A D D E N D U M

Supplement to pages 21-22.

Emergency Medical Services Communications Systems

DHEW Pub. No. (HSM)73-2003
August 1973

While this publication was in press, the Federal Communications Commission (FCC) listed four frequencies and their *limitations that should be added to TABLE 4A on pages 21-22.

Federal Communications Commission (FCC): Rules and Regulations Changed By Docket No. 19327 (dated 7-29-72)

Table 4A (Supplement)
LOW BAND VHF RADIO FREQUENCIES
FCC Allocations – Type Radio Service by Frequency
Limited to those frequencies assigned to the
SPECIAL EMERGENCY RADIO SERVICE (SER)
and adjacent frequencies

FREQUENCY (MHz)	SER with Limitations*	OTHER ALLOCATIONS	FREQUENCY (MHz)	SER with Limitations*	OTHER ALLOCATIONS
35.64	x(5, 6, 7)		43.64	x(5, 7)	
35.68	x(5, 6, 7)		43.68	x(5, 7)	

*Limitations: The above numbers in parentheses are explained in the following paragraphs:

5. This frequency will be assigned only for one-way paging communications to mobile receivers. Transmissions for the purpose of activating or controlling remote objects on this frequency are not authorized.

6. Prior to October 1, 1974, 35.64 MHz will not be assigned within 40 miles of the center of Houston, Texas; Portland, Maine; Charleston, West Virginia; Boston, Massachusetts; and Binghamton, New York; nor will 35.68 MHz be assigned within 40 miles of the center of Portland, Maine; Boston, Massachusetts; Binghamton, New York; and Charleston, West Virginia. The centers of cities are taken as the reference points indicated on pages 226-238 of the U.S. Department of Commerce publication "Air-Line Distances Between Cities in the United States."

7. Available for assignment only to eligible hospitals and to those ambulances which submit a showing that they render coordination and cooperation with a hospital authorized on this frequency.

Supplement to pages 21-22.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
HEALTH SERVICES AND MENTAL HEALTH ADMINISTRATION
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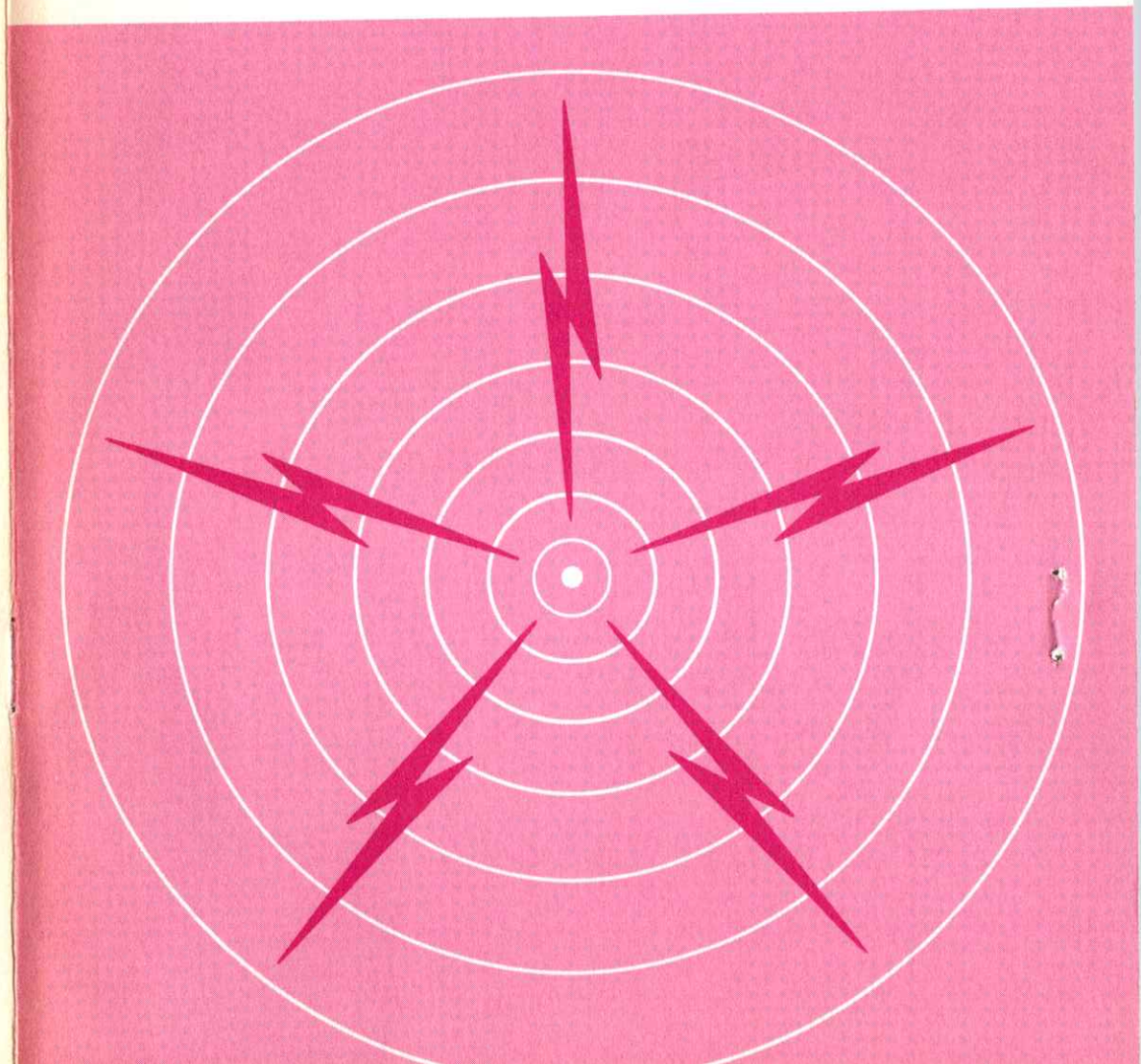
Emergency Medical Services Communications Systems



