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A STUDY OF MICROWAVE TELEVISION FOR TRAFFIC SURVEILLANCE IN TEXAS

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Research Report Number 165-9

Development of Urban Traffic Management
and Control Systems

Sponsored by
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State Department of Highways and Public Transportation

in cooperation with the
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TEXAS TRANSPORTATION INSTITUTE
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August 1975

ABSTRACT

This study is concerned with the design and evaluation of a closed circuit television system which uses a microwave transmission system for the video signals. A one-camera system was designed and installed at an urban intersection to monitor the operation of traffic and traffic control devices.

The system has operated well for three years with only infrequent disruptions of service which were due primarily to lightning damage. Initial costs for the transmission system were high when compared to direct cable systems, but considerations for lower maintenance cost, flexibility of design for relocation and low costs for long range transmission (up to 10 miles (6.2 kilometers) make the microwave system of transmission very competitive with other designs.

SUMMARY

A one-camera closed circuit television system, utilizing microwave transmission for the video signal, was installed at the intersection of Wayside Drive and Telephone Road near the Gulf Freeway in Houston, June 1972. The monitor was located in the Gulf Freeway Surveillance Center and the quality of the video transmission was compared to that of direct cable transmission from 14 cameras positioned along the freeway. Maintenance records of video and control systems were kept for both types of transmission systems.

Results of the study suggest that microwave transmission for closed circuit television systems for traffic surveillance is technically feasible and economically competitive to cable systems, especially for long transmission distances.

1. Horizontal resolution is limited by the microwave system, but vertical resolution is approximately equal to the cable system. The quality of the picture was not impaired by the microwave link which was approximately 1000 meters.
2. The system reliability was better than the cable system. Most outages were caused by lightning.
3. Cost of installation of cable for long distances can only be justified if several cables are installed at the same time. Microwave systems are very cost competitive when individual links or long distances are considered.
4. The portability of the system is a distinct advantage over cable systems. The microwave system can be relocated within a 5- to 10-mile radius for less than $1,000.

Based on the experience of three years of operation of the microwave system, the following recommendations are made:

1. Microwave transmission should be included in consideration of alternate designs for CCTV systems for traffic surveillance.
2. The use of microwave for transmission of traffic data and signal controls in urban-wide surveillance and control systems should be considered.

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INTRODUCTION

Need for the Study

Closed circuit television systems for traffic surveillance have been in operation for over 10 years. The fact that there are not many systems in operation today should not detract from the usefulness in and the potential for the application of television to other traffic surveillance systems in the country. The primary problem has been a lack of organization and staff to operate the systems in an efficient manner. Since most urban areas are now beginning to develop these operational agencies, the need for closed circuit television is becoming more apparent as these agencies design, install, and operate traffic surveillance and control systems.

Therefore, it is necessary to determine the best system design for application to traffic surveillance. Several installations have utilized hardwire for video transmission, either with the balanced video pairs or coaxial RF systems. There are some locations that use microwave transmission in a system for traffic surveillance from a helicopter to a ground receiving station. With the recent developments in microwave transmission design which have reduced the size and cost of transmitters and receivers, the application of small-powered microwave transmission equipment for ground-to-ground systems is now feasible.

The surveillance and control projects that are being designed today are centered along urban freeways, but the study areas are not limited to the right-of-way of these freeways. The area of influence of a surveillance and control project is being expanded to include the street network

that supports the urban freeway. This expansion in area makes visual surveillance from the freeway impossible and the establishment of an adequate electronic surveillance system of detectors and computers impractical in the early stages of development. A video surveillance system that has a portable design that enables it to be moved to several locations offers considerable promise for urban arterial network studies.

Objective

The objective of this study is to design, procure, install, operate, and evaluate for traffic surveillance a typical microwave closed circuit television system which uses microwave transmission of the video signal.

Approach to the Problem

The approach to the problem is outlined in accordance with the various activities described in the statement of the objectives. First, the design of the system was handled in the following way. A survey was made of the television industry to determine the equipment that was available for microwave transmission of video signals. Based on the literature available in the technical periodicals and journals, representatives of microwave companies were contacted and discussions on system design were conducted. Based on these discussions, a typical system was designed in terms of available transmission equipment. Since the objective was not to evaluate the equipment for a microwave system, all contractors were asked to bid on a specific microwave design. The other video equipment necessary to complete the television system was designed according to the experience gained through the operation of the television surveillance system in Houston. Therefore, the specifications were written to

describe a typical and acceptable system design with which the project staff had experience. The contractors were asked to bid this system and to submit alternate bids if they wished to modify the system specifications. With few exceptions, this approach resulted in the preparation of specifications on which contractors satisfactorily bid the proposed system.

The second activity in the approach to the problem was the procurement of the system. The first step was to obtain approval and funding for the purchase of the television system for use on research projects. The request for purchase of the equipment was included in the annual research proposal and was approved by the Research Committee for the State Department of Highways and Public Transportation. The funds were allocated to the Gulf Freeway Surveillance Project through the Highway Planning and Research Program in the following year, during which the preparation plans and specifications were completed. The State Department of Highways and Public Transportation used their standard procedure for the review of the specifications, the advertisement for bids, and the award of the contract to the low bidder. The specifications proved to be adequate and three comparable bids with only minor exceptions to the design were received.

The next step was the installation of the system. The State Department of Highways and Public Transportation provided the design for the installation of the equipment adjacent to the Gulf Freeway Surveillance Project. Poles were erected at the Gulf Freeway Control Center and at the intersection of Wayside and Telephone Road where the traffic signal control was supervised by the digital computer located in the Freeway Surveillance Control Center. The contractor was required to install the equipment

on the poles and to check out the installation in the Control Center to insure that the video and control systems were working properly.

The operation of the television system was handled by the staff of the State Department of Highways and Public Transportation and the Texas Transportation Institute at the Surveillance Office. The system was used in research studies on the control by digital computer of the traffic signals at the arterial street intersection.

The evaluation of the system was the documentation of the successful operation of the system as it was installed adjacent to the Gulf Freeway. The resolution, the reliability, the quality of the picture, as well as the other factors of cost, portability and design, were considered.

This approach to the problem, utilizing an operational installation as a documentation, is beneficial to the research program as well as the operational agencies sponsoring the research. First, the research staff has an opportunity to evaluate one system while conducting research by utilizing that system. Secondly, the operating agency has the experience of purchasing the system, obtaining the license permits for operation and providing the facilities for the installation and operation of the camera at one or more locations.

SYSTEM DESIGN

General Requirements

A closed circuit television (CCTV) system consists of the following subsystems: television camera and lens, video transmission, television monitor and camera control system. There are many design configurations with several levels of quality and cost available for traffic surveillance. The determination of the best design for a specific application is difficult because there are several alternatives which may be capable of meeting the surveillance requirements. In the following discussion some of the more important aspects of design are presented with the assumption that in all cases, the most cost effective system for a set of conditions is preferred.

Camera and Lens Subsystem - The two requirements of a CCTV system for traffic surveillance are reliability and picture quality. In the design of the television camera, reliability is more important because the installation will be exposed to the outdoor environment 24 hours a day and the cameras will be positioned so that direct access for maintenance will be difficult. These conditions are necessary to provide the desired coverage of the traffic and to reduce the opportunity for vandalism. Therefore, those characteristics of the camera that describe its reliability and durability under a wide range of light, temperature, and moisture conditions are of primary importance.

The characteristic of picture resolution is of secondary importance since the camera will not be the critical component in the CCTV system. Most cameras that are selected for this type of surveillance have resolution capabilities much greater than the requirement for the system.

Still, the resolution specification is important to establish the quality of the system and to define a level of acceptance. In general, there are three broad levels for quality for television cameras. The requirements of traffic surveillance can be satisfied by a CCTV system that produces 300 to 400 lines of resolution, but the camera subsystem should be capable of producing in excess of 600 lines of resolution.

