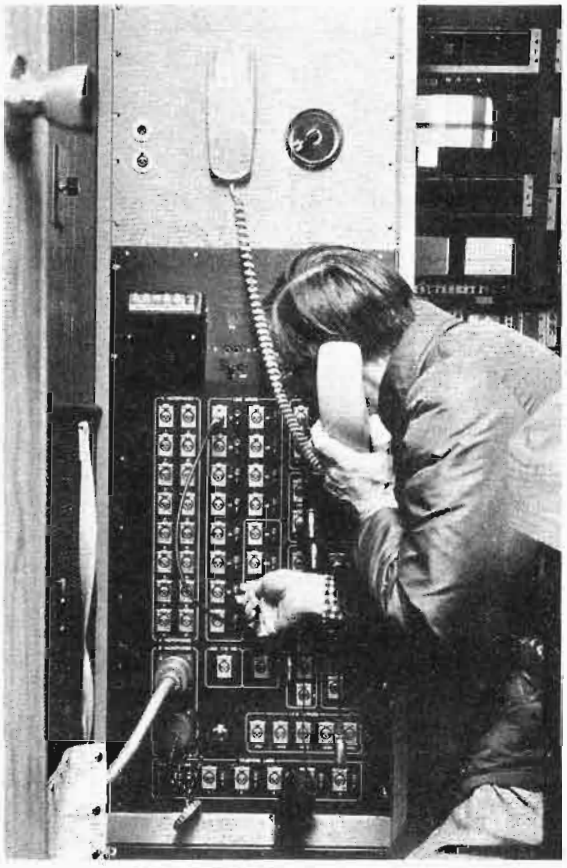


Fig. 5. Audio bulkhead panel.

The principal operating areas are: production control, audio control booth, camera shading, and the utility area. Storage provisions, communications, and other features of the interior and exterior of this mobile unit will also be described.

Production Control Area

A 10 ft. 4 in. X 8 ft. area is used for the production area. A switcher, director, and slo mo operator sit side by side at the front control desk, some 4 ft. 8 in. away from the monitor bay (Fig. 3). Behind them in the control area is a foldaway table and cushioned bench for use by additional production personnel.

The switcher (Central Dynamics) has 20 inputs, two special effects systems, chroma key, modulator, downstream keyer, quad split, and color matte on eight switch busses (two at the shader area and one in the audio control booth). Isolation busses feed the network and the slo mo disc recorder.

Essential to the production area are program and preview aural monitoring, a dual tally system on the visual monitors for air and slo mo record, talkback system, color monitors for line and preview, interphone facilities, and business telephones for studio communication. This control area is lit with dimmable, low-wattage spots above the control room desk for optimum monitor viewing during air time.

Audio Control Booth

A 6 ft. X 8 ft. area is utilized for the audio control booth. A custom, 16 input, four-channel console features a reverberation unit with echo send/receive on each input, equalizers, compressor, preview system, two aural monitoring systems and remote control of two cartridge record/playback machines and one reel tape machine (Fig. 4). It is of solid state construction, using vertical attenuators. The audio console was designed so that it could be removed from the trailer and installed elsewhere. This would allow the audio operator to have eye contact with a stage performance or other pickup that has this requirement.

Front and rear doors to the booth allow for complete isolation from other areas in the vehicle. A large front window provides full viewing into the production area. An important feature is the small visual monitor included in the booth; the audio operator has a full-switcher-input-selector bus feeding this monitor.

All external audio cables and telephone lines enter the vehicle through a curbside access port and terminate on the audio bulkhead connector panel (Figs. 5 & 6) inside the vehicle. This panel provides an entrance for all console inputs, outputs from all four channels of the console, talkback to studio, and business telephones. Microphone inputs enter by way of individual Canon XLR connectors, numbers 1-16, or through two multiple-pair harness connectors. These feed the A and B preselectors, respectively, of each of the console's mixers. A large patch bay is located in the utility rack to the left of the audio console. Also included in the rack are the cartridge machines, reel-to-reel tape machine, intercom amplifiers, visual monitor selector, and motor-driven monitor pads used throughout the mobile facility.

Camera Shading Area

To the rear of the audio booth is the camera shading area. Here each of three custom-made racks (R-9, 10 & 11 of Fig. 2) contain necessary control equipment for four color cameras (RCA TK/44). Two additional camera chains are completely wired and have the necessary visual monitoring equipment already installed. It is a relatively simple transition for the addition of some studio equipment to make the mobile unit a six-camera facility. The slo mo control unit can be

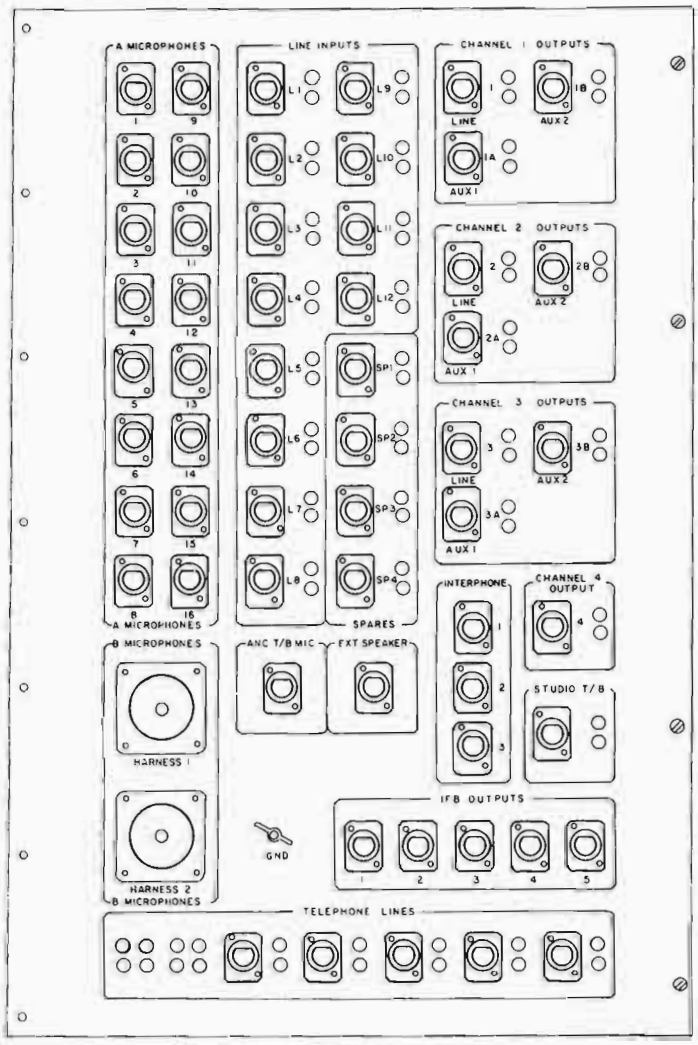


Fig. 6. Audio bulkhead panel.

operated from the console housing the fifth and sixth camera control units by employing a cover shown in Fig. 7. In order to effectively allow for containment of two camera chains in a rack, the upper portion of each camera control rack was extended forward and its front surface angled downward 12 degrees to improve the shader's viewing angle of the visual monitoring equipment. The side view of the shading consoles is seen in Fig. 8.

Convenient to the technical operation in the camera shading area is the needed switching equipment for video monitoring with the vectorscope, line scopes, and two color monitors. Total video patching for the trailer, with more than 300 video jacks, is located in the same rack as the video bulkhead panel, two process amplifiers, a VIT signal generator, and 30 video distribution amplifiers (Fig. 9). In this same area is the rack housing the video switcher (R-6 and 7 of Fig. 2), all encoders, and power supplies for the camera chains. Figs. 10 and 11 show the arrangement of video connectors and camera cable connectors on the video bulkhead panel.

Utility Area

In the rear portion of this primary mobile unit is the utility area (Fig. 12). Housed in this area is the slow motion disc recorder (Ampex HS/100). This recorder is primarily kept in this vehicle, although it is also used in a small van when it becomes necessary to supplement the operation of our second mobile unit. Internal wiring, plus patching, allows the flexibility of using the slo mo control unit at three different locations within the trailer, or even in an adjacent mobile unit.

Three utility racks contain pulse generators, pulse amplifiers, off-air receiver, modulator and additional audio and video monitoring equipment. Space has been left, and internal wiring provided, for a microwave control unit, auxiliary handheld camera chain, and character generator in these auxiliary racks. A tally patch board

Fig. 7. Camera shading and slo mo control.

provides the flexibility of tally needed to accommodate the needs of the many production people that are involved in this vehicle's remote assignments.

The main power distribution rack contains all circuit breakers and distribution of ac to the 14 equipment racks, utility outlets, and lighting and air conditioning equipment (Fig. 13). Metering of current, voltage, and frequency is provided. All utility outlets on the trailer exterior, belly compartments, and camera chains are protected by ground-fault breakers.

Power enters the trailer through two four-wire cables to the power connectors located on the lower rear curbside bulkhead panel (No. 18 of Fig. 2). Directly behind this panel, and accessible from the rear through the roadside belly compartment

Fig. 8. Camera shading area.

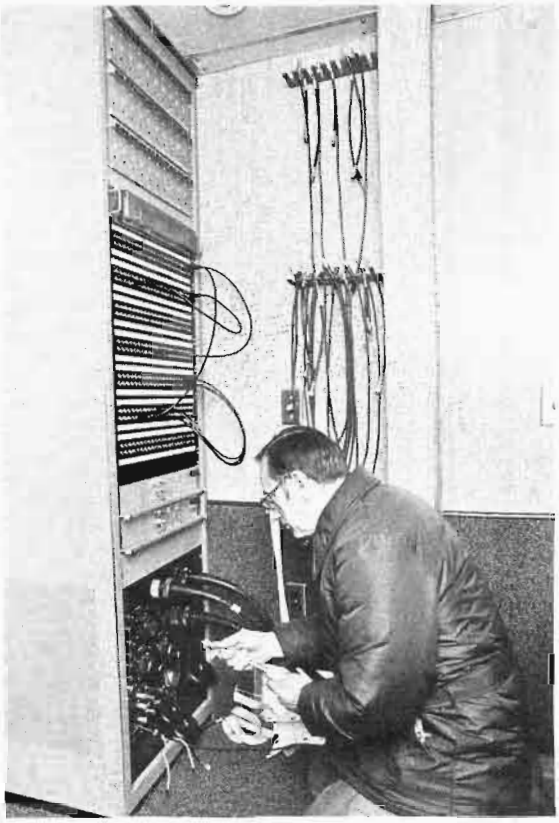


Fig. 9. Video patching and video bulkhead panel.

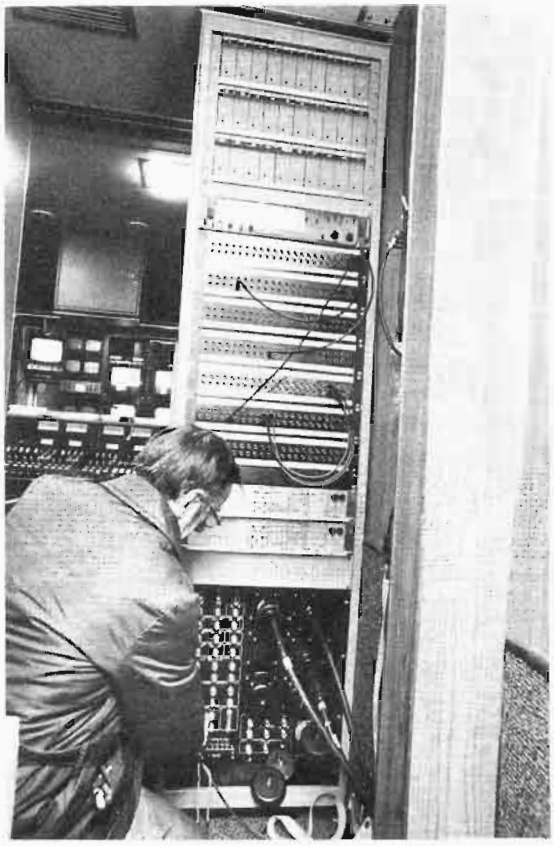


Fig. 10. Video bulkhead panel.