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Health Services and Mental Health Administration (HSMHA)

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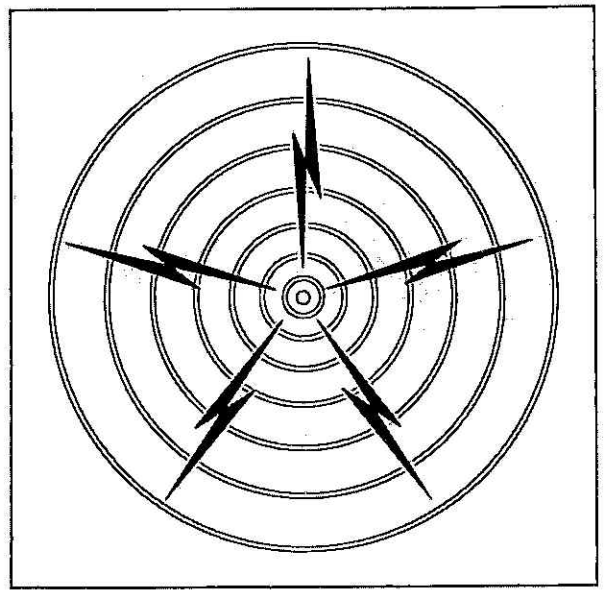
*Please refer to the back cover for the addresses of the 10 DHEW Regional Offices.

Emergency Medical Services Communications Systems



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Health Services and Mental Health Administration
Division of Emergency Health Services
5600 Fishers Lane, Rockville Maryland 20852

DHEW Publication No. (HSM) 73-2003
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U.S. DEPARTMENT OF TRANSPORTATION (DOT), National Highway Traffic Safety Administration

- Funds for certain communications equipment available under provisions of Standards 11 et al. of the Highway Safety Act of 1966.

  For information, contact: At State Capitols in the several States, the Governor's Representative to the National Highway Traffic Safety Administration.

U.S. DEFENSE CIVIL PREPAREDNESS AGENCY (DCPA)

- Provides assistance in coordinating civil defense *emergency operating center* facilities with a community's emergency medical communications system.