The lens system to be used in the CCTV system will be determined by the field of view required of each camera. Most systems prefer a zoom type lens with focal lengths ranging from .15 mm to 150 mm. The quality of the lens should be high enough so as not to restrict the horizontal resolution of the system. If visibility under poor light conditions is required, a lens that provides a greater lens opening at the extended position must be used. The lens controls should have the same reliability and durability as the camera.

Video Transmission - Picture resolution and detailed cost analyses will probably dictate the type of video transmission system to be used:

1. The use of coaxial cable for direct video transmission is limited to short distances since the attentuation of noise increases with the length of cable.
2. The balanced pair video cable provides a high quality picture, but the cost is higher because of the special amplifying, balancing, and equalizing equipment.
3. The use of radio frequency modulation on a coaxial cable provides an economical installation, since one cable can transmit up to thirteen channels. Long distance transmission would favor this system design, although the quality of the

picture would be less than the balanced system.

4. The microwave system provides flexibility for location and portability that is an advantage in the study of large traffic systems. The purchase cost is higher than the other systems, but the cost for providing many different camera locations is lower. The license requirement may restrict the use of this medium in urban areas. However, a different transmission medium must be provided for the control functions of the camera, lens, and pan and tilt unit.

There is not an established procedure for determining the mimimum picture resolution required for traffic surveillance. Resolution will vary widely for different light conditions and, as the system ages, for different components. Picture resolution of 400 lines was set for a RF system for the Dallas Project and 650 lines for a balanced pair video cable for the Houston Project. Both systems produce good usable pictures for traffic surveillance, but the Dallas system has, on the average, less clarity and sharpness.

The best approach to the selection of the resolution requirement is to obtain a field demonstration of two comparable systems that produce pictures of minimum and a maximum resolution and simulate the desired surveillance tasks.

Television Monitors - As in the case of the television camera, the monitors selected for the CCTV system should not limit the picture resolution. Monitors especially designed for closed circuit surveillance have no tuning systems and sound systems; the electronic circuits are more refined and stable; and the picture resolution is greater.

Commerical television sets, adapted to receive video signals over a coaxial cable, are less expensive, but are less reliable and have less picture resolution.

Size of the monitors depends on the viewing distance. A desk installation uses 14-inch monitors, and a 10-foot viewing distance in Houston required 17-inch monitors.

The monitor controls should be located on the front panel of the set if the monitors are to be displayed in equipment racks or shelves. Special attention must be given to air conditioning if solid state monitors are not used.

Since the monitor is a low-cost item in the CCTV system, much higher quality can be obtained with a small increase in price.

Camera Control System - If a CCTV system is to provide surveillance of traffic operations over a large field of view and under varying light conditions, it will be necessary to control the position of the camera and the condition of the lens. The functions to be controlled are:

Camera Position	Lens Condition
Pan - Left	Increase Focal Length
Pan - Right	Reduce Focal Length
Tilt Up	Open Iris
Tilt Down	Close Iris
	Move Lens In (Focus)
	Move Lens Out (Focus)

Some additional functions such as auto scan and variable speed of the pan and tilt units can be added if required.

The transmission of the control commands for the functions can be accomplished in several ways:

1. A multiconductor cable, usually installed with video cables, provides one conductor for each function and one common ground

to complete the circuit. D.C. voltage is applied or grounded to operate control relays.

2. A time division multiplexing system transmits serial data as a modified frequency shift keyed (FSK) signal over a private dedicated voice grade telephone line.

System Description

A one-camera system using microwave transmission has been specified for application in both the Houston and Dallas areas (Table 1). The initial installation was in Houston.[1]

The video system uses a low-power microwave transmission with a line of sight range of ten miles. The system has remote control of a pan and tilt unit that provides 360-degree horizontal and ± 45-degree vertical coverage, and of a zoom lens with focal length of 15 to 150 mm. The focus and iris adjustments of the lens have remote control. The control is accomplished over telephone lines by a multiplexing system, with data transmitted as a modified (FSK) signal with 2400 H_z representing the mark condition and 1200 H_z representing the spacing condition. The video display is accomplished by one 19-inch monitor.

More details of the description of the components of the systems are found in the copy of the system specifications, Appendix B.

PROCUREMENT OF THE SYSTEM

It required 38 months to obtain the microwave television system for use in the research program. This is an unusually long time, but the purchase of a new and unfamiliar system that requires special governmental approval requires special handling and attention. The statements below

TABLE 1

EQUIPMENT DESCRIPTION OF THE
PROPOSED MICROWAVE TELEVISION SURVEILLANCE SYSTEM

Television Camera	- Diamond Electronics Model ST-2: Silicon transistorized vidicon camera; Horizontal Resolution 800 lines; Positive interlace.
Television Monitor	- 19-inch portable VTR/CCTV monitor, Panasonic Model AN-69V with resolutuon greater than 600 lines. Capable of receiving commercial broadcasts on VHF and UHF.
Pan and Tilt Unit	- Pelco Medium Duty Model PT-550-M.
Camera Lens	- Pelco TV - VIOX15 with f 2.8.
Transmission Cable	- Video Cable as required. One pair #22 AWG telephone solid control wires.
Transmission Equipment	- Microwave Associates MA-12C Low Power Microwave System. Specification in Appendix A.
Camera Housing	- Pelco Model EHD Camera Enclosure.
Amplifier Cabinet	- Field cabinets custom designed to protect equipment from vandals and the environmental conditions in Texas.
Control System	- A Pelco Model DM 3200 Series Digital Multiplexor to provide control of the following functions: camera pan, tilt, lens focal length, focus and iris over one pair of dedicated telephone wires or one balanced twisted pair. The remote controls are located in the television control room and local controls are provided at the field cabinet.

are presented for the purpose of facilitating similar installations and are not to be interpretated as criticism of any agency or person involved in the procurement process.

Approval and Funding

In April 1969, the objective to obtain a microwave television system was included in the research proposal for the 1969-71 Fiscal Year. This objective was approved by the Highway Planning and Research Program for the State Department of Highways and Public Transportation in September 1969. During that year, information on systems using microwave television was collected from the television industry. Estimates for the cost of the system were developed and funds were made available to the research project in September 1970.

Specifications and Award of Contract

The specifications for the system were completed in June 1971. The specifications, which are included in Appendix B, describe the system by specifying acceptable components. This approach did not restrict the bidders, since they were given the necessary latitude to propose alternate designs. The specifications were submitted to the Headquarters of the State Department of Highways and Public Transportation in July 1971 for review. Bids on the contract were received on August 30, 1971. After 30 days, for review of the bids, the contract was awarded to Audio Video Designs, Inc., of Houston on September 28, 1971 (Table 2).

Application for FCC License

The State Department of Highways and Public Transportation required the contractor, Audio Video Designs, Inc., to make application to the Federal Communications Commission (FCC) for a license to operate the

TABLE 2

ANALYSIS OF BIDS

Company	Bid Price	Exceptions
Audio Video Designs, Inc. Houston, Texas	$14,599	Zoom lens Bid - Pelco TV-V10X15
Microwave Associates Burling, Massachusetts 01803	$17,000	Zoom Lens Bid - Zoomar Mark X-B1 15 - 150 mm. F2.5
Taft Broadcasting Co. Houston, Texas	$17,990	None

microwave television system as a mobile station in the State of Texas.

The application was made under Subpart L-Highway Maintenance Radio Service of the FCC Rules and Regulations. Section 89.401 states:

> *"Authorization for stations in the Highway Maintenance Radio Service will be issued only to states, territories, possessions, and other governmental subdivisions including countries, cities, towns, and similar governmental entities."*

The application was made for frequency 10,600 MH_z which is assigned to a Base and Mobile class of stations. The FCC definitions of these stations are:

> Base Station: A land station in the land mobile service carrying on a service with land mobile stations.
>
> Mobile Station: A station in the mobile service intended to be used in motion or during halts at unspecified points.