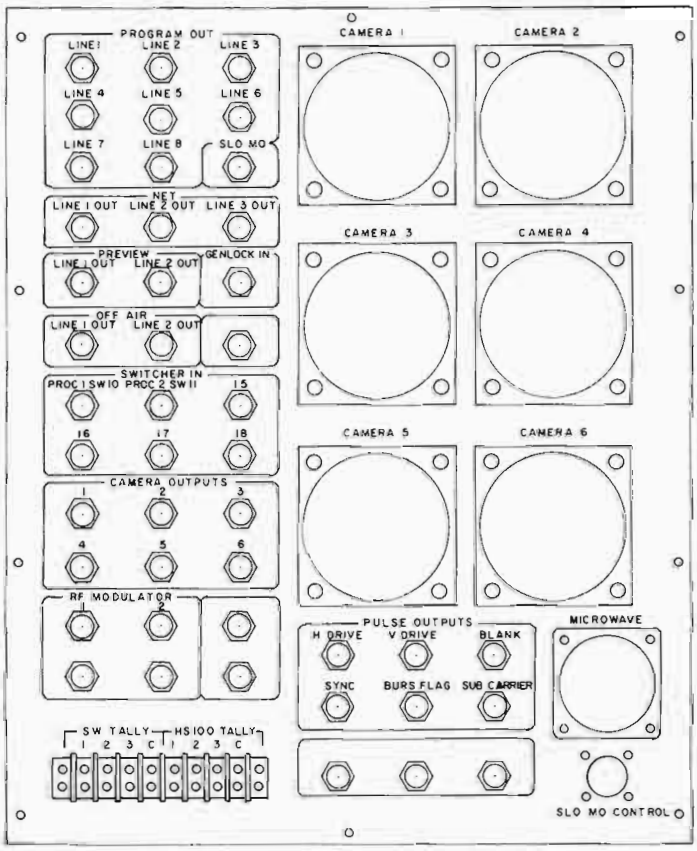


Fig. 11. Video bulkhead panel.

door, power is fed through manual disconnect switches and on to two 15-KVA input transformers for the technical equipment and, also, to one 30-KVA transformer for the mobile space conditioning units. On the panel are utility outlets and connectors. A grounding lug completes facilities on this panel (Fig. 14).

Within the rear power compartment, the technical load is fed to two 15-KVA voltage regulators that will assure constant voltage to the technical equipment. Please refer to the diagram shown in Fig. 15. You will note that the tapped primary winding allows for input phases of 208-240 volts. No neutral is included in the input wiring. In this

Fig. 12. Utility area.

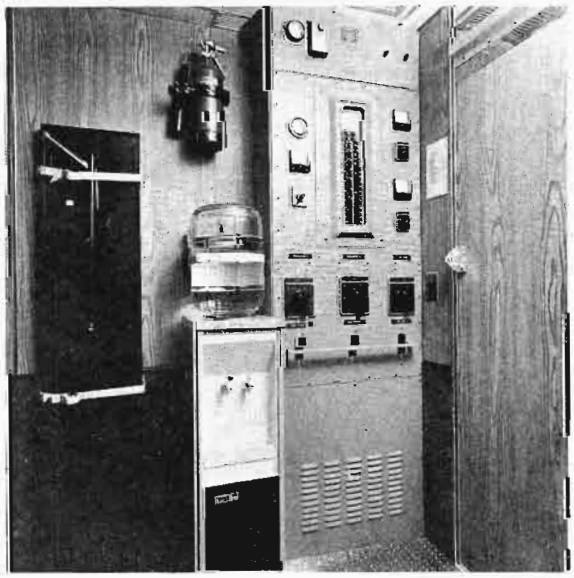


Fig. 13. Power distribution and space conditioning control.

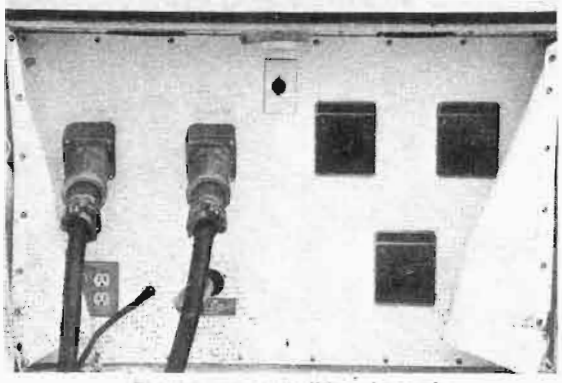


Fig. 14. Power bulkhead panel.

same general area are the battery and charger that provide dc for a number of ceiling lights, as well as the roof hoist. Telephone company distribution and key equipment for the five wall-mounted business telephones are also located in this rear compartment.

Communications

Each of the four basic operating areas in this vehicle is in full communication with each other via a microphone/speaker talkback system. In addition, all stations may converse with the studio, cameramen, and assistant directors. Five "IFB" key positions are also on each talkback panel. These are used principally to feed program, interruptible by cues, to sports announcers or talent when on camera. The latter generally utilize the small ear plug on these circuits. Each IFB position has a choice of two program sources, selectable in the audio booth.

Outside communication is accomplished through five jack-equipped wall-mounted business telephones, each capable of receiving five business lines and hold.

A headset interphone system also interconnects all working areas on three selectable busses—engineering, production, and isolate. The camera cue bus can also be heard on local panel speakers in the production and shading areas. Controls are mounted on this panel in order to attain desired levels. For the director who prefers privacy with the cameramen, the speaker may be turned off. In order to maintain desirable levels on the production busses, all interphone positions in the trailer and in the cameras are equipped with send and receive amplifiers.

Storage

Remote mobile units never seem to have enough storage area. In order to avoid any such problem, our primary mobile facility has ample storage in each of the operating areas. Cabinets are provided under the production visual monitors in the front of the trailer, above the audio console in the audio booth under the production desk, and, also, above the slo mo disc in the rear of the trailer. Where possible, slide-out drawers are also included in some of the utility racks. The inside cabinets are used for microphones, adapter cords, test charts, spare parts, hand tools, hardware, and manuals.

Larger items are stored beneath the floor and accessible from the outside in eight large belly compartments (Fig. 16). Each compartment has its own ac-dc ceiling light fixture. Outlets are also provided in these areas. Cameras are stored on

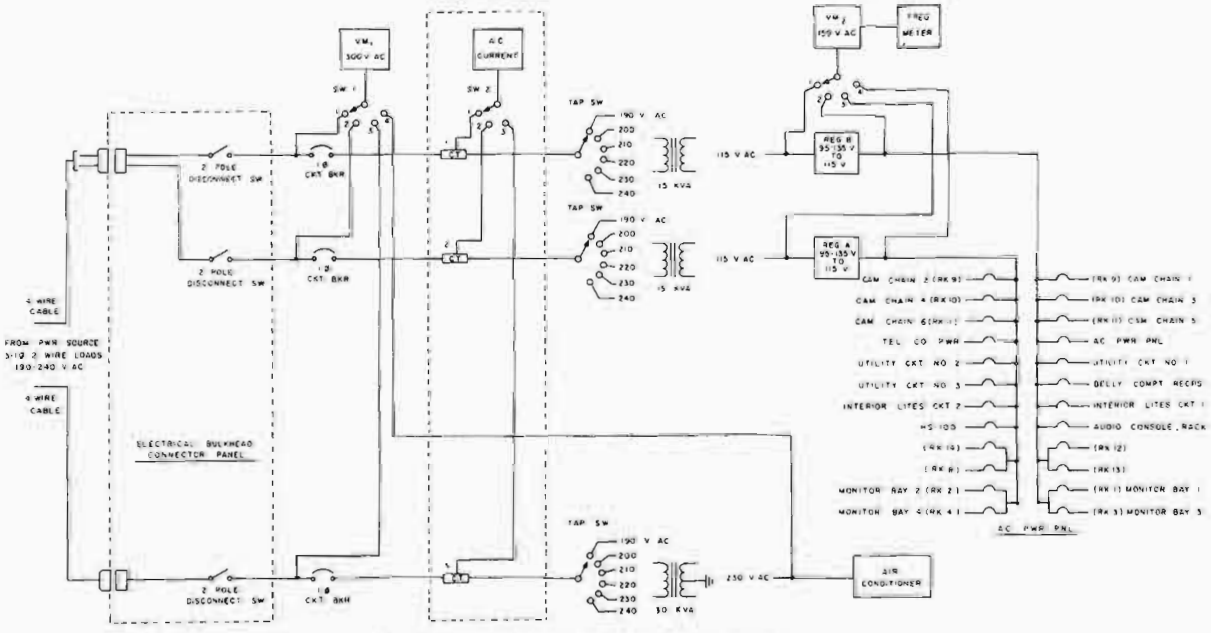


Fig. 15. Single line drawing of ac power system.

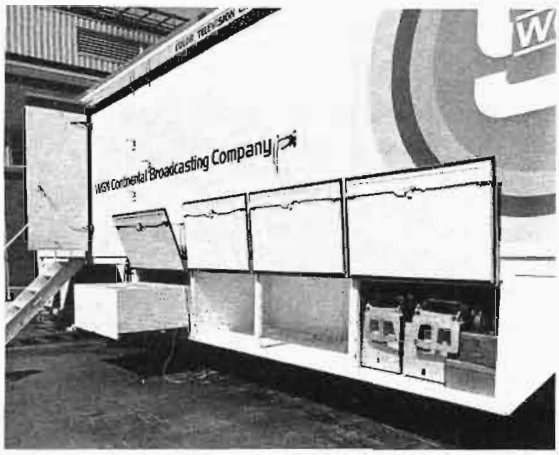


Fig. 16. Curbside belly compartments.

their own transport dollies, two in a compartment. Zoom lenses in their individual lens cases, plus cameramen's utility cases, are stored in another belly compartment.

The fourth curbside storage area has a slide-out drawer, 4½ ft. X 3½ ft. X 15 in., which is subdivided into five cubicles (Fig. 17). In this cable drawer are stored harnesses, rope, and various small audio and video cables which are categorized for quick accessibility. On the road side of the mobile unit, four more storage compartments are used for the storage of other remote equipment, such as camera tripods, dollies, camera cables, power cables, hoist extension boom, harnesses, ladder, ramps, ropes, and hoists.

The outside staircases for each of the three trailer doors are stored during travel on the inside of the doors by means of special bracketing that is attached to the inside surface of these doors.

Other Features of the Trailer Interior and Exterior

The Midwest climate and the year-round operation of this particular remote unit necessitate a heavy floor, ceiling, and wall insulation in order to maintain a proper comfortable temperature for the operating personnel. The floor is completely carpeted by a durable indoor/outdoor carpet having antistatic characteristics. The carpet extends up the side walls to a height of 30 in.

A wood grain laminate surface extends to the ceiling. This same surface was used in the production desk and audio console. Within the off-white laminate ceiling surface are the ac-dc work lights for general illumination and the strategically placed dimmable spotlights for on-the-air lighting.

Two five-ton mobile space conditioning units are located in the front of the trailer. These units provide a combination of heating, cooling, ventilating, and dehumidifying. Maintenance of the space conditioning equipment is simplified because there is full accessibility to these units through the full-length double doors at the very front of the trailer. A dc-operated hoist (Fig. 18 and 19) operating within the curbside center wall, may be used to raise and lower cameras or other equipment to the roof of the trailer. A secondary use of the hoist is to "fly" overhead cabling used on many of the remotes.

Fig. 17. Cable drawer.

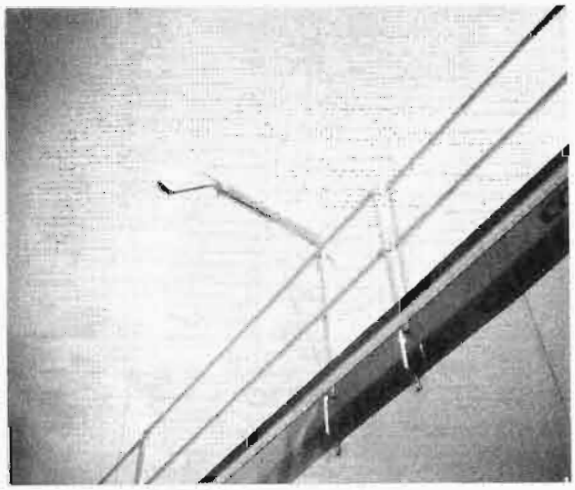


Fig. 18. DC-operated hoist.

Fig. 19. DC-operated hoist.

Fig. 20. Primary unit at Chicago's Christmas parade.

Fig. 21. Parade commentators atop the primary mobile unit.

Fig. 22. Camera transport dolly.