  For information, contact: State and Local Civil Defense Directors.

APPALACHIAN REGIONAL COMMISSION

- Funds available for demonstration health projects covering the total area of emergency medical services, including emergency medical communications.

  For information, contact: The Governor's Office in each State.

U.S. DEPARTMENT OF JUSTICE, Law Enforcement Assistance Administration

- Funds are avilable under the *Crime Control and Safe Streets Act* to strengthen police communications capabilities.

  For information, contact: State Planning Agencies, Office of the Governor in the several States.

BELL TELEPHONE and other telephone companies

- Assist political jurisdictions to study community requirements, costs of installation, and operation of the "911" system.

  For information contact: Local offices of telephone companies.

CERTAIN PHILANTHROPIC AND OTHER FOUNDATIONS

- Provide financial support for emergency medical services, including biomedical communications. A useful reference to locate these functions is the *Foundation Director,* published by the Russell Sage Foundation, New York, N.Y. 10017 (copy available at most libraries).

CONTENTS

FOREWORD

This booklet was prepared to help communities to develop a communications network to serve their emergency medical care needs. It is intended for use by persons with some knowledge of emergency medical services and their operations who are ready to plan the communications components for local or regional emergency medical care systems.

PART V

SOURCES OF ASSISTANCE FOR EMERGENCY MEDICAL COMMUNICATIONS

For technical advice or information about possible financial support in the development and implementation of emergency medical communications, the following organizations may be contacted nationwide as shown hereafter. Potential assistance available from the various groups is described briefly.

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

- Information and guidance is available on emergency medical communications matters. Provides technical assistance to States and their communities on designing communications systems to meet area emergency medical services plans.

  Contact points: Division of Emergency Health Services, HSMHA* Regional Health Directors at ten DHEW Regional Offices (See back cover for addresses).

- Hill-Burton funds available to eligible hospitals to procure communications equipment.

  Source: Health Care Facilities Services, HSMHA*

  For information, contact: Hill-Burton Program Director in State Departments of Health.

- Assistance in community comprehensive health planning.

  Source: Comprehensive Health Planning Service, HSMHA*

  For information, contact: Comprehensive Health Planning Agency offices in the several States.

- Funds to support various types of emergency medical services programs that might include communications.

  Source: Regional Medical Programs Service, HSMHA*

  For information, contact: State and/or Areawide Regional Medical Program offices in the several States; or DHEW Regional Health Directors (See back cover); or State Departments of Health.

*Health Services and Mental Health Administration, U.S. Department of Health, Education, and Welfare, 5600 Fishers Lane, Rockville, Md. 20852.

of the summoner. The single number system can even relieve him of the need to have a dime because the local telephone company can configure the 911-system to function from any telephone merely by dialing the number.

The time between notification and dispatch, is principally controlled by the internal communications systems configuration. It is determined by the manner in which the request for aid is turned over to the dispatcher. Perhaps the most efficient method for handling this turnover is to have the 911-operator also function as the emergency resource dispatcher. This method, however, requires versatile and well-trained operators. It is also a system which may not be readily acceptable to public service organizations. The more frequently-used method is to have the 911-operator either collect the required information and pass it on to the appropriate response agency dispatcher or to switch the call over to the appropriate response agency dispatcher. Thus, the public safety agency can retain control of its own dispatch operation.

If, in using the consumer's definition of response time, the 911-system results in an increase in response time, a further analysis of the overall emergency service organization is indicated. An objective review of the system's organization and procedures undoubtedly will reveal means of expediting overall response time.

When contemplating the implementation of the 911-concept, the telephone company should be one of the first organizations consulted. Telephone companies are obligated to provide 911-capability within their current dial station facilities when requested just as they provide "411" for directory assistance, and "611" for repair service. They also should provide immediate dial tone response on all pay phones. This allows all 411–611–or–911 calls to be placed without payment, but blocks all other calls until proper payment has been made.