The first submission to the FCC in Washington, D.C. was made on November 9, 1971. After review by the FCC, the application was returned on January 12, 1972, for additional information. The forms were amended by the State Department of Highways and Public Transportation and re-submitted on February 7, 1972. The license was awarded to the State on March 27, 1972 (Appendix C).

Shipment and Installation

The television equipment was shipped to the Houston area in January 1972 but installation was delayed until the license for operation was approved. The footings for the poles on which the antennae and camera are mounted were constructed in April 1972. The steel poles were fitted

with the brackets and conduit in May, and the system became operational in June 1972.

INSTALLATION OF THE SYSTEM

General

Although the design emphasizes the portability of the system, and although the license is for a mobile unit, the first installation of the camera and microwave equipment emphasized stability and took on the appearance of permanence. Subsequent studies will determine the facility of moving the camera and the receiving station from place to place.

Description of the Site

The television camera and microwave transmitter were installed on a 30-foot steel pole at the intersection of Wayside Drive and Telephone Road in Houston. This location provides excellent coverage of all approaches to the intersection. The traffic signals at this intersection are a part of a network of signals controlled by a digital computer located at the Gulf Freeway Surveillance Office.

The microwave receiver and television monitor are located at the Surveillance Office. The distance between the two microwave antennea is approximately 3300 feet (1000 meters).

Description of Installation

The State Department of Highways and Public Transportation provided the materials and made the installation of the foundations and poles for the microwave system. Concrete footings with anchor bolts provided the foundation for steel poles. A 40-foot pole was installed at the receiver location and a 30-foot pole at the transmitter station (Figures 1 and 2).