The 40 X 8 ft. expanse of roof is accessible via two attached ladders located on the front and rear sides of the unit. The roof surface is constructed to support cameras and personnel for on-the-spot reporting of parades, etc. You will note in Figs. 20 and 21, a scene at the annual telecast of Chicago's Christmas Parade, that two commentators, an assistant director, stagehands and cameraman (plus a few guests) have the excellent vantage point for the television parade coverage. There is a protective metal railing, which is 96 ft. in total length, mounted on the outside edge of the trailer roof. The roof surface is a one-piece aluminum skin painted with a nonskid carborundum particle paint.

Finally, this primary remote facility is supported by eight 10:00 X 20:00 12-ply tires mounted on tandem axles. The rear axles and the front coupler are cushioned on air bellows affording the best road performance possible.

ADDITIONAL FEATURES WORTH CONSIDERING IN A PRIMARY REMOTE FACILITY

Protection of Cameras and Lenses

The cameras used on remotes are handled more frequently and are subject to more abuse than the typical studio camera. Care should be taken to minimize possible damage to this expensive equipment.

A picture of the custom-made transport dolly used at WGN is shown in Figs. 22 and 23. The cameras are stored, two to a compartment, with their dollies. When setting up a remote, they are rolled as close to the camera operating position as possible. Heavy durable covers are kept on the cameras in storage and while they are moved on their dollies. The dolly shown is large enough to carry the camera tilthead as well.

An outer plastic cover is used as a second covering when our cameras are left in position at the

Fig. 23. Camera dolly being hoisted to football booth.

baseball parks overnight. A steel cable within the second cover allows the cameraman to lock the outer cover in place and provides some security of his equipment. Special plastic covers are provided for protection against light rainfall.

Lenses are always removed from the color remote cameras before transporting the cameras and are always restored to their respective cases. The cases are generally taken to the camera location during setup and remain there until teardown.

Multipaired Harnesses as an Aid to Setups

Around 1960, we had a prominent cable manufacturer provide us with a multiconductor cable that had ten shielded audio pair, one coaxial cable and, also, an ac pair all in one cable. Lengths of 100, 150, 200, and 300 ft. terminated in MS connectors are still used regularly on one-time-only remotes.

We have found this cable to be a real time saver in remote setups. It is used almost without exception on all of our remote originations. Incidentally, the coax in the multiple-pair cable is used principally for a visual monitor feed at the announcer's or sportscaster's table. Even the ac pair with its five ampere limit has proven advantageous when no power is available or when the normal service blows a fuse or breaker.

Business Telephones and the Voice Coupler

In recent years, the Western Electric Type 30A voice coupler has really come into its own as a valuable aid to broadcasters. Many broadcasters use the coupler attached to the business telephone as a means of sending programs back to their studios rather than ordering a broadcast circuit.

Our primary mobile unit incorporates the voice coupler on two of its business lines. Business Line 1, which is called our production line, is used by the director or other production people in the trailer for studio coordination. After dialing is completed and the circuit is established, the voice coupler key is thrown. The voice coupler on this line gives the director the option of using his headset for private studio conversations or, with the voice coupler key engaged, allows for a more public communication with the studio.

The engineering business line (line 2) can be used as a backup aural program circuit should the primary audio circuit fail. This is accomplished by providing an audio output dedicated to feed the second voice coupler. Panel toggle switches mounted on the voice coupler telco panel are easily accessible to the audio engineer in the audio booth area.

It should be noted that at the studio master control, similar facilities are needed to couple designated business telephones into the studio talkback system or on patch for use as an emergency program circuit.

Disc Recorder (Slo Mo) and Features Necessary to Its Operation

The disc recorder that is used for slow motion and stop action has become an essential tool for replays in sports telecasting. Improvements made in head and disc construction, coupled with a reasonable amount of care in their routine maintenance program, will certainly provide many hours of trouble-free performance. Needless to say, the slo mo unit should be firmly secured in the remote facility, yet allowances should be made for its easy removal from the vehicle.

The desired versatility in the operation of the remote control unit should be emphasized. For day in and day out routine baseball pickups, we have found it quite satisfactory for the second shader to also function as a slo mo operator. Isolated camera selection is switched on the switcher slo mo bus. The remote control unit is shown on a panel which covers cameras five and six control units (Fig. 7).

There are times when it becomes necessary to have the slo mo operator located adjacent to the director, using the fold-up counter of the production desk (No. 14 of Fig. 2). An external portable switcher bus, paralleling the slo mo bus of the main switcher, is plugged into a connector at the base of the production console. This, with the remote control unit, gives the slo mo operator control of the special isolate requirements from this location. The control unit is patched at the base of R-13 (Fig. 2).

In connection with the slo mo operation, it is important to include a secondary tally on the cameras and the camera monitors that are activated when the particular camera is being recorded either by a disc or by a videotape machine.

Inside Bulkhead Connectors for External Audio, Video and Camera Cabling

Attention is once again called to Rack 8 in Fig. 2 and its relative placement to the side-wall cable-access ports. Reference is also made to illustrations six and nine.

Past experience with bulkhead connector panels, when located in the belly compartments, has proven that corrosion of connectors will occur, especially when exposed to the Midwest winters. Continuity checks during setup can be done more comfortably in the environment within the trailer. Audio and telco connections within the audio booth, and camera cable and coax connections in the video shading area, have also proven a time saver during the setup period.

Hoists and Cargo Nets

To avoid hand-carrying all camera equipment to the sometimes lofty camera locations, a hand-operated or power-operated chain hoist can be very useful. There are some occasions where a 40-ft. load chain is a necessity. At the Chicago Stadium, two power-operated hoists (Figs. 24 and 25) are employed in order to elevate the cameras and lenses to their "basket" locations (Figs. 26, 27, and 28). One hoist connected to the steel-ceiling beams is used to lift the cargo vertically, while a second wire rope hoist pulls the load up on an angle in order to reach the otherwise difficult camera locations. Cameras are often lifted while still on their transport dollies, as shown in Fig. 26. Lenses, tripods, test charts, etc., are hoisted by using a specially fabricated cargo net. Such a net is shown in Figs. 29, 30, and 31. The Chicago Stadium camera basket locations are of such a nature that particular effort needed to be made to minimize the possibility of cameras and cameramen blocking the view of spectators behind. A special swivel chair mounted on angled casters was devised for the cameramen (Figs. 32 and 33).

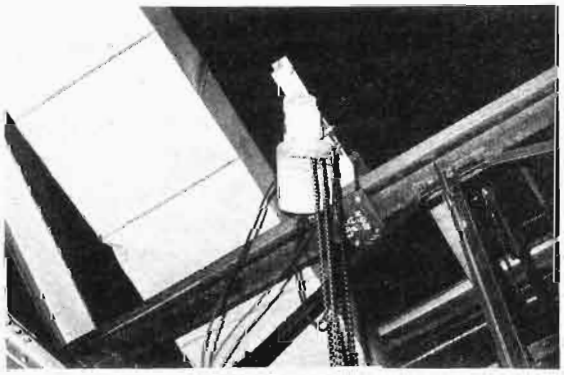


Fig. 24. Power chain hoist at the Chicago Stadium.

Fig. 25. Power cable hoist at the Chicago Stadium.

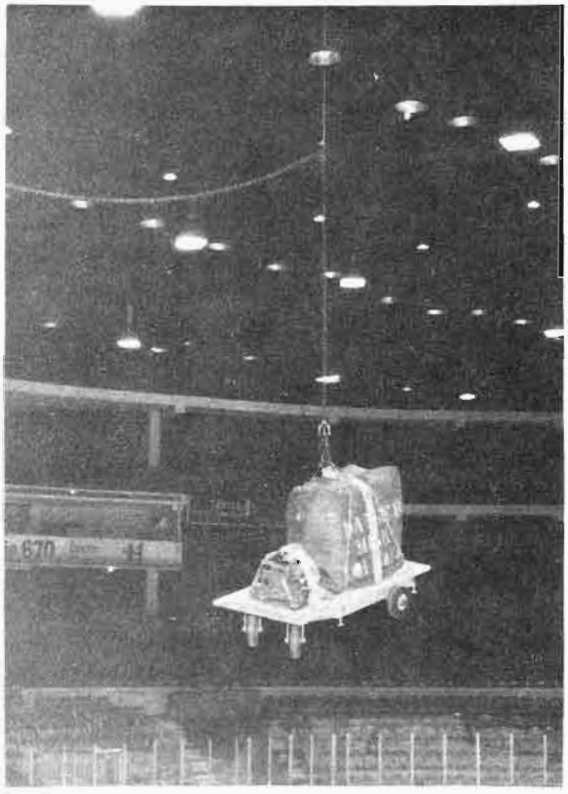


Fig. 26. Camera being elevated using stadium hoists.

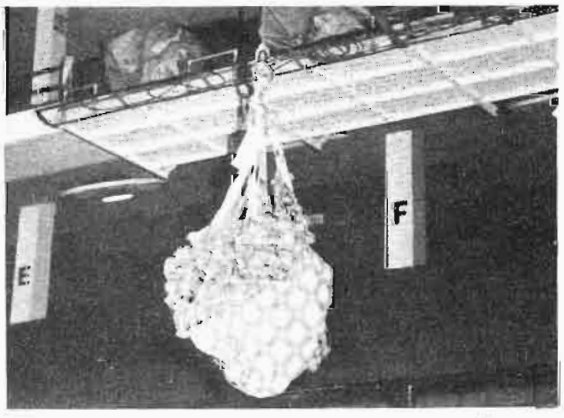


Fig. 27. Cargo net being hoisted to camera positions.

Fig. 28. Hoist operator and cargo.

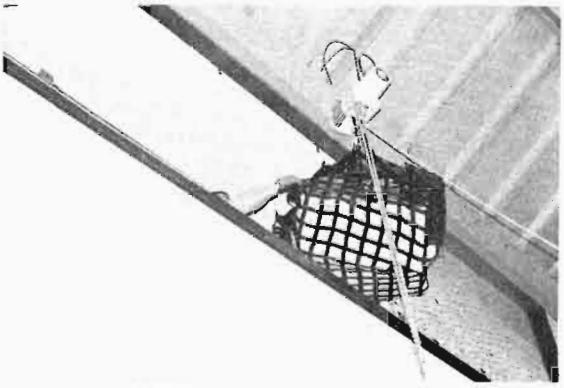


Fig. 31. Cargo arrives at top.

Fig. 29. Cargo net carrying lens cases.

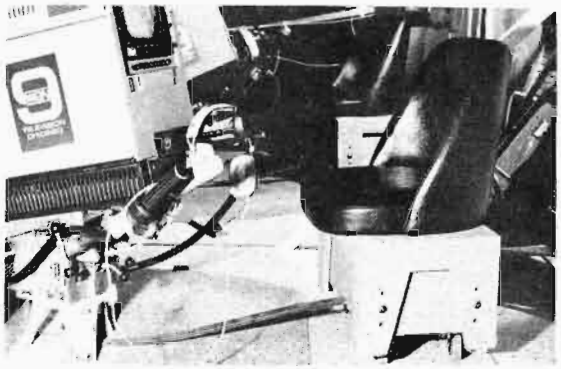


Fig. 32. Special swivel chairs at basket camera location—Chicago Stadium.

Fig. 30. Cargo ready to be raised.

Fig. 33. Cameramen ready for hockey game.

Handheld Cameras and Mobile Carts

Handheld cameras are being used with greater regularity as a production tool on sports telecasts. There is no question that a handheld unit has the maneuverability that cannot be attained with a typical tripod/dolly remote camera.

Prolonged operation of a portable camera, however, must nearly always be supplemented with the use of a unipod or some nearby tripod, for cameramen do tire. Effective usefulness of these cameras is where air operation can be in relative short takes or where the picture content,

by its unique nature of not being reachable by any fixed camera, enhances the overall capturing of the sports activities.

Very often a tripod-mounted camera on a battery-operated mobile cart will accomplish similar results. Fig. 34 shows a type of cart used to telecast the sideline activity at the Illinois High School Association Football Tournament. Three people were needed for the camera operation, a cameraman, cable puller and the vehicle driver. Note the rain covers and camera-mounted microphone used for pickup of field noise.

SECONDARY OR AUXILIARY MOBILE UNIT

The advantages of having a second TV mobile unit are, naturally, dependent upon what facilities are included in the unit.

The small van shown in Fig. 35 was initially designed for on-the-spot videotaping of commercials. Taped sequences would be recorded at the remote site and brought back to the studio for assembling and editing. It is equipped with a 5-kw gasoline generator. The two racks that house the control equipment (Fig. 36) for the three color cameras (Ampex BC-230) are mounted on wheels so that they can be rolled out of the remote vehicle and rolled into a building when required. This feature has proven extremely beneficial when pickups are being made in tall buildings, etc.