The Public

The public, as the user of the 911-system, has a major role in its successful operation. The term "emergency" is highly subjective; it defies precise definition. The public, however, must be educated to use the 911-system correctly and intelligently. The number must not by used as an information service or as a means of airing grievances. Even an understanding and intelligent public will generate some nuisance calls. However, methods for handling them will be similar to those currently used by public safety agencies.

When the public is properly educated, the 911-system can be used effectively by the young, the old, the handicapped, the illiterate, and by those with limited knowledge of English to report an emergency. The system allows almost every citizen to reach help quickly and correctly.

PART I

EMERGENCY MEDICAL SERVICES COMMUNICATIONS SYSTEMS

The Emergency medical communications network has been called the backbone of an emergency medical services (EMS) system. Its implementation ties together the various elements of the total EMS system, and its use requires interagency cooperation and coordination. All parts of an emergency medical services system are interdependent. A communications system cannot be designed to meet the needs of a community's emergency medical services system unless the other elements of the system are known.

A communications system is no exception. It cannot be implemented successfully without coordination with the other elements of the total emergency medical services system. Designing a communications system before an area emergency medical services plan has been developed can only result in a system that is either too costly, over-equipped, or improperly designed to meet the actual emergency medical services needs of a community.

Area Planning Essential

An affirmative answer to the question, *"Is there an Emergency Medical Services Plan for the area to be served?"* is a prerequisite to any discussion of emergency medical communications. Although various local groups may develop an emergency medical services plan, it is desirable that an area plan be designed under the auspices of an *areawide comprehensive health planning agency* with both professional and consumer input. Planning on an area basis allows for (1) more effective utilization of limited medical resources; and (2) assures interjurisdictional determination and support on such matters as categorization of hospital facilities, ambulance service districts, command and control, financing, and training. Determining the level of sophistication of an emergency medical communications setup becomes a part of the planning process for the area's emergency medical services system.

Communications should be one of the last components of the emergency medical services system to be developed because decisions on equipment needs require the answers to many questions. Once these questions are answered, more definitive steps may be taken in the identification of specific communications equipment. As a minimum, answers to the following questions should be determined:

- How will ambulances be dispatched?
- Will there be a central dispatch for the total area to be serviced?
- If not, will individual hospitals dispatch ambulances?
- Will the dispatch function be added to that of another public safety agency, such as police or fire service?

- Will there be an *Emergency Operating Center* for all emergency functions?
- Will the ambulances be equipped to provide pre-hospital coronary care capability? If so, where will the fixed coronary care terminal or terminals be?
- Does the hospital or hospitals with the fixed terminal(s) have adequate staff to provide a round-the-clock response to telemetered data?
- Will provision be made for ambulance attendants to have the capability to talk by radio to hospital emergency departments? to central dispatch? to other ambulances? to physicians outside the emergency department? to police, fire, or other civil units?
- Who is going to provide the emergency medical transportation service?
- To what extent will the fire department, police department, volunteer squads, and private enterprise be involved in the service?
- Where will the ambulances be based?
- How will the victim of an accident or suspected heart attack enter into the emergency medical services system?
- Will the public be able to dial "911" *toll free* from anywhere in the area?
- Will the public be educated to call a police or fire dispatcher? a hospital? or "911"?

Interagency Cooperation In Emergency Communications

Good management principles insist upon effective utilization of existing resources. Applying those principles to an emergency medical communications system requires interagency cooperation and multi-agency use of facilities, manpower, and other resources. One way of bringing about this coordination is through the establishment of an Emergency Operating Center (EOC) which incorporates sharing and integration of services. A command post for emergency medical services exclusive of other emergency services required during major emergencies or disasters is economically unsound for most communities, and separate command posts for various public safety and service agencies make coordination difficult. By placing day to day command and control functions for police, fire, rescue, and public works together in an Emergency Operating Center, it is possible to overcome most of the coordination problems which arise during a major emergency or disaster. The importance of embedding the normal emergency medical services system in that which is planned for disaster response cannot be overemphasized. This approach assures a working system which needs only augmentation as necessary or possible to provide disaster response to the limit of its capabilities.