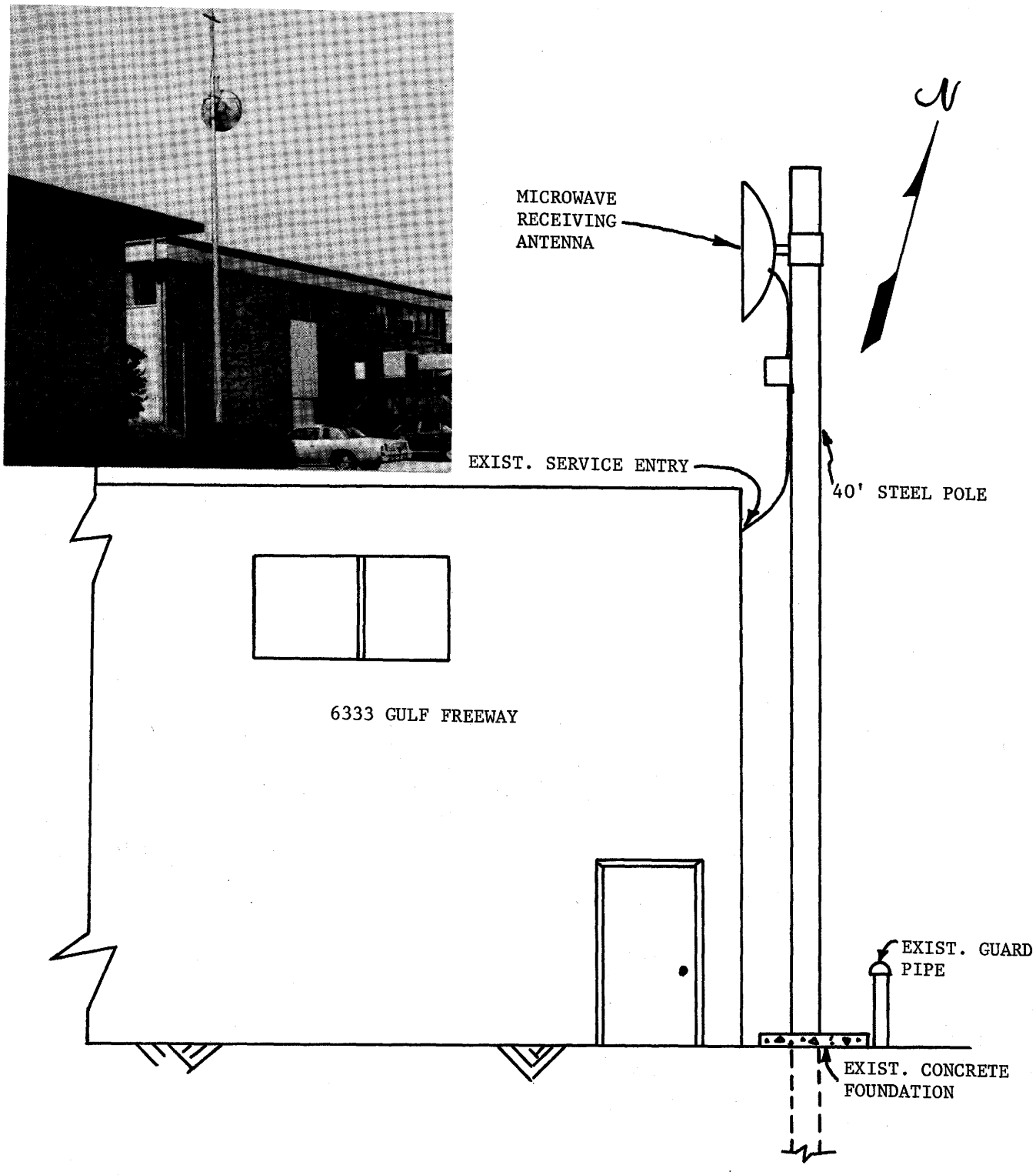


FIGURE 1

MICROWAVE RECEIVER
INSTALLATION AT THE SURVEILLANCE CENTER

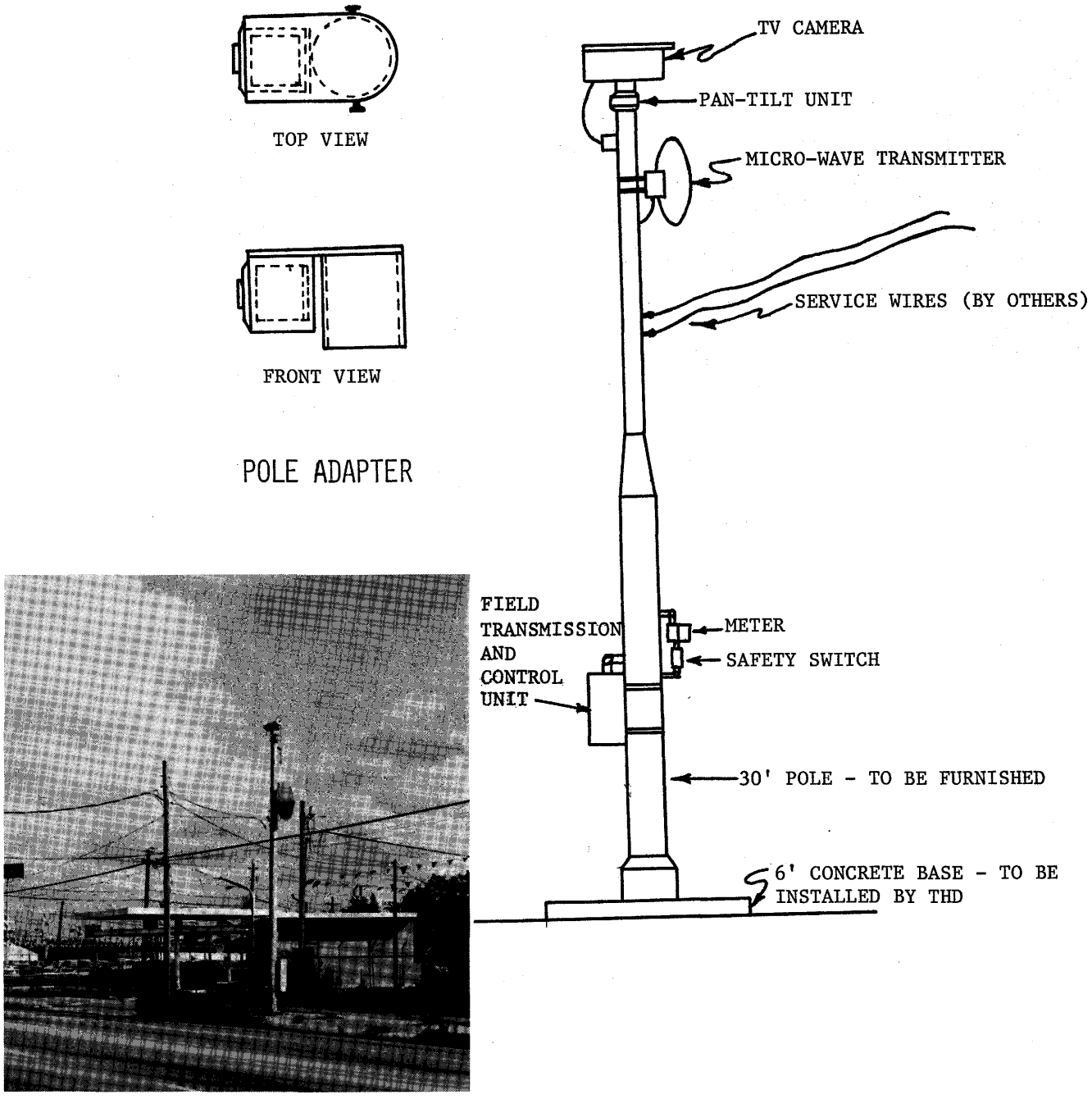


FIGURE 2

TELEVISION CAMERA AND MICROWAVE TRANSMITTER INSTALLATION
AT WAYSIDE DRIVE AND TELEPHONE ROAD

The mounting fixtures for the camera, antennea dishes, and control cabinets were furnished by the contractor. The power lines, meter, and safety switches were installed by the power company.

A dedicated pair of #22 control lines were provided by the City of Houston and the State Department of Highways and Public Transportation for control of the camera lens and pan and tilt unit. The control signals are transmitted through a time division multiplexor and operated on a dedicated leased telephone line. Details of the installation are contained in the specifications of the system in Appendix B.

Cost of Installation

The cost for constructing the foundation and installing the hardware was $400. The two steel poles are valued at $900 and the power line hook-up costs $75. If a telephone line were to be used for the control conductor, the cost would have been $40 installation and $6.10/mile per month.

The costs for installing the mounting brackets and television equipment and for aligning the antennae were included in the bid cost of the system. However, for moving the transmitter station from one pole to another, the cost is estimated to be $850 for making the television system operative.

EVALUATION OF THE SYSTEM

Resolution

The critical measure for monitoring traffic flow is vertical resolution which is directly proportional to the scanning rate of the camera. Since this camera produces a standard 525 lines per frame, a positive vertical resolution of approximately 375 lines is produced, which is

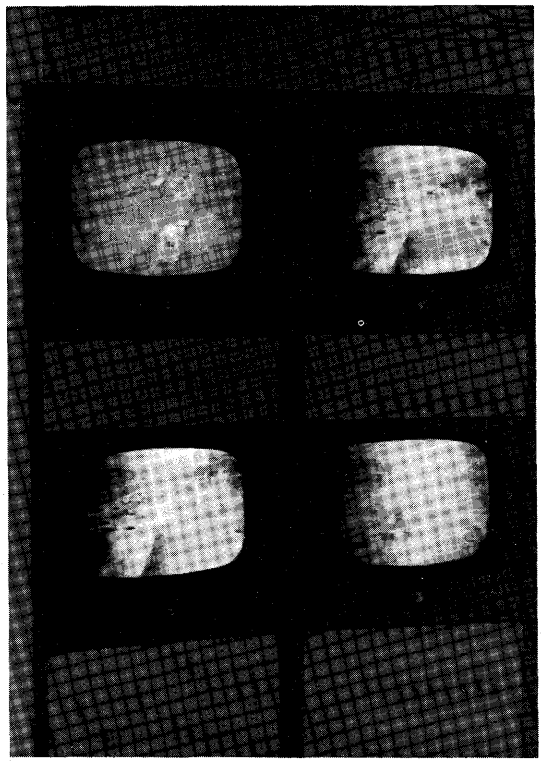
the same as with a cable system. (2)

The horizontal resolution is dependent on the ability of the camera, transmission system, and the monitor to go through light change cycles. The camera and monitor are both rated over 700 lines, but the microwave equipment is only rated at 4.5 megahertz which produces a horizontal resolution of approximately 300. This corresponds to the resolution level of broadcast quality for home television and has been considered adequate for traffic surveillance. Higher resolution requirements are usually specified for the camera and monitor to insure higher quality in the equipment and better reliability.

The microwave television system has been in operation for three years. During the period the total transmission system, control and video, signals operated very well. Subjective evaluations of the resolution capabilities failed to discern any difference between the microwave camera link and those cameras using the balanced pair video cables to connect similar video equipment. Monitors for both of these transmission systems are located in the same control room (Figure 3). Monitor Number 1 is the microwave system. It was the opinion of the surveillance staff that the microwave transmission over the 1000-meter link on the Gulf Freeway provides adequate horizontal and vertical resolution for traffic surveillance. This research study did not conduct studies over longer transmission distances, because the staff was unable to obtain permission and assistance to move the camera to an alternate study site.

System Reliability

Maintenance records of the closed circuit television system for the Gulf Freeway indicate that the microwave system has operated very well.



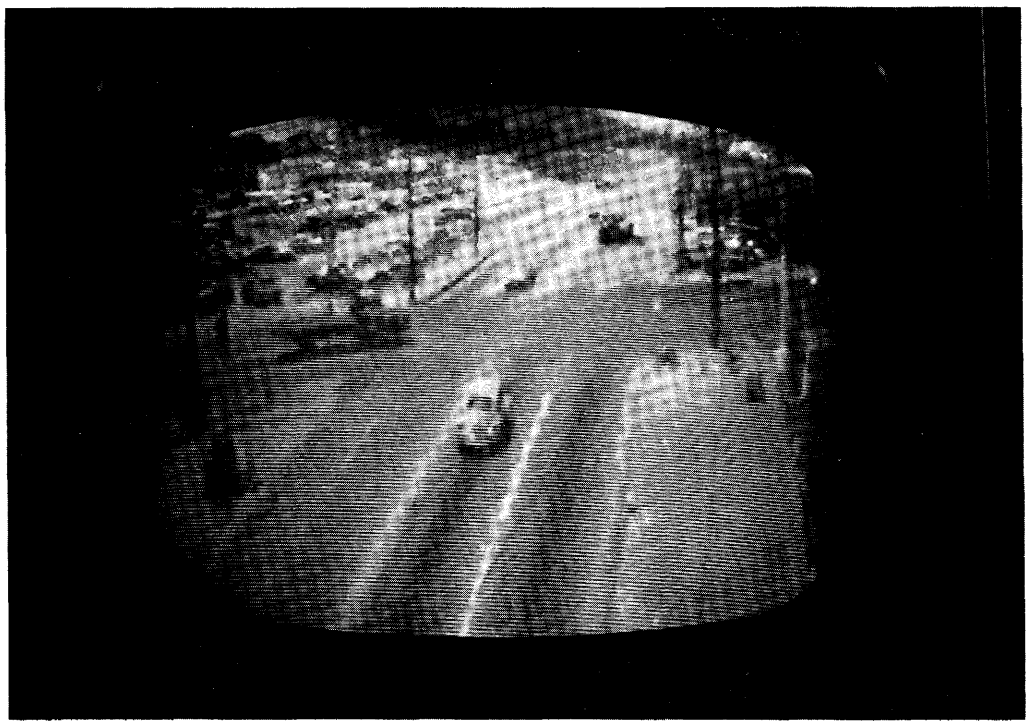


FIGURE 3

MONITOR FOR THE MICROWAVE TELEVISION SYSTEM

Just after the system was turned on in June 1972, several components were damaged by lightning, and the test period was extended until October 12, 1972. During the next three years, the microwave video transmission was interrupted two times; once for oscillator problems in the receiver and once for transmitter problems caused by lightning. The camera control system has been disrupted four times, usually by lightning.