When the van is used for commercial production work, the portable quad head type videotape recorder (Ampex VR3000) is principally used.

Approximately 50 remote originations were made with this unit in 1974. Figs. 37 and 38 show scenes from the Community Affairs series, "Ark in the Park." Two cameras were used for a series of visits to Chicago's Lincoln Park Zoo. Note the use of a mobile cart for the second camera.

Each year, on the eve of the opening of the Chicago Automobile Show in immense McCormick Place, this unit is used to record several hours of videotape on two portable recorders (Ampex VR3000x). The mini truck (our secondary unit) moves from one exhibit to another as it records all the impressive features of the newest automobile models. The 20-minute reels are shuttled back to the studio through the night and next morning where they are screened and prepared for final editing.

Fig. 34. Sideline camera on battery-operated mobile cart.

Fig. 35. Secondary or auxiliary mobile unit.

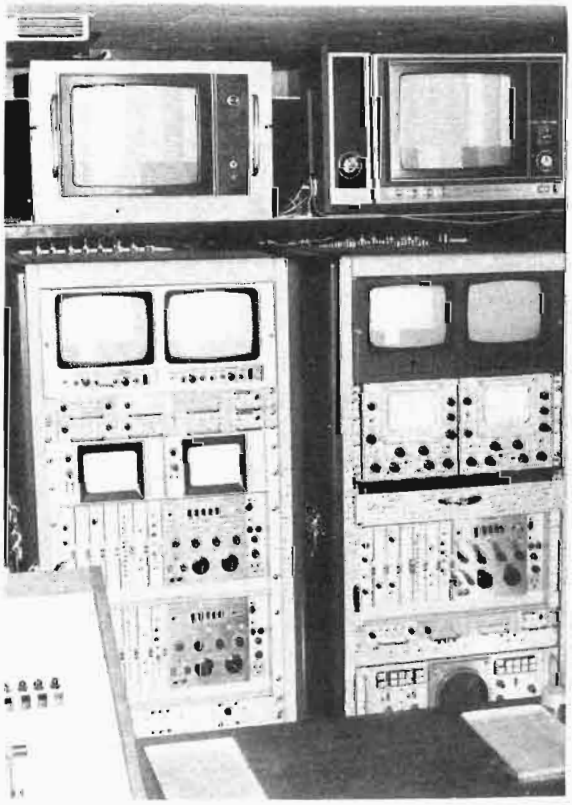


Fig. 36. Camera control equipment for secondary mobile unit. (Racks are removable from van.)

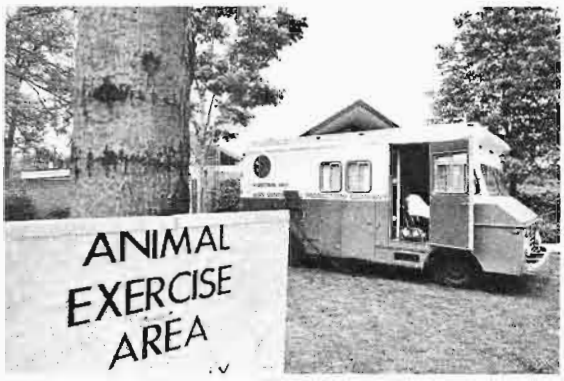


Fig. 37. Secondary unit at the zoo.

Our secondary mobile unit also doubles as a sports pickup facility when two sports telecasts occur on the same day. Should the need for a slo mo arise in connection with the mini-truck operation, the slo mo from the larger trailer is removed and installed in an equipment van and operated from the mini truck using an external control cable.

VIDEOTAPING AND REMOTES

Mobile units which have been designed principally for network originations or for production companies will, most likely, include the incorporation of videotape equipment. This is due to the need of commercial spot playbacks as an integral part of the remote production or where there is the requirement of recording and editing at the remote location.

The independent broadcaster is caught in the dilemma of making this very difficult choice. If he chooses not to include VTRs in his mobile fleet, he will occasionally have to rent costly mobile units which have tape machines in them. If the choice is to include VTR facilities, then there is the risk of too little productive use of this valuable asset. Another direction, of course, is to borrow several VTRs that are normally a part of the studio facilities. This can be a problem, also, since the total tape involvement at the station may not allow for the disappearance of several of its machines.

Fig. 38. Recording an interview for "Ark in the Park."

At WGN-TV, we have rented VTRs which are normally housed in the supplier's vehicle and have, on a number of occasions, rented the VTRs and installed them in our own "tape trailer" that was specifically constructed to house rental or future-owned VTRs. This trailer has cooling and/or heating necessary for a comfortable tape area. Future plans include provisions for audio and switching facilities, utilizing the roll-in color camera control units (Ampex BC-230) from the secondary mobile unit previously described.

The advantages of having an independent vehicle for tape equipment need to be mentioned. First, this affords a facility which can team up with either of the two pickup units. Second, the original design of the primary remote vehicle, having excluded videotape, allowed for roomier areas for all operations within that unit, a feature that is especially important considering that most of our remote telecasts do not require videotape facilities. Finally, this choice of not including tape in the primary unit provided better serviceability of equipment racks. Most racks could be arranged for accessibility from either side, which is very often not the case when VTRs are housed in the same total area.

Television broadcasters principally have been using quad videotape machines in their remote units. With the introduction of the time base corrector, VTRs using the slant track format are appearing on the scene and can be expected to be a part of television remote program originations.

LIGHTING AND REMOTES

To generalize, remote lighting usually falls into two categories: the fixed, planned arena type of installation and the temporary situations found in the one-time-only remote locations. These applications are to be considered here.

First, however, acknowledgment must be made of the tremendous advantage the newer cameras offer. With their improved response to lower light levels, the remote lighting job is no longer the monster it used to be. Whereas sufficient power was a problem at most sites, existing amperage now usually proves adequate. More emphasis then can be made on quality of light rather than attempting to reach 300 or 400 F.C.

In the course of the year, Robert T. Stebbins, Manager, Arts and Facilities, WGN Continental Group Stations, indicated that WGN-TV will handle a great variety of remote locations under varying conditions of ambient light. Our approach probably parallels the procedures of most in that

an initial survey is made with such personnel as the producer, director, engineer-in-charge, and the chief electrician of the stagehand crew who will make the installation. During the survey, the scope of the performance will be laid out. A conference with location representatives will normally include the house electrician and, in some cases, power utility personnel. At this point, the method of installing and positioning will be determined. If no building or site plans are available, measurements are taken and existing power sources located. This information is assembled and incorporated into a ground plan (and elevations, if necessary) showing camera and lighting positions, types of instruments to be hung, expected light level, cable runs, junction and distribution boxes, etc.

Normally, on the OTO television remote, most installations are made several days in advance of the actual event. This is done primarily to allow time for changes or replacement of gear that may prove faulty, or if advanced rehearsals are planned.

Each location is treated for its own problems; that is, the lighting approach is tailored for the limitations of a particular location and often special lighting rigging may be built from the notes and photos taken at the preliminary survey. As one may surmize, this might include many variations. Where a low ceiling exists above bleacher audiences, this may take the form of outriggers off columns, as in Fig. 39 (Illinois State High School Swimming Championships). Probably the most common device is the trapeze, a 5 to 10 ft. section of 1½ in. diameter pipe (preferably aluminum) hung on hemp lines or cable dropped through ceiling openings. Often this system is the only practical method in hotels or public buildings.

Luminaires used on remotes are separate and apart (in the WGN procedure) from studio instruments; in fact, most of the remote gear is chosen specifically for remote usage even though it may have studio application. Here in Figs. 40 and 41 is a representative part of the WGN inventory. More often than not, the multiple par is the workhorse. Its ability to cover large areas from considerable distance and the availability of the various lamp configurations make these a must in the television station's inventory. Along with this unit, the single par is also a good item. A variety of lensless quartz instruments with barn doors and focusing in the 650W/2000W range are also useful. When quality of light is an important factor on the job, our remote gear will include a number of 2K spotlights. Softlights can be especially useful in covering situations where glass is a factor. Outdoor work done in daylight frequently will require a certain amount of shadow filling. This might be achieved with any of the units mentioned above

Fig. 39. Swim finals—lamps mounted on out-riggers off columns.

equipped with dichroic filters. If sunlight is convenient, reflectors on stands (long a Hollywood item) will do the job.

If special remote situations are to be a part of your operation, it is well to have a "collection" of hanging devices which should include beam clamps, 1/2 in. hemp, 1/8 in. aircraft cable, 1-1/2 in. OD pipe of various lengths from 4 to 10 ft. along with stands, booms, and adapters.

Speaking of adapters, it is important that remote cabling be able to enter any type of connection. In many instances, connectors at the site will not fit directly into gear being introduced. Hence, electrical adapters are a must. Naturally, in the larger demand remote, connecting is done directly from the bus bars of the electrical service cabinet at the site to the "bull boxes" and then to distribution boxes. The cable route is fused, probably several times. First, an in-line fuse is

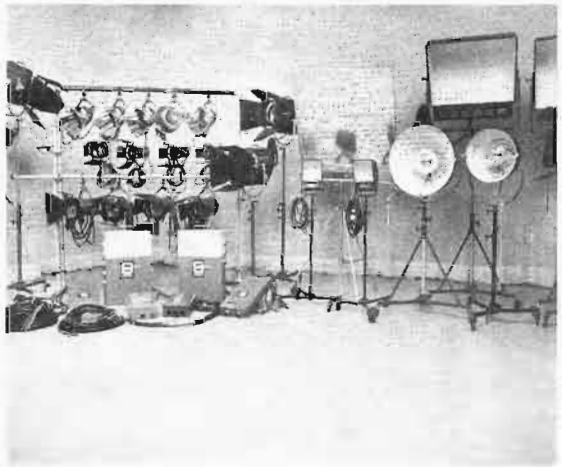


Fig. 40. Remote lighting equipment.

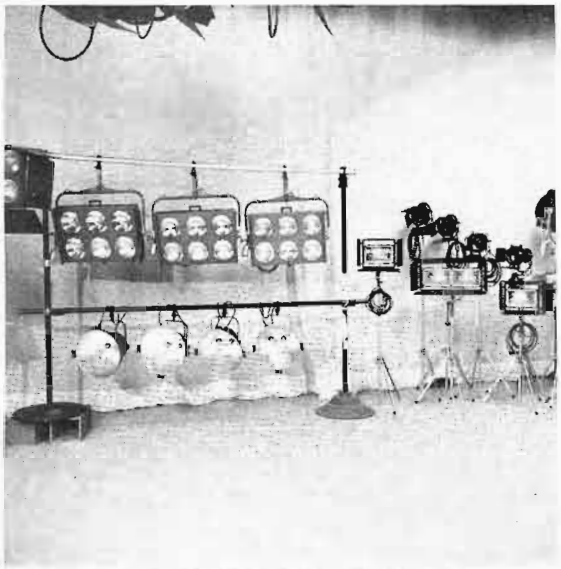


Fig. 41. Remote lighting equipment.

Fig. 42. Lighting circuit breaker panel and disconnects.

introduced (Fig. 42). Second, another at the bull box and once more at the distribution point. All equipment is grounded for safety. All of the cabling gear pictured can be assembled from available parts. Those shown are made to our own specifications.

If remotes include a healthy number of exterior originations, a generator will solve the immediate power source problem. Of course, lighting control, though not as important as in studio operations, is needed in most instances, if not as dimming, certainly as a means of balancing.