The following recommendation was made at the National Symposium* on the Development of a Model System for Emergency Medical Services in a Metropolitan Area: "In general, it is not necessary to create a new

*Held May 6-7, in Philadelphia, Pa.

To date most 911 systems are within a single jurisdictional area. When more than one political jurisdiction is included, it is more difficult to establish the system – not because of the technical problems, but because of the problems of obtaining agreement among different agencies and jurisdictions on the working arrangement. To overcome these problems, public officials must understand that 911 can provide better emergency service to the public; public safety organizations must understand that the system allows them to retain control over their own dispatch functions; and the public must understand how to use the system.

Public Officials

Although government officials have shown no direct opposition to the *911-concept,* they are sometimes apathetic, and apathy is one of the surest ways to kill the idea. The National Service to Regional Councils reports that "in every area where 911 has been adopted, a prominent frequently-elected local official has had to push the concept as an issue, sometimes publicly." And the Franklin Institute Research Laboratories, Philadelphia, Pa., in its report entitled *911 – A Study of the Single Emergency Telephone Number,* states that *"It is significant that in most areas in which 911 has been installed, the decision to implement the system has been political. 911 has not been installed at the request of public safety organizations nor through the initiative of telephone companies, but rather because it was a politically wise decision."*

Public Safety Organizations

Public safety organizations must understand that the 911-system will, in fact, improve their operations. It will not weaken or downgrade their operations nor will it take away any of their responsibilities. In the 911-system, a public safety organization can retain control over its own dispatch functions.

Emergency service agencies often argue that implementation of the 911-system will increase their response time. This argument will not stand up under analysis. The most glaring flaw in the argument is their definition of *response time* as the "time interval between the receipt of an emergency call by the 911-operator and dispatch of the appropriate emergency resource." It completely disregards the time lapse between detection and notification. Under a single number system, summoning assistance is virtually automatic. Without a single number system, the sequence of events from detection to notification is further interrupted by the requirement to seek the proper number in a telephone book. Dialing the operator will not necessarily alleviate this problem. The operator very often is located at some distance from the caller and may have even less information about the emergency medical resources available in the area. The length of this interruption is frequently compounded by the excited, highly emotional, or confused state

Operation

Regardless of the organization of a *911-system* the operation is the same. Every system works through the following five steps:

1. A citizen, reporting an emergency, dials 911.
2. The call is automatically routed through the central office to the communications center which is not necessarily a separate public safety agency. By mutual agreement, an existing service – fire, police, or other – could operate the communications center as a service to all agencies.
3. The call is received at the communications center switchboard by the 911-operator. This incoming call can be handled in one of several ways depending on the preference of the director of the communications center. Four examples are as follows:
   a. One operator handles all calls regardless of the degree of emergency.
   b. A primary operator ascertains the true emergencies and turns them over to a secondary operator who handles the call. The primary operator retains and disposes of non-emergency calls.
   c. A primary operator handles the true emergency calls and routes the non-emergencies to a secondary operator for disposition.
   d. A primary operator refers calls immediately to the proper agency.
4. The 911-operator determines the extent and nature of the emergency and obtains information about the identity and location of the caller. It is important that the operator determine the political entity from which the call is placed. Problems are seldom encountered on calls originating from homes or businesses, as most people know the address and thus the jurisdiction in which they live or work. However, a caller from a pay phone may not know his location. This difficulty can be overcome by providing the 911-operator with a list of pay telephone numbers by political subdivision or by affixing identification plaques to pay telephones. The plaque might say: "you are calling from telephone 21 in the Village of Woodside." With this information and an appropriate listing, the 911 operator can identify the location and select the appropriate response agency. In the future, an automatic number identification (ANI) system, operating in conjunction with a computer, will be able to provide this information.
5. The 911-operator notifies the appropriate response organization in the proper jurisdiction of the nature and location of the problem. This procedure requires minimal time and ensures that the caller promptly receives aid.

communications system for medical purposes; instead the public, including the police and fire services, should join in integrating emergency medical communications wihthin the community's overall emergency response capability."