During the same time period, outages for the cable system were at a rate of twelve per camera for video transmission and two per camera for control transmission. Some allowance must be made for the age of the cable system, which has been in operation since 1966. Even so, the microwave system appears to be a very reliable mode of transmission.

System Cost

The total cost of the one-camera system was $14,599, of which approximately $8,000 was for the microwave transmission and receiving units. To analyze the cost of this system versus that of a cable system, it only requires the equating of cable and installation costs per meter to the length of transmission. If, for example, the link distance was 8000 meters, then the cable must be installed for a cost of $1 per meter. This is only possible if cables for several cameras can be installed at the same time. The cost of the cable, not including amplification or installation, varies from $.66 to $3.28 per meter so the installation can not be competitive over long distances (Table 3). But at long distances the towers required for the microwave antennae become more expensive.

TABLE 3

Estimated Costs for Television Cable and Conduit

Type of Material	Cost of Material	
Foam Filled Coax Cable	$1.00/ft. ($ 3.28/meter)	Not Installed
RG II Coax Cable	$ .20/ft. ($ 0.66/meter)	Not Installed
Balanced Pair Coax Cable	$ .70/ft. ($ 2.30/meter)	Not Installed
2" PVC Conduit	$3.00/ft. ($ 9.84/meter)	Installed
3" PVC	$4.00/ft. ($13.12/meter)	Installed

CONCLUSIONS AND RECOMMENDATIONS

This study of microwave transmission of video signals consists of three-year experience in operations and maintenance of a single camera system at one site on the Gulf Freeway. The conclusions drawn from this experience are primarily subjective:

1. The camera system with the microwave transmission provide picture quality equal to the balanced pair transmission system for application to traffic surveillance.
2. The system reliability was very good. Major outages were caused by lightning.
3. Comparison of system costs is difficult without detailed descriptions of alternate designs. However, the cost of the microwave is very favorable when compared to cable systems with long transmission distances.
4. The costs for relocating the camera and microwave were estimated to be $850. Since the camera was not moved, the problems of relocation were not identified. However, the initial installation proceeded without difficulty.

Based on the experience gained by the procurement, installation, operation, and maintenance of the microwave transmission system, the following recommendations are made:

1. Microwave transmission should be included in consideration of alternate designs for CCTV systems for traffic surveillance.
2. The supplier of the equipment should be required to secure the operating license for the State.
3. The use of microwave transmission for traffic data and signal controls should be investigated.

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APPENDIX A

SPECIFICATIONS FOR MA-12 C LOW COST MICROWAVE COMMUNICATION SYSTEM

APPENDIX A

SPECIFICATIONS FOR MA-12 C LOW COST MICROWAVE COMMUNICATION SYSTEM

Function

Microwave Associates MA-12C Microwave Communication System provides one-way or two-way high quality color or black and white video and audio between two or more locations where low cost (without sacrificing reliability) is a major factor. The MA-12C permits closed-circuit television interconnection between facilities without the need for video or audio lines. Additional use may be obtained from the MA-12C by adding subcarriers to be transmitted simultaneously with the video.

Applications

The MA-12C provides one-way Studio-to-Transmitter Link (STL) or Transmitter-to-Studio Link (TSL) as well as two-way STL-TSL video transmission. Additionally, the MA-12C may be used in CATV for CARS band remote TV pickup for live local origination programming.

Desription

The MA-12C Microwave Communication System is a two-piece assembly including a control unit and an RF unit. The control unit is usually located inside a building and contains the transmitting inputs and/or the receiver outputs. The weatherproof RF unit is designed for continuous outdoor service under all weather conditions.

The RF unit consists of an integral parabolic antenna, antenna feed and housing which contains the microwave components. The housing, which is part of the antenna, contains the transmitter or receiver components for a one-way system, or both the transmitter and receiver

components for a two-way station. Future expansion from a one-way to a two-way system is easily accomplished.

Installation

The MA-12C is fitted with a universal mount which allows installation to a wide variety of supporting structures including vertical or horizontal pipes, tower legs and tripods. The universal mount also provides adjustment for azimuth and elevation for complete installation flexibility. Because the MA-12C is compact and lightweight it can be easily moved from one location to another.

Installation locations require line-of-sight between transmitting and receiving stations. Typical sites include roof tops, existing masts or towers, or even through a window which provides a line-of-sight transmission path.

Specifications

RF Frequency	12.7 to 13.2 CHz
Emission Designator	25000 E9
Video Bandwidth	4.5 MHz
Video Input	1 Volt Peak-to-Peak, 75 Ohms
Video Output	1 Volt Peak-to-Peak, 75 Ohms
Video Signal to Noise Ratio	60 dB, EIA Weighted
AGC Range	50 dB
Differential Phase	$\pm$ 1/2"
Differential Gain	1 dB
Transmitter Power Output	50 mW, Nominal
Receiver Noise Figure	11 dB, Nominal
Antenna Size	4 ft. Parabolic Dish

Temperature Range	
RF Unit	$-30^{o}C$ to $+50^{o}C$
Control Unit	$0^{o}C$ to $+40^{o}C$
Input Voltage	117 V ac $\pm$ 10%
Options	
Audio Channel (Hi-Fi)	50 Hz to 15 KHz
Audio Signal to Noise Ratio	60 dB
Data or Voice Channels Above Video	300 Hz to 4 KHz
Up to 600 Message Channels in Place of Video	

APPENDIX B

TEXAS HIGHWAY DEPARTMENT
SPECIAL SPECIFICATION FOR
CLOSED CIRCUIT TELEVISION SYSTEM
USING MICROWAVE TRANSMISSION

APPENDIX B

TEXAS HIGHWAY DEPARTMENT
SPECIAL SPECIFICATION FOR
CLOSED CIRCUIT TELEVISION SYSTEM
USING MICROWAVE TRANSMISSION

0.0 SYSTEM DESCRIPTION

Closed Circuit Television System using Microwave Transmission. Single camera and monitor closed circuit television system using video transmission by microwave with a ten (10) mile range. Mobile design so that camera can be moved to another location in one day or that total system can be moved to another city in Texas. Rugged design to operate in the environmental conditions in Texas. Remote control of pan-tilt, and zoom lens functions over one pair of telephone lines. System shall be in accordance with attached Special Specification for Closed Circuit Television System using Microwave Transmission.

0.1 GENERAL

1.1 This specification describes the minimum acceptable design and operating requirements for a single camera and monitor closed circuit television system using microwave video transmission.

2.0 DESIGN REQUIREMENTS

2.1 Functional

The closed circuit television system shall provide the following operational features:

2.1.1 Television Camera

Positive interlace, horizontal resolution greater than 800 lines; Model Diamond Electronic ST-2, or equal.

2.1.2 Camera Lens

Zoomer Mark X-B15 mm. to 150 mm. focal length range with f2.8, or equal.

2.1.3 Camera Housing

Compatible with television camera capable of operating in all weather conditions experienced in Texas. Cylindrical shape with sun shade.

2.1.4 Pan and Tilt Unit

Pelco Medium Duty Model PT-550M, or equal.

2.1.5 The mounting base for the pan and tilt assembly shall be designed to fit snugly over the top of a standard thirty (30)

foot Strain Gage Pole. Pole is to be furnished by Texas Highway Department. Pole specifications are available on request.