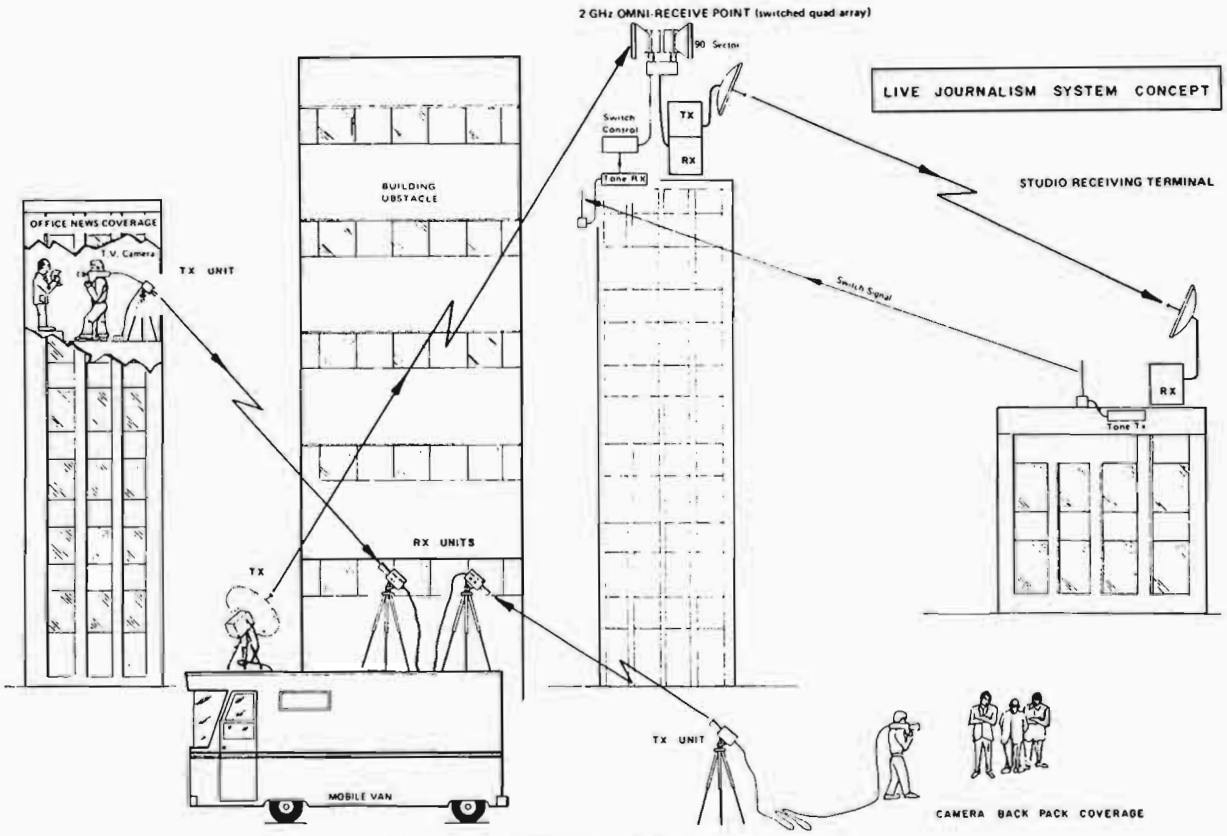


Fig. 43. Electronic journalism, microwave concept.

Finally, flexibility is the key in any acquisition program of remote lighting gear. The ability to cover almost any set of conditions in your respective community governs just how extensive one's inventory should become.

ELECTRONIC JOURNALISM

A discussion of television remote program originations would not be complete without some reference to the changes that have begun in the methods used by broadcasters in obtaining their news stories—that of "electronic journalism."

The traditional system of gathering news has generally been by using 16 mm. motion picture cameras. With this system, news events are photographed, the film is delivered for processing, the processed film is edited, and then it is played on a telecine camera chain for broadcast.

Since late 1971, a new system has made its appearance, that of electronic journalism or electronic news gathering. In 1974, a number of television stations had converted completely to the all electronic system and all of the networks were involved in this new system in varying degrees. This new system employs a portable electronic color camera for the pickup of the news event. The color signal is either recorded on videotape in the field or is transmitted by microwave directly to the studios. Here the signal can be aired live or may be recorded, edited, and played back as an insert into news programs.

There are a number of reasons why this new method of gathering news is being used by a growing number of broadcasters.

1. The speed in which the recorded material can be put on the air. Time is lost in the processing of film which, in the end, may delay editing and judgment of the final news product. Live news break-ins are now possible.
2. The cost of raw film stock and processing of that film is a significant expense.
3. Recent developments in reliable, lightweight, portable color cameras; portable, lightweight videotape recorders; microwave systems and time base correctors make the new method of an all electronic system even more favorable.
4. Less lighting is required due to the greater sensitivity of the portable color cameras.

Whatever the advantages, it is apparent that without the recent electronic developments, we would not be witnessing the changes that are occurring today in the broadcasters' news gathering operations.

There are a substantial number of handheld color cameras available for the news pickups, but their individual virtues will not be identified at this time. Certainly, the broadcaster who is ready to embark into electronic journalism must consider these factors before making the choice of camera:

1. *Performance and picture quality.* Does the final product measure up to the criteria for acceptable picture quality of the station's air product?
2. *Reliability.* Will the camera perform with regularity with minimum or no setup adjustments?
3. *Serviceability.* Is the construction rugged enough to endure the treatment typified in the news operation? Are the setup adjustments easily accessible? Is factory service available? Are service manuals complete? Are parts readily procurable?
4. *Portability.* Is the camera light enough in weight for extended periods of operation?
5. *Cost factor.* If the total change to electronic journalism is to eventually take place, will the final capital expenditure for the total number of cameras be within the budgetary allowance?

One of the primary advantages of electronic journalism is the ability to air news segments live. A number of stations using electronic journalism schedule live segments in their news programs to increase viewer interest. This means that microwave systems need to play an important role in the overall electronic news gathering picture.

A concept of relaying news happenings to the television studio is shown in Fig. 43, as suggested by Microwave Associates. Three different microwave links are employed to deliver the final picture and sound to the news editors in the studio building.

Several battery-operated, seven-pound miniature microwave transmitters, utilizing a circularly polarized horn antennae, beam their signals to the roof of the mobile van. Operating in the 12.7 GHz to 13.25 GHz range, the units typically have a range of up to one mile. With the use of a two- or four-foot parabolic antenna, their range may be increased up to five miles.

At the mobile unit, the camera signal is monitored and either recorded or retransmitted. For this retransmission, the sketch shows a portable, 2-w, 2 GHz transmitter aiming its signal to the central omnireceiving site. Here a four sector, switchable quad array is utilized for the receiving antennae. The selection of the antennae covering the proper direction and the best of four antennae polarizations is effected from the studio building. The signal path is completed by including a fixed microwave link to the studio where the news sequence is aired live or recorded for later editing and playback.

An equally important method of electronic news gathering is to record on videotape the remote news pickup using a portable, lightweight, helical scan recorder, reel to reel, or cassette. The hand portable unit can be on the scene with the camera while a second recorder may also be used in the mobile van. Line level, battery-operated

microphones are being used for sound pickup in the simpler news recordings.

Essential to the use of this recorded material is the time base corrector. Variations in timing of the playback signal of the helical scan recorder can be corrected to broadcast standards. It should be noted that the TBCs cannot improve picture quality that is not related to time base instability. Nevertheless, with the insertion of the time base corrector, it is now possible for recordings made on the lightweight portable helical machines to be aired directly or to be dubbed up to a quad VTR.

Those entering into electronic journalism will want to consider the use of both methods of gathering news—by recorder and by microwave. The broadcaster will also want to look closely at the station's videotape editing facilities in order to better complement the electronic news gathering process.

TELEVISION REMOTE OPERATIONAL CONSIDERATIONS

Surveys

Remote pickups which are of the one-time-only variety will require an advance survey, no less than two weeks in advance of the remote. Usually, representatives from production, facilities and engineering are present at this survey which is made at the site of the remote origination. The remote engineer-in-charge making the survey for the Engineering Department will gather all detailed engineering data and will enter it on a remote survey report form.

Included in this report form are the following:

1. Power source and location of power cabinets.
2. Length of camera cable runs and camera cable routings.
3. Mobile unit location, stating requirements with regard to parking permits.
4. Camera locations, specifying any need for hoisting equipment, camera risers, etc.
5. P.A. requirements.
6. Audio requirements with regard to microphones needed (six omnidirectional, six cardioid, and four headset microphones are normal complement), multipaired harness location and cable lengths.
7. Visual monitors or receivers needed external to mobile unit (seven is the normal complement).
8. Microwave possibilities following a line-of-sight check. Recommended microwave location, if any.
9. All contacts; i.e., electrician foreman, PA man, building supervisor, electrical contractor, if needed, security contact, etc., and their telephone numbers.
10. Telephone and business line requirements.
11. Security needs.
12. A sketch of the relative placement of all facilities, including cable runs, parking site, camera locations, etc.
13. Whenever possible, the engineer-in-charge will take photographs (Polaroids) to supplement the survey data.

The Facilities Department would determine the need for lighting, camera platforms, props, risers, rental equipment, snorkels, etc. Production would secure any information they need to prepare for programming, would establish the necessary contacts for talent procurement, credentials, script information and would advise people at the remote location of the scope of the program and its special requirements as pertaining to them. Notification of the remote crew arrival time should be given to the necessary personnel at the remote site prior to the program date.

Using the completed survey form, the administrative engineering personnel would schedule the required remote crew for the setup day, when required, and, also, for the operational day. Detailed arrangements for electronic equipment rental, hiring of security personnel, mobile unit drayage, parking permits, electrical contractor or power utility services, will be concluded by administrative engineering personnel.

Setup

What entails the setup? Just about everything short of the rehearsal and the actual program itself.

Setups will vary considerably in the amount of work required. Hopefully, this work has all been analyzed before the remote setup date. The crew time is scheduled accordingly. No two setups are alike, but all have some very common tasks included in their agenda.

These include unloading of equipment, camera setups, cabling of cameras, power hookup and cabling, audio and video cabling, microphone placement, antennae setup and communications lines and TV monitors installed.

Figs. 44, 45, 46, 47, and 48 illustrate very well some of these setup tasks. These are scenes from the Chicago Christmas Parade taken shortly after the primary mobile trailer arrived on the scene for the annual telecast. Cable runs were at a minimum for this setup, but the trailer roof work and the snorkel setup made up for it.

Basically, setups can be divided into two main categories: those that are repetitive, such as the baseball and hockey pickups, and the one-time-only type.

Setup time for repeated sports pickups at baseball parks, hockey stadia, etc., can be substantially reduced if permanent facilities are installed.

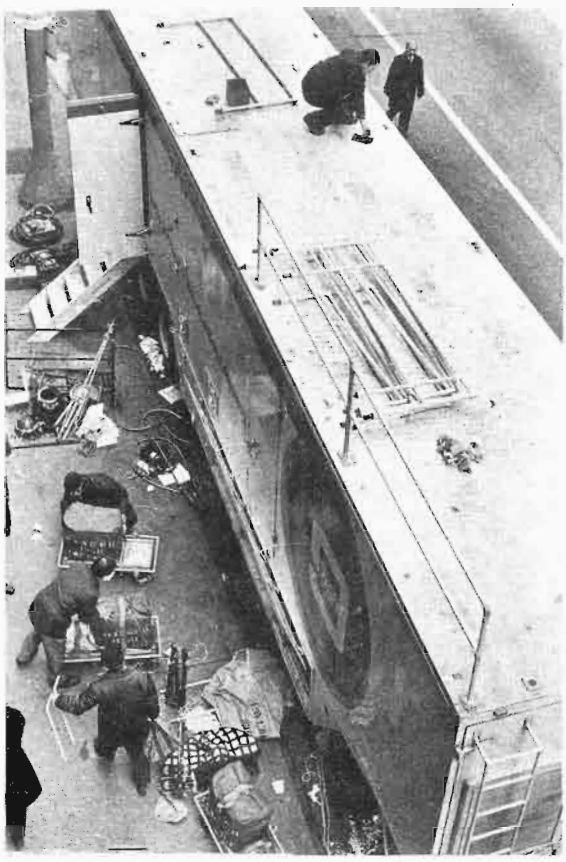


Fig. 44. Setup—unloading and roof railing installation.

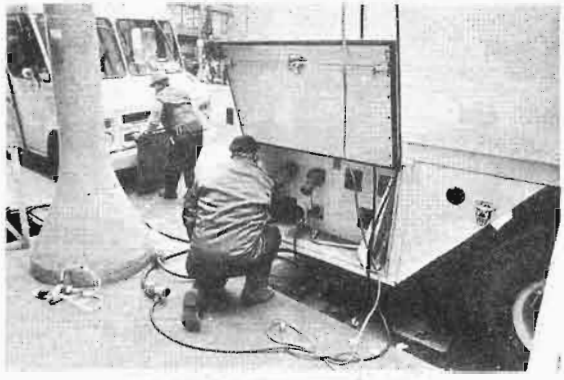


Fig. 45. Setup—power hookup.

Fig. 46. Setup—lighting on the trailer roof.

Fig. 47. Setup—raising equipment to the trailer roof.

Fig. 48. Setup—checking out the camera snorkel.

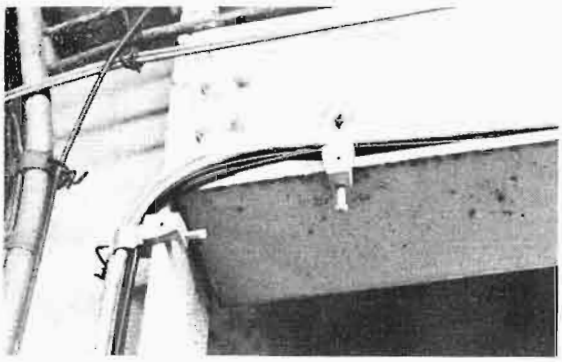


Fig. 49. "I" beam clamps for cable tie-downs.

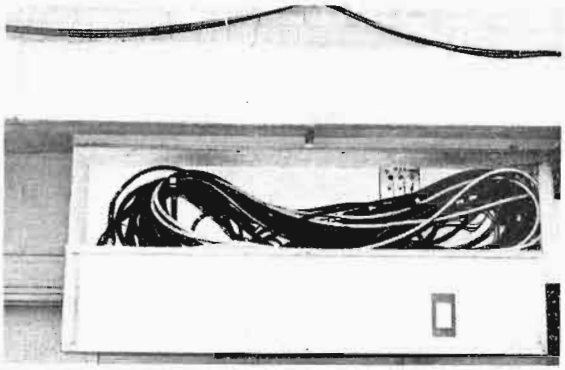


Fig. 50. Cable box at mobile unit location, Chicago Stadium.

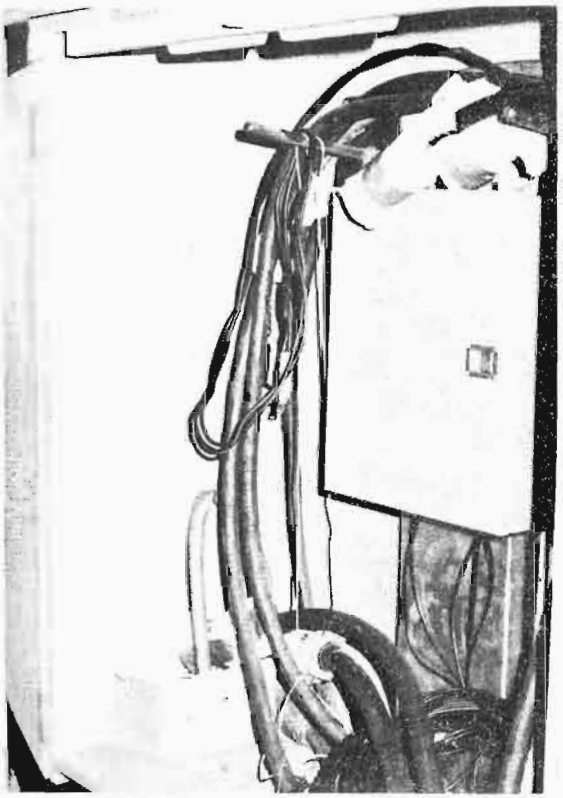


Fig. 51. Cable enclosure at mobile unit location, Wrigley Field.

Fig. 52. Audio/video terminal box at mobile unit location, Wrigley Field.

At such locations, cabling for all camera positions is permanently installed. Cables are routed in such a way as to avoid vulnerable areas where cable damage could occur, especially if mini camera cable is used. "I" beam clamps and adequate tie down of all cabling is recommended (Fig. 49). Sufficient length is provided in order to anticipate possible cutbacks of cables due to connector problems or due to repeated flexing of cables. Also to be considered is to provide enough cable length to reach a second camera that may be located on the adjoining camera mount; this is for the purpose of quick troubleshooting of cables and cameras.

At the mobile unit parking site, all cabling may be coiled inside a protective enclosure to keep connectors out of the weather. Loops of cable are of sufficient length to reach their normal mobile unit terminations. This enclosure may be a painted wood enclosure as large as 5 ft. X 6 ft. X 18 in. used at the ballparks, or, as shown in Fig. 50, used at the Chicago Stadium. Large spindles or brackets protrude from the back inside surface of the enclosure. Cables generally are coiled together around the outer edge of the brackets. Those shown in Fig. 51 have connectors which have been wrapped for winter protection.

Each location where permanent facilities are installed should also include a lockable power disconnect box. It can be located within another enclosure that is of sufficient size to include the power cables that are extended to the mobile unit when in use.

Permanent audio and video tie lines to the remote vehicle from all parts of the Chicago Cubs Wrigley Field terminate in the distribution box located within the cable enclosure at the mobile unit site (Fig. 52). This includes lines to the principal broadcast booth, visiting team booths, dugouts and center field camera locations. Very often the visiting team will have its own sportscaster utilizing the video signal from the mobile unit which supplies the program for telecasting to the local TV audience. This necessitates that all

booths be interconnected permanently with audio and video tie lines. Patching can be made in the local booth audio/video connector panel (Fig. 53) to the truck terminal enclosure.

When the remote crew reports for duty at the reoccurring remote pickup site, they most generally find all cameras cabled and in position (but covered and secured). All audio, video, and camera cables are connected to the mobile unit (perhaps from the previous day's use).

At WGN-TV, it has been the custom for the remote crew to check all systems immediately after arrival, making certain that all equipment is functioning. Early corrective measures are sometimes needed and an experienced crew makes the necessary repairs, substitutes with spare equipment, or notifies the studio that a replacement is needed.

Power is first applied to all equipment in the mobile unit. The broadcast positions or booths are prepared for broadcast, including the setting up of all microphones, headphones, and monitors. Similarly, all mikes, headphones and monitors are installed on the field or dugout in the case of baseball, or on the ice level or courtside in the case of hockey or basketball, respectively. Continuity checks of all operational equipment are then made.

Generally speaking, this includes voice checks of all microphones—those used by talent as well as those used as crowd noise for baseball, field noise for football, and backboard noise for basketball. Visual monitors used at the announcer locations are checked for picture quality and the source signal properly identified. All headphones and ear plugs are checked for level and clarity of signal.

Cameras are uncovered, power is applied, and a number of preliminary operational checks are made prior to a warm-up period. Cameramen and camera shaders work together at the camera and camera control, respectively, each determining that all systems are functioning. A quick check of signals from each of the three plumbicons in each camera is a necessity.

The cameraman is concerned about lens performance, clarity of viewfinder picture, tilt/pan head operation, camera cue and program continuity on his headset and tally continuity on both tally circuits.

The shader(s) checks all monitoring equipment on each camera console. He is concerned with the overall performance of the camera chain, which includes registration, color balance, focus tracking, video levels, aperture setting and peaking of the video signal and encoder check out.

In addition, the switcher or audio engineer checks continuity of all telco facilities (broadcast circuits, PLs and business telephones). An early call to master control for check-in and time check for clock synchronization is always in order.

After time has been allowed for equipment to warm up and the crew lunch break has been taken, a detailed camera alignment is made along with the final color balancing of all cameras. Audio and video levels to the studio are set and verified. Color bars from a camera control unit are used to substantiate the performance of the telco video circuit or microwave circuit to the studio location. The variable tone oscillator used in the audio console is a source feed for checking the audio circuit levels and response. A voice quality check is usually required to assure master control that peak distortion is not occurring. Any suspicions of distortion in that regard may require a more detailed check of headroom capabilities of the audio circuit. Both the color bar signal during setup and the vertical interval test signal during air time assure master control that the telco video loop or the microwave transmission is functioning properly.

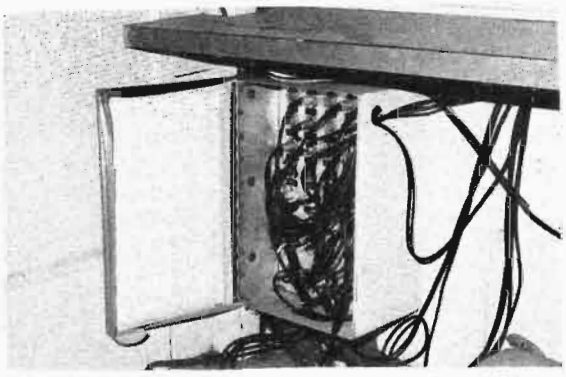


Fig. 53. Booth audio/video connector box, Wrigley Field.

One-Time-Only Remotes

These remote originations involve considerably more setup time. It would probably be more accurate to define one-time-only remotes as those which do not have permanent cabling installed. Since camera locations may be as far as 1000 ft. away from the mobile unit, cable installation time can be considerable. On such a setup, the entire remote crew with proper supervision and preplanning can be involved in the running of cables.

Care must be taken to avoid leaving any hazards for the public in these installations. Camera cables are usually flown overhead in order that tripping accidents may be avoided. When it is required for cables to lie on the ground where traffic is expected, cable ramp covers or bridges are provided. At the very least, a heavy, wide carpet tape should be employed.

Frequently, the one-time-only remote will require a microwave setup. Microwave installations

are usually established as being possible by line-of-sight checks on the earlier survey date.

The setup of microwave equipment on the top of the mobile unit is not always possible. At times, the transmitting gear must be carried or hoisted to the rooftop of a nearby building where the only line-of-sight vantage point is available. If the survey indicates that the microwave check be made before the day of setup, this precaution should be taken. A minimum of a week's advance notice might still leave time for a telephone video facility to be ordered. Needless to say, microwave usage adds to the total time needed for setup. Depending upon the degree of difficulty of installation and antennae orientation, three engineers on the crew could be occupied for one to two hours.

In order to avoid long operating days for the crew on this type of remote origination, it is sometimes prudent to make a partial setup on the day before the program day. Prior commitments at assembly halls, stadia, and churches may also dictate working around these events. On the setup day, power tie-in and power cable installation should be accomplished, camera cable runs completed, microwave gear set up and continuity checked, and long audio harnesses and microphone cables installed.

It should be noted that on these preliminary setup days, all scaffolding and camera platforms ought to be similarly installed by the Facilities Department.

An early setup day not only reduces the call for the crew, but may provide the additional rehearsal time required of that program. Depending upon the length of the rehearsal and program itself, final tear out of all facilities can be either after the program or on a future day.

The remote survey for the one-time-only remote pickup, hopefully, included methods of obtaining power for the mobile trailer. It is usually advantageous to have these arrangements made prior to the day that power is first needed.

A useful facility for this purpose is the portable dual disconnect box(es) shown in Figs. 54 and 55. The lower box is used for utility power (fused at 200 amperes per leg) in the trailer, and the top box is used for equipment power (fused at 100 amperes per leg). The input of each disconnect box has 15-ft. pigtails of No. 1-0 wire. Across the output of the disconnect units are short cables outfitted with power cable connectors—mates for the 50- or 100-ft. extension cables to the mobile trailer.

The power boxes, which are permanently mounted on a hand truck, are delivered in advance to the remote location where a qualified electrician or power utility personnel ties in the input pigtails. The remote crew on the setup day

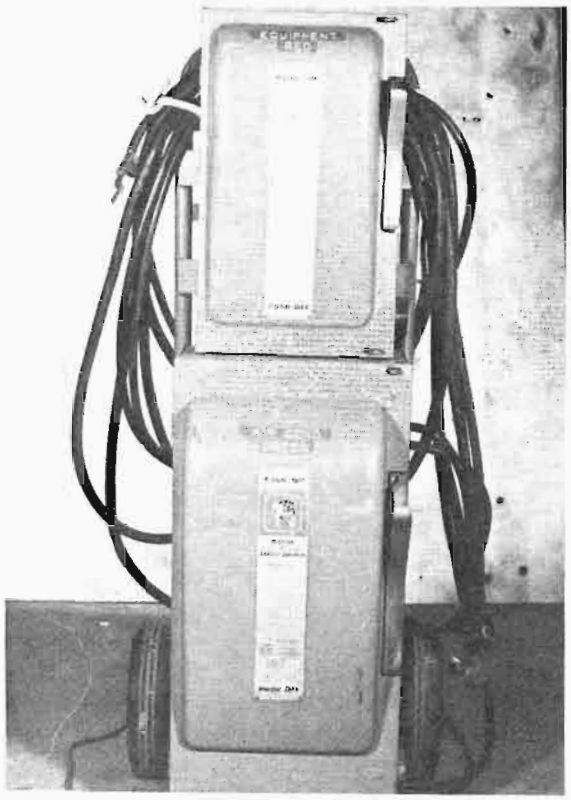


Fig. 54. Portable dual disconnect boxes.