2.1.6 Video Transmission

The video signal is to be transmitted by a microwave system capable of signal transmission of ten (10) miles line of sight in an urban area. (Microwave Associates MA-12C system, or equal). All necessary accessories to provide an operational system are to be included in the bid. The contractor shall provide all FCC licensing permits. The license shall be in the name of the Texas Highway Department. System shall be licensed as portable throughout the State of Texas.

2.1.7 Television Monitor

One seventeen (17) inch portable monitor with resolution greater than the transmission system and with a selector switch for normal commercial television reception will be provided. A video outlet will be provided to interface with a Javalin Video Recorder, Model X-400.

2.1.8 Control System for pan and tilt and lens operation will be provided which can utilize one pair of dedicated telephone lines (voice grade) for remote control at the monitor location. Control functions are pan left and right, tilt up and down, zoom in and out, focus near and far, and iris control open and close. Capability shall exist for control of these functions at the camera location or remotely at the monitor location.

2.1.9 Equipment Housing

The system shall be designed to be mobile. The field Transmission and control units shall be housed in a weatherproof cabinet that can be mounted to a pole (see Figure 1). The cabinet shall have terminals for external power and transmission lines. The housing shall protect the equipment from vandals and the environmental conditions experienced in Texas.

The office equipment (monitor and control console) shall be housed in individual, portable cabinets.

The microwave transmitter and antenna shall be mounted to the camera pole approximately twenty-two (22) feet from the base. The microwave power supply and control unit shall be installed in the television cabinet mounted to the pole.

2.1.10 Installation

The contractor will furnish all materials and equipment necessary to provide a complete operational system as described herein. The contractor shall a 90-day installation and checkout

period. Said 90-day period will commence upon issuance of work order. This installation period shall be followed by a 30-day operational period. The contractor will maintain the system until the system operates satisfactory for a period of 30 days.

2.2 Electrical

The Closed Circuit Television System and Microwave Transmission System shall be electrically designed to meet the following requirements. These design requirements shall be considered to be minimum acceptable.

2.2.1 The camera, controls, monitor, and microwave shall operate on 117 V AC $\pm$ 10%, 60 Hz. power, and shall not draw more than 2 KW at either trasmitter or receiver site.

2.2.2 All functionally operating equipment except the monitor receiver shall employ solid state circuitry.

2.2.3 All internal wiring shall be of copper and shall be neat and firm.

2.2.4 All printed circuits shall be of epoxy glass with extra heavy 2 oz. copper per sq. ft. All printed circuit boards shall be plug in type.

2.2.5 Terminals shall be barrier type and suitably identified as to funcion.

2.2.6 Load side polarity shall be same as line voltage polarity.

2.2.7 Duplex outlet to be provided, polarized, inside the cabinet.

2.2.8 Thyractor protection shall be provided on line side.

2.2.9 The Closed Circuit Television System, including the Microwave Transmission System shall be capable of sustained operation in an ambient temperature range between minus twenty (-20) degrees Fahrenheit to plus one hundred and sixty (+160) degrees Fahrenheit.

2.2.10 All cabling shall be of a heavy duty design to withstand the stress caused by relocation of the system. The cables, except primary power, shall be terminated at standard AN connectors for ease in disconnection for mobility.

2.3 Mechanical

The Closed Circuit Television System and Microwave Transmission System shall be physically constructed in accordance with accepted practice in commercial television and microwave industry. The system shall be designed to be so mobile that relocation can be accomplished in twenty-four (24) hours. The field transmission and control units shall be housed in a metal cabinet that can be mounted to a standard thirty foot Strain Gage Pole furnished by the State. The housing slhall be rugged enough to protect the equipment from vandals and environmental conditions to include an ambient temperature range of from minus twenty (-20) degrees Fahrenheit to plus one hundred and sixty (+160) degrees Fahrenheit. The cables shall be terminated at standard AN connectors for ease in disconnection for mobility.

2.3.1 All field equipment at the camera site shall be installed on a pole (standard 30-foot Strain Gage) to be furnished by the Texas Highway Department. Specifications for the pole and its concrete base mount are shown in Figure 1. All equipment mounted to the pole shall be so cabled and fastened as to permit ease of dismantling and remounting for mobility.

2.3.2 The receiving antenna will be installed by the contractor on the roof of the Gulf Freeway Surveillance Project Office at 6333 Gulf Freeway, Houston, Texas.

2.3.3 The receiving monitor, receiver power supply and camera remote console shall be installed in the Control Center of the Gulf Freeway Surveillance Project Office at 6333 Gulf Freeway, Houston, Texas.

2.3.4 The bidder shall furnish the purchaser with two (2) copies of Instructional Manual, suitably bound, which will include schematics, parts list, and operating and maintenance instructions.

2.3.5 The equipment shall be warranted for two (2) years from date of acceptance against any inperfections in workmanship or material.

2.3.6 All items furnished shall be brand new.

2.4 Delivery

Delivery shall be to the Texas Highway Department warehouse as specified on the purchase order.

2.5 Measurement

Measurement of an acceptable Closed Circuit Television System using Microwave Transmission will be made on the basis of its physical appearance and its ability to function as described in this specification and as determined by the Engineer. In any event, the decision of the Engineer will be final and binding.

2.6 Payment

The "Closed Circuit Television System using Microwave Transmission," measured as provided under "Measurement," will be paid for at the unit price bid, which price shall be full compensation for furnishing all materials, installing and connecting all parts including enclosures, breakers, conduit, fittings, conductors, brackets, bolts, hangers, hardware and all manipulation, labor, tools, hauling, equipment and incidentals necessary to complete and provide a Closed Circuit Television System using Microwave Transmission.