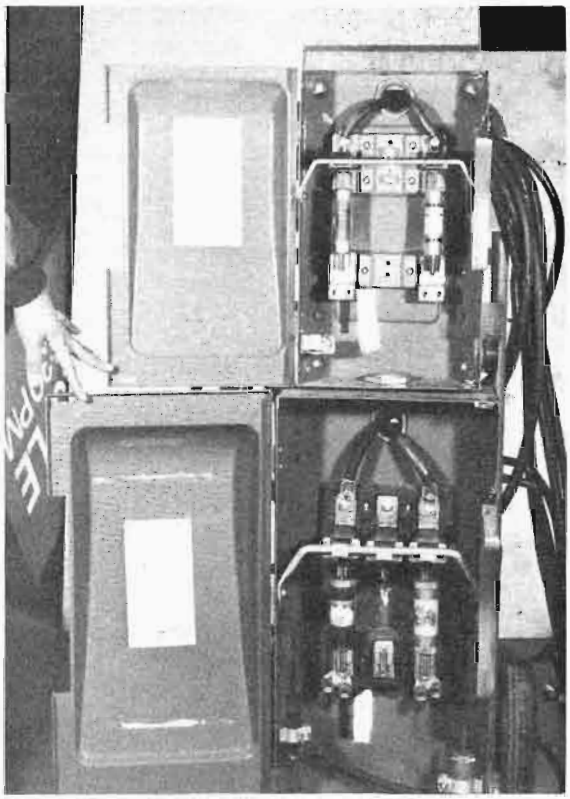


Fig. 55. Portable dual disconnect boxes showing equipment box at top and utility box at bottom.

cables in the extension cables to the trailer and activates the portable disconnect switches.

Advance preparation needed for out-of-town remote pickups can become quite extensive, especially if the program extends beyond several days. Such is the case of the television coverage of the two Illinois High School Association basketball tournaments.

A little background would be helpful in better understanding the scope of the preparation required for these telecasts. The tournaments are held each year at the University of Illinois Assembly Hall in Champaign, Illinois. Quarter final, semifinal, consolation and championship games are played for small schools (Class A) and larger schools (Class AA) in the state. These 16 games are telecast to a statewide network on Friday and Saturday of two successive weekends.

At the remote location, a studio, called Tournament Central, is set up in the lower level of the Assembly Hall. On-camera commentary and interviews originate in this area and supplement the courtside activities of the games where three or four sportscasters provide the play-by-play and color commentary. Fan and cheerleader interviews are conducted and inserted frequently into different positions in the program script.

A videotape spot reel with as many as 75 taped segments is played back from a tape mobile unit at the remote site. Included on the tape reels are commercials, prerecorded interviews and highlights of earlier games. The primary mobile unit is used to coordinate the production, which utilizes six cameras, two VTRs, slo mo, character generator, and an assortment of 20 microphones. Team and player backgrounds, foul information, scoring data, and other pertinent statistics are inserted throughout the course of the telecasts. Total air time for each tournament is approximately 12 hours.

Engineering preparation by administrative engineers for this annual tournament is done over a three-month period. The agenda for this preparation follows:

1. Administrative engineer, in the company of producers, facilities supervisor and agency personnel, meets with Assembly Hall staff to review upcoming tournament.

2. Guard and electrician's needs are listed and a schedule of these needed services is left with the Assembly Hall superintendent.

3. Motel reservations are made for the total personnel who will be assigned to this pickup.

4. Engineering reviews remote personnel assignments of past years for this pickup, reviews recent performances of its personnel and submits selected crew members to the Production Department for the purpose of credential procurement.

5. Business telephones, private lines and broadcast circuit needs are submitted in writing to the telephone company along with a tentative list of television stations due to receive tournament telecasts.

6. Correspondence is written and final arrangements are made for the following:

a. Rental equipment.

b. Temporary help that is to be used at the remote location.

c. Truck or vehicle leasing.

d. Notification of the FCC for use of auxiliary broadcast equipment (handi-talkies) in the downstate area.

e. Business lunch and meeting arrangements during tournament weeks.

7. Review equipment needs with the two engineers-in-charge who are to be assigned to the remote. Check last year's equipment list and ascertain if any purchases have to be made to meet this year's requirements. Orders for needed cabling, connectors, etc., should be submitted at least six weeks in advance of the tournament.

8. Post remote crew assignments about four weeks in advance of the tournament. List vehicles to be used for personnel travel, supply motel information, details of expense money advances and travel directions.

9. Arrange for drayage of mobile trailer and tape trailer for trips to and from the remote location.

10. Delegate engineer-in-charge to prepare information booklet for crew members. Ask that data be included regarding cable runs, audio and video interconnects between trailers and the Assembly Hall, camera placements, power hookup information, rehearsal and videotape recording times, and information supplied by the Engineering Department Office regarding lunches, the use of company blazers, etc.

11. Arrange for catered food for crew lunches on the tournament days.

12. Provide crew and master control with the listings of all business telephone numbers, PL interconnects and broadcast circuit identifications.

13. Work with the Production Department in scheduling studio time for advance preparation of the videotape spot reels. All segments will be placed into their proper position on this reel. The tape engineer making the recording will be one of the engineers eventually assigned to the tape mobile unit at the remote.

14. Advise the Auditing Department of the advance monies needed for engineering personnel.

15. Send memo to the Program Department reminding them of the use of two cameras and the character generator on remote location and indicating the times this equipment will not be available for studio use.

16. Advise the News Department that Engineering will be utilizing its handi-talkies for com-

munication purposes during the two weeks of the tournament.

17. Submit a final reminder to the remote engineers-in-charge that they should be prepared, along with the administrative supervisor, to submit a critique of the engineering operation following the telecasts.

Two and one-half days are devoted to travel and the total setup of this remote origination. The engineering crew schedule is staggered over three days in order that the later arrivals may bring with them any equipment that was overlooked or has become needed due to breakdowns. Although the nature of the telecast of the basketball games cannot provide a complete "rehearsal," all crew members are thoroughly checked out and must be available for system checks well in advance of air time. The videotape recording in Tournament Central on the afternoon preceding the telecast date allows for a good system checkout in that area.

Air time with this remote, or any other remote, exemplifies the teamwork capabilities of a remote crew. Directors and cameramen who work together on sports pickups can attain a degree of perfection for which the home viewers are most appreciative. Conversely, it can be quite obvious if crew members are not in tune with each other's actions because they are not accustomed to working together.

In all cases, the director should run the show at air time. Responsiveness to his cues on the part of the switcher, the audio engineer, the slo mo operator, and the cameramen is essential to the final effectiveness of the remote telecast. A good director will allow certain freedom on the part of the cameramen as long as it is within the general bounds of their coverage responsibility. By this is meant, the principal coverage camera should have certain responsibilities such as following the play action where another camera may principally be employed for close-ups of the pitcher, quarterback, hockey net, etc.

The final air product will always show whether the teamwork was achieved. Whether it be proper iris settings, a well-balanced sound, punctual and accurate switching, good color balance, effective use of the slo mo, smooth zooms, proper framing, or a good choice of close-ups, all will contribute to the culmination of a final product—that of a successful television remote program origination.

32

"Live Journalism" Antenna

Thomas J. Vaughan
President, Micro Communications, Inc.
Manchester, New Hampshire

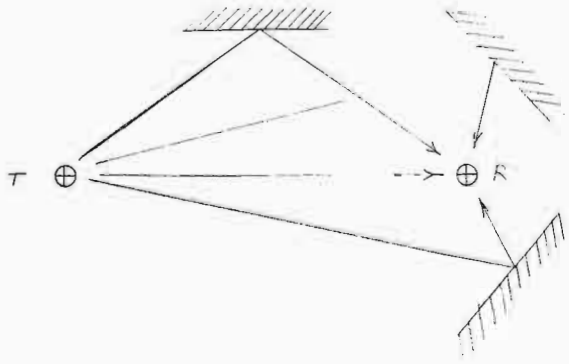
Live Journalism (ENG)—Requirements

Live Journalism requires the use of a receiving antenna that can be "seen" electrically from anywhere in the metropolitan area.

Because of the proximity of tall buildings, it is not possible to have direct line of sight from the antenna on the transmitting van to the receiving antenna for all locations.

It is therefore necessary to use a receiving antenna that can make use of signals that are reflected from nearby buildings.

A second requirement is that some form of filtering be incorporated into the antenna to eliminate or minimize multipath signals—the cause of ghosting.



Multipath Discrimination

There are two useful techniques that can be used to discriminate against multipath reflections:

1. Pattern Directivity
2. Circular Polarization

Pattern Directivity

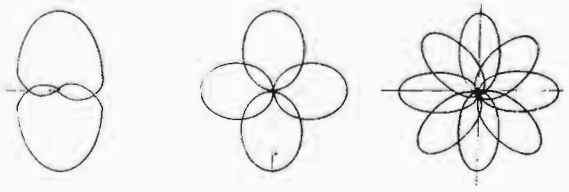
An omnidirectional antenna would be an ideal receiving antenna in that signals could be received from any azimuth direction. The disadvantage is that all multiply reflected signals would be received equally well and the ghosting problem would be greatly aggravated. The obvious solution is to use a circular array of more than one antenna and take advantage of pattern directivity.

The array can be composed of any number of individual radiators and a switch used to select the radiator pointing in the direction of the maximum signal.

It is quite possible that the maximum signal is not in the direction of the transmitting antenna. For example, if a large building is located in the path of the signal, it may be desirable to use the best quality reflected signal. The selection process in this case would be done by the operator.

The criteria for determining the individual antenna properties in the array are based on ± 2 dB ripple factor, e.g., the cross over level of any two adjacent antennas be down no more than 4 dB from the peak or point of maximum gain.

This will permit most signals to be received on more than one antenna.



Two Antennas	*Four Antennas*	*Eight Antennas*
$BW_{AZ} = 180°$	$BW_{AZ} = 90°$	$BW_{AZ} = 45°$
$BW_{EL} = 13.2°$	$BW_{EL} = 13.2°$	$BW_{EL} = 13.2°$
Gain = 12.3 dB	Gain = 15.4 dB	Gain = 18.4 dB

$$\text{Gain} = K \frac{4\pi \left(360/2\pi\right)^2}{\theta_1 \times \theta_2}$$

Where θ_1 = Beamwidth — Azimuth Plane
θ_2 = Beamwidth — Elevation Plane
K = Efficiency Factor of Antenna

The greater the number of antennas, the higher the gain and the greater the discrimination to reflected signals.

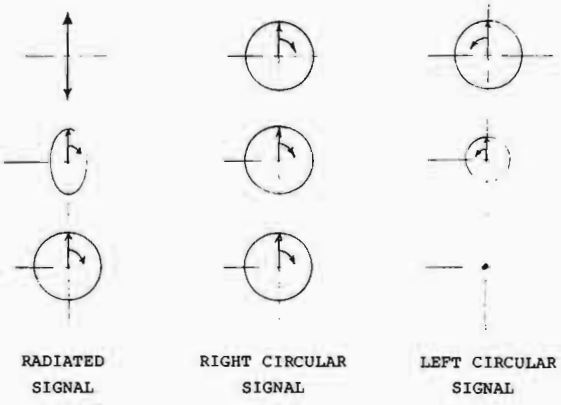
Circular Polarization

Cross polarization has been used as a means of filtering unwanted signals for many years.

By having one TV station radiate horizontal polarization and the other vertical polarization (England), it has been used to space cochannel stations closer than the table of allocation would normally permit.

Circular polarization has been used in television in (Mexico and South America) and recently in the USA. One advantage is that improved signal reception can be obtained regardless of the orientation of the receiving antenna. A second and more important advantage is that many of the unwanted reflected signals will be cross polarized. These can be filtered if a circular polarized receiving antenna is used.

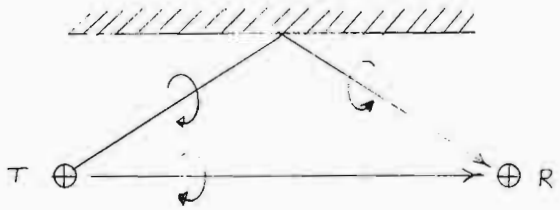
This can be explained as follows. An elliptically polarized wave is composed of two circularly polarized signals one left-handed and one right-handed. When the elliptical wave reduces to a linearly polarized wave the right- and left-handed signals are equal. When the signal is right handed, the left handed signal is zero.



If a circularly polarized receiving antenna is used, it will only receive that component of the signal that is the same sense. The other will be cross polarized.

A feature of circular polarized transmission is that the reflected signal will be of the opposite sense of the direct signal.

The degree of filtering is a function of the axial ratio of the transmitting antenna, magnitude of the reflected signal and the axial ratio of the receiving antenna.



$$\text{Axial ratio} = 20 \log \left(\frac{E_v}{E_H}\right)$$

Since;

$E_V = E_R + E_L$ $\quad E_R$ = right circular

$E_H = E_R - E_L$ $\quad E_L$ = left circular

Therefore;

$$AR = 20 \log \left(\frac{E_R + E_L}{E_R - E_L}\right)$$

The ghost rejection ratio when the reflection coefficient is one will be;

$$\text{Ghost rejection} = 20 \log \left(\frac{E_R}{E_L}\right)$$

Therefore;

$$\text{Ghost rejection} = 20 \log \left[\frac{1 + 10^{AR/20}}{1 - 10^{AR/20}}\right]$$

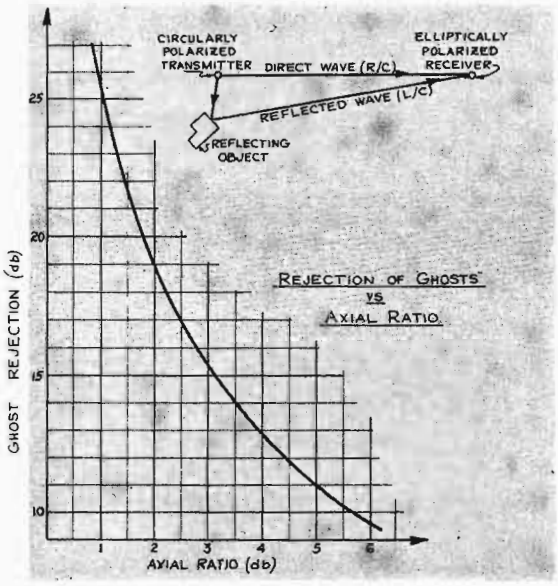


Fig. 1. Rejection of ghosts versus axial ratio.

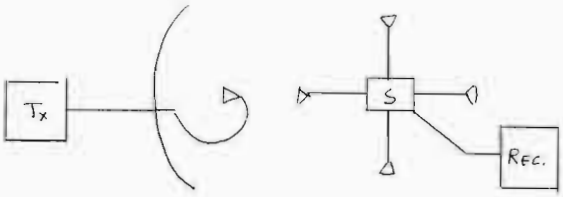


Fig. 2. A 4-ft. parabolic dish with a right circular feed as the transmitting antenna and a four antenna receiving antenna.

For Electronic News Gathering applications it is possible to have:

1. The antenna in the van transmit right circular and to receive horizontal or vertical, right circular or left circular.
2. The antenna in the van transmit horizontal, vertical right circular or left circular while receiving right circular.

The law of reciprocity permits, the role of the transmitting and receiving antenna to be interchanged. Therefore there is no loss in information if fixed polarization is received and multiple polarization is transmitted. It should be noted that a circularly polarized signal of either sense can be received by a linearly polarized antenna of any orientation but it will be reduced by 3 dB.

$$E_H = .707\ E_{CIR}$$

$$E_V = .707\ E_{CIR}$$

Type of Antenna

Most of the ENG systems uses a 4-ft.-parabolic dish with a right circular feed (some capable of being manually switched to left circular) as the transmitting antenna and a four antenna receiving antenna.

The receiving antennas are of two types.[1]

1. Four element phased arrays
2. Flared horns

Each is capable of remotely controlled multiple polarizations and have the same azimuth and elevation beamwidths. They differ in the following respects.

[1]A third type of antenna makes use of a parabolic antenna mounted on a X-/Y pedestal. The antenna can be remotely positioned in azimuth and declination. Although this system has higher gain, it suffers from disadvantages; (a) being side mounted on a tower approximately 90° of azimuth orientation which is blocked by the tower; (b) the drive power available with commercial pedestals cannot drive in winds greater than 45 mph; (c) many insurance policies will not permit a moving antenna on the tower.

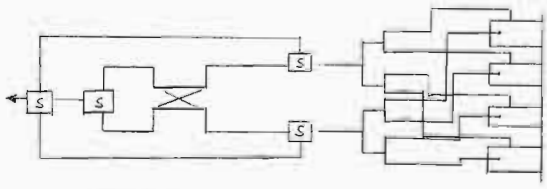


Fig. 3. Four element array module.

Four Element Array

The array consist of four waveguide horns spaced one wave length apart. Each horn contains a dual polarized feed. By processing the horizontal and vertical components through a solid state switching matrix it is possible to receive horizontal, vertical, left and right circular polarizations.

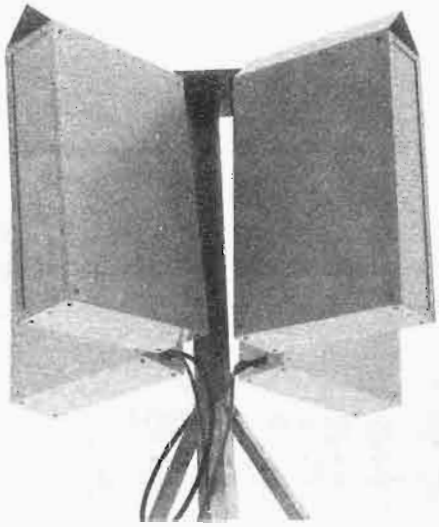
An advantage with this construction is that any amplitude and phase distribution can be placed across the array and null fill and beam tilt can be obtained.

A second advantage is that since a near uniform distribution can be placed across the antenna a near 100 percent aperture efficiency can be obtained. The resultant antenna can be made very small and compact (Photo 1).

The solid state switching permits polarization and quadrant selection to be done live, e.g., with programming on line since switching speed is on the order of 200 nanoseconds.

Flared Horns

The flared horns uses a single dual polarized feed (Fig. 4). The azimuth and elevation beam widths are essentially the same as the four element array. To obtain these beamwidths, it is necessary for (L) to be very large (approximately



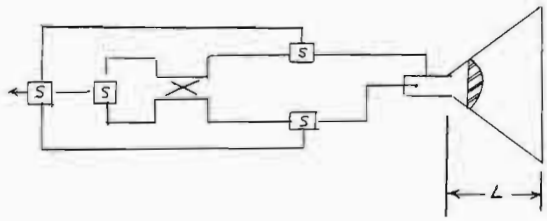


Fig. 4. Flared horns module.

70 in.). To reduce this to reasonable figures (like 30 in.), it is necessary to mount a phase correcting lens in the throat of the horn. This will delay the energy at the center of the horn a greater amount than the energy at the edge resulting in a more uniform phase front.

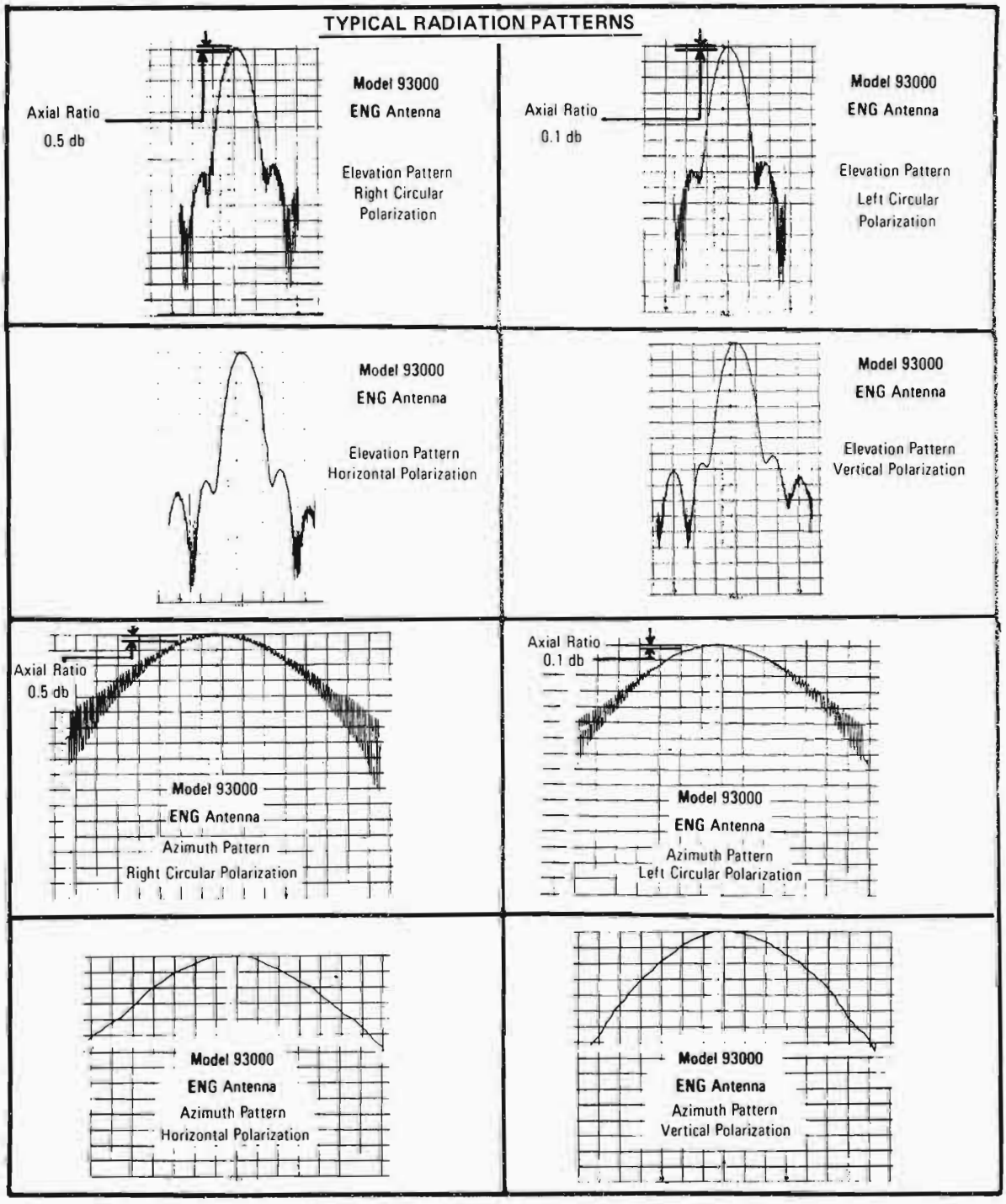


Fig. 5. Typical azimuth and elevation patterns.

Siting Considerations

Typical azimuth and elevation patterns are shown in Fig. 5. An important consideration in the choice of locations is the height of the receiving antenna.

For TV and FM transmissions, the signal level at a point above the ground will increase proportional to height. This increase is due to the reflected signals,[2] adding in-phase when a low gain antenna (dipole) is located at one end of the link.

The ENG antenna uses a high gain (25 dB) parabolic dish at the ground location and the reflected signal will not contribute to an increase in field. Therefore, increase in height will not increase signal level.

In fact the reverse is true. As the height of the receiving antenna is increased, the near in signal will decrease because we are moving further down on the elevation pattern. In addition, the nulls close to the tower will move out.

This can be seen in the enclosed plot of signal to threshold level versus distance for a typical system (Fig. 6).

As can be seen there is no improvement if the antenna is increased from 500 ft. to 2,000 ft. at distances beyond 10 miles although there is considerable reduction for near in signals.

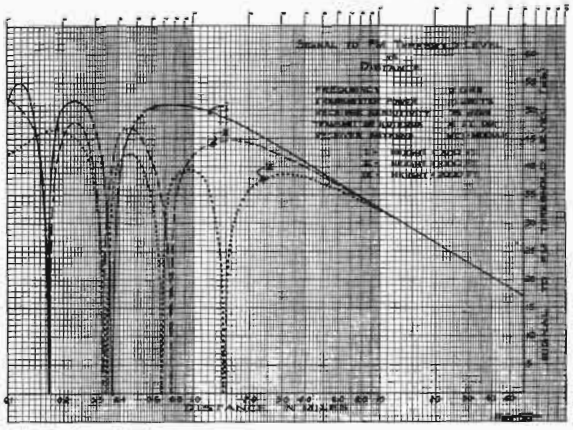


Fig. 6. Plot of signal to threshold level versus distance for a typical system.

The conclusion is that the antenna should be located no higher in height than necessary to obtain *reasonable* line-of-sight paths.

Where high heights are required for line of sight reason, it may be necessary to provide null fill. At a 1,000 ft., no signal will be obtained at 0.8 miles from the receiving antenna. The first null can easily be filled with the four-element array by providing an amplitude taper across the array.

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[2]"*Transmission of Circular Polarized Waves between Elevated Antennas,*" By T.J. Vaughan and R. Pozgay.—*IEEE Transactions Publication* September of 1974, Volume BC-20 Number 3.