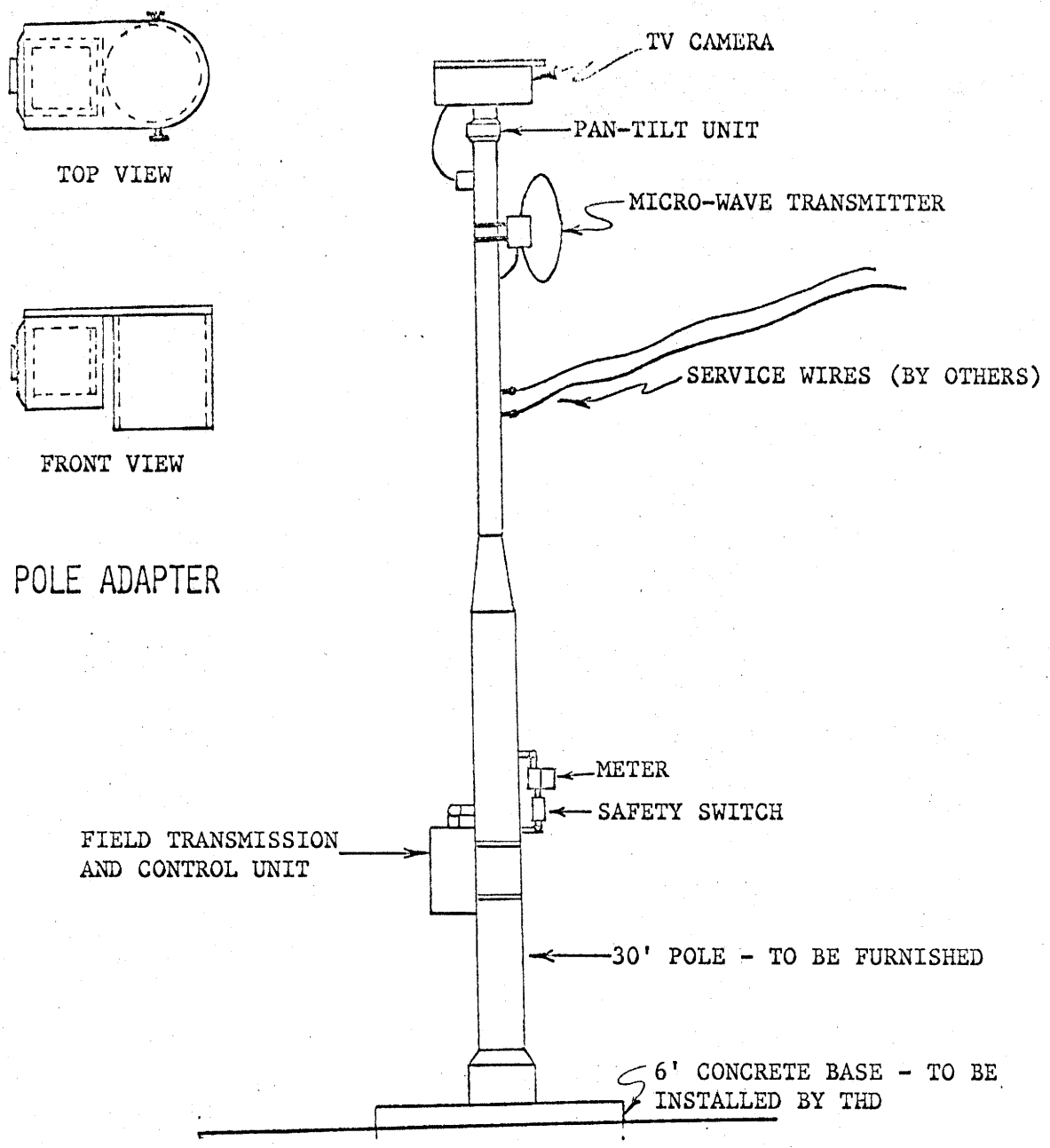

FIGURE 1B

TELEVISION CAMERA AND MICROWAVE TRANSMITTER INSTALLATION
AT WAYSIDE DRIVE AND TELEPHONE ROAD

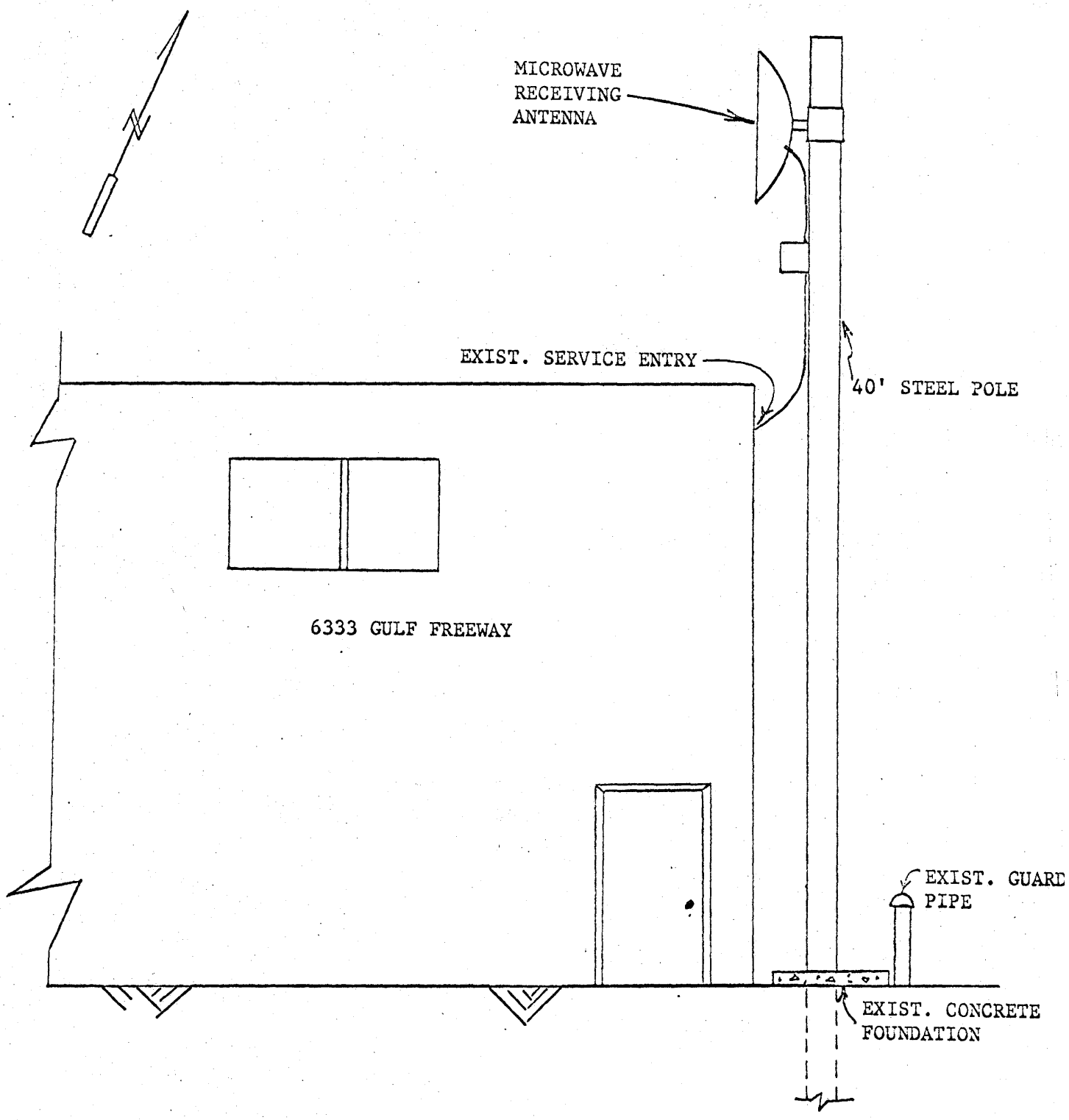

FIGURE 2B

MICROWAVE RECEIVER
INSTALLATION AT THE SURVEILLANCE CENTER

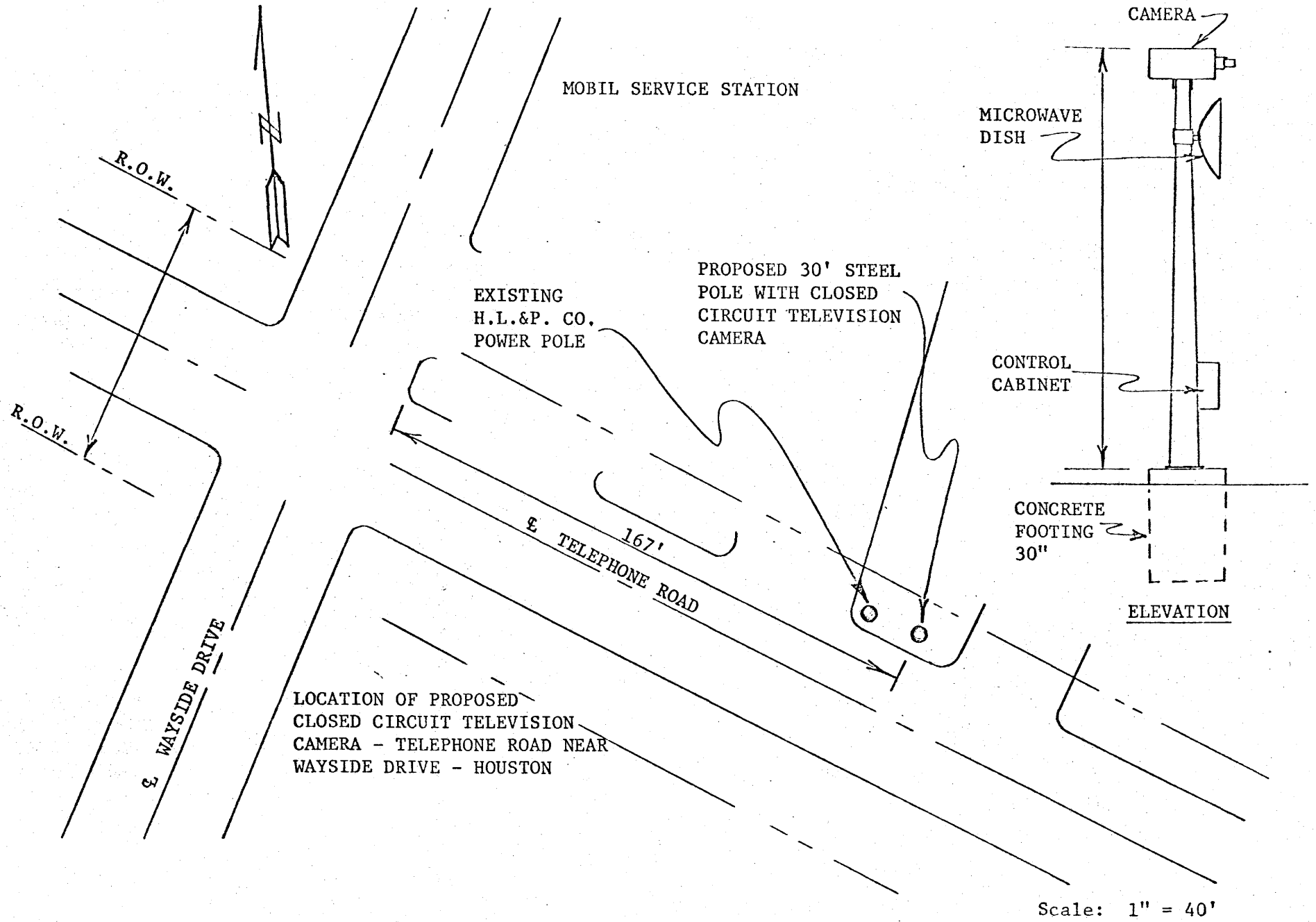
MOBIL SERVICE STATION
R.O.W.
R.O.W.
EXISTING
H.L.&P. CO.
POWER POLE
PROPOSED 30' STEEL
POLE WITH CLOSED
CIRCUIT TELEVISION
CAMERA
167'
℄ TELEPHONE ROAD
℄ WAYSIDE DRIVE
LOCATION OF PROPOSED
CLOSED CIRCUIT TELEVISION
CAMERA - TELEPHONE ROAD NEAR
WAYSIDE DRIVE - HOUSTON
CAMERA
MICROWAVE
DISH
CONTROL
CABINET
CONCRETE
FOOTING
30"
ELEVATION
Scale: 1" = 40'

FIGURE 3B

APPENDIX C

FCC LICENSE

FCC Form 402
June 1965

Form Approved
Budget Bureau No. 52-R177

UNITED STATES OF AMERICA
FEDERAL COMMUNICATIONS COMMISSION

LICENSE

MICROWAVE STATION AUTHORIZATION

4. (a) Name of Radio: Highway Maintenance

(b) Class of Station: Mobile

AUTHORIZATION
FOR COMMISSION USE ONLY
K 0 4 5 1 9
CALL SIGN
7866-PH-L-112X
FILE NUMBER

1. TECHNICAL TERMS

	1	2	3	4	5
(a) FREQUENCY	10600.0				
(b) EMISSION	20,000F9/F5				
(c) MAKE AND MODEL OF TRANSMITTER	MA85T12C Microwave Associates				
(d) TRANSMITTER RATED OUTPUT POWER	0.1 watts				
(e) ANTENNA INPUT POWER (DBM)	+10DBM				
(f) TYPE OF ANTENNA	4' Dish				
(g) TYPE OF FINAL RADIATING ELEMENT	A				
(h) HEIGHT OF FINAL RADIATING ELEMENT	30'				
(i) BEAM WIDTH	1.4°				
(j) PATH LENGTH					
(k) AZIMUTH					

5. Address at which station records are maintained:
Texas Highway Department
Austin, Texas

6. Overall height above ground to tip of antenna: feet.

7. Total number of transmitters: 1

8. Location of passive repeater associated with this station (if any)

Latitude: ° ' "
Longitude: ° ' "
N / W

Height of repeater: feet.
Site elevation: feet.

2. (a) Name (see instructions)
State of Texas

(b) Mailing address (number, street, city, state & zip code)
Texas Highway Department
State Highway Building
Austin, Texas 78701

3. Location of antenna
Number and street (or other indication of location)
Mobile

City | County | State

Latitude: ° ' "
Longitude: ° ' "
N / W

new

FOR COMMISSION USE ONLY

Construction Permit ☐
License ☒

Antenna painting and lighting specifications:

Special Conditions:

See attached Form 1024-B

Effective date: March 27, 1972
Expiration date: March 27, 1977 (3 A.M. EST)

This authorization is subject to further conditions set forth on reverse side.
FEDERAL COMMUNICATIONS COMMISSION

Ben F. Waple
SECRETARY

FEDERAL COMMUNICATIONS COMMISSION
Safety and Special Radio Services Bureau
Washington, D. C. 20554

SS BULLETIN 1097
March 1967

NOTICE TO LICENSEES AND OPERATORS OF LAND MOBILE RADIO STATIONS

A survey of the various types of infractions of the Commission's rules by licensees of land mobile radio stations indicates that a large number of violation notices may be avoided if radio station licensees will observe the following suggestions:

1. IDENTIFY YOUR RADIO STATION WHEN TRANSMITTING, AS REQUIRED BY THE COMMISSION'S RULES. *
2. HAVE FREQUENCY, POWER AND MODULATION MEASUREMENTS MADE EVERY SIX MONTHS, EVEN THOUGH THIS MAY NOT BE REQUIRED BY THE RULES, AND MAINTAIN APPROPRIATE RADIO STATION RECORDS.
3. DO NOT MAKE UNAUTHORIZED CHANGES IN YOUR RADIO STATION EQUIPMENT OR LOCATION.
4. POST YOUR RADIO STATION LICENSE AND ATTACH TRANSMITTER IDENTIFICATION CARDS TO ALL MOBILE UNITS.
5. COOPERATE WITH OTHER LICENSEES IN FREQUENCY USE.
6. IF FOR SOME REASON YOU RECEIVE AN OFFICIAL NOTICE OF VIOLATION, TAKE THE NECESSARY CORRECTIVE ACTION AND NOTIFY THE COMMISSION PROMPTLY.
7. REMEMBER, THAT AS A RADIO STATION LICENSEE, YOU ARE RESPONSIBLE FOR THE OPERATION OF YOUR RADIO STATION IN COMPLIANCE WITH THE COMMUNICATIONS ACT, THE COMMISSION'S RULES AND THE TERMS OF YOUR RADIO STATION LICENSE.

Timing devices which emit an audio and/or visual signal are available to remind the station operator of the time interval at which station identification must be made.

POST THIS CARD NEAR YOUR STATION LICENSE

FCC - WASHINGTON, D.C.

FCC Form 1024-B
March 1970

FEDERAL COMMUNICATIONS COMMISSION

ATTACHMENT TO MICROWAVE LICENSE
(Systems employing frequencies above 950 Mc)

PUBLIC SAFETY RADIO SERVICE

K 0 4 5 1 9
(CALL SIGN)

Frequency	*Antenna Azimuth (Hor.) (Degrees)*	*Beam Width (Degrees)*	*Path Length (Miles)*
10600.0	Mobile 360°	1.40	10

Authorized to use radiotelephony, radioteletype, facsimile and audio tones and impulses for signalling, telemetering and supervisory control.

This station is governed by Part 89 of the Commission's Rules, but is exempt from the requirements of the following Rules Paragraphs: 89.109, 89.113(b), 89.113(e), 89.115(a)(3)(4), 89.115(b), 89.115(c), 89.151(b), 89.153(c), 89.163(e) and 89.175(c).

Transmitters	Maximum Plate Power Input to Final Radio Frequency Stage	Frequency Tolerance (per cent)
MA85T12C Microwave Associates	0.1 Watts	± .02%

F.C.C. - WASHINGTON, D. C.