COMMUNICATIONS REQUIREMENTS IN EACH STAGE OF THE EMERGENCY MEDICAL SERVICES CYCLE

The communications requirements for emergency medical care are similar whether there is a single case of sudden illness or injury or a disaster involving large numbers of victims. After the emergency medical services system has been defined in terms of *what* services are to be provided as well as *how* these services are to be provided, functional communications system requirements may be determined.

EMS Cycle

The normal emergency medical services cycle consists of the following functions or stages:

1. Incident	The occurrence which generates the need for emergency services. Patient(s) with acute illness or injury.
2. Detection	The action which determines that the incident took place.
3. Notification	The action which informs the emergency resource control agency where and when the incident took place and the nature of the incident.
4. Dispatch	The act which orders emergency resources to the scene of the incident.
5. Closure	The process which transports emergency resources to the scene of the incident.
6. Action	The necessary acts which correct or alleviate conditions generated by the incident, including both immediate care and transport to a medical facility.
7. Return to Station	The return of all emergency resources to a state of readiness for a new cycle.

Once the incident is detected, communications are necessary complements to each successive stage of the emergency medical service cycle. For highway accidents notification is usually made by patrolling law enforcement vehicles,

ambulatory surviving victims, or the casual passerby. The State of Nebraska has organized a voluntary highway accident surveillance system composed of State and county radio equipped vehicles; Department of Roads vehicles; vehicles which operate in rural areas on a regular schedule such as R.F.D. mailmen, milkmen, milk tank trucks, bakery trucks, etc; and citizen's band volunteer groups. Some exploration has been made into the design of an automatic electronic alarm system built into vehicles which would alert appropriate authorities that an incident had occurred which might require aid. However, such a system does not appear to be imminent at this time. For the victim of a heart attack or other sudden illness, emphasis has been placed on early detection followed by immediate communication with the appropriate authority. In order to reduce the interval between the incident and initiation of definitive care, some communities have conducted educational programs aimed at alerting the public to symptoms that might be indicative of a heart attack.

Emergency Telephone – 911

Reducing the time between detection and notification has been given great impetus through the establishment of the *universal emergency telephone number 911.* From its inception in January 1968 until June 1972, approximately 230 communities have adopted the 911 system. Although the installation of this system may require considerable effort, the cost is usually nominal. The local telephone company is available to assist in planning the system for the individual community.

Dispatch

Communication needs during dispatch require channels by which the ambulance crew can be notified to proceed to the scene of the emergency. Dispatch can normally be made by telephone to reduce the radio air time. However, this does not eliminate the requirement for radio communications between the ambulance and the dispatcher. Two-way radio communication is necessary during the closure and action stages. This permits the dispatcher to supply supplemental information to the crew of the emergency vehicle and enables the crew to request assistance as needed enroute. It also permits change in destination or assignment while enroute and reassignment while returning to the ambulance base from the hospital. This permits the dispatcher to supply supplemental information to the crew of the emergency vehicle and enables the crew to request assistance as needed.

Two-way radio communication between ambulance and hospital is necessary during the action stage of the cycle if optimum emergency medical care is to be provided. The voice channel to the emergency room from the scene of the incident enables the emergency medical technician at the ambulance to request advice to aid in stabilizing the condition of the casualty prior to transport. Communities should consider equipping ambulances with portable communication units for use where victims are beyond the point where the

PART IV

THE 911 SYSTEM

In January of 1968, the American Telephone and Telegraph Company announced the establishment of Nine-One-One (911) as the single emergency telephone number for use in the United States. The single emergency number concept is not new. It has been used in England for more than thirty years.

The *911-system* can be described as an easy-to-remember, three-digit telephone number used to provide the general public with an immediate and direct access to emergency service resources. The system eliminates the need for the caller under stress to make decisions for which he may be ill-prepared, particularly when outside his home community.

About 230 of the *911-systems* exist today in jurisdictions which range in population from several thousand to several million. Although public acceptance generally has been favorable, Public Safety Agencies have sometimes been reluctant to adopt this system. Following is a discussion of the *911-system* which in part explains the problems which must be faced and solved by public officials and the public safety agencies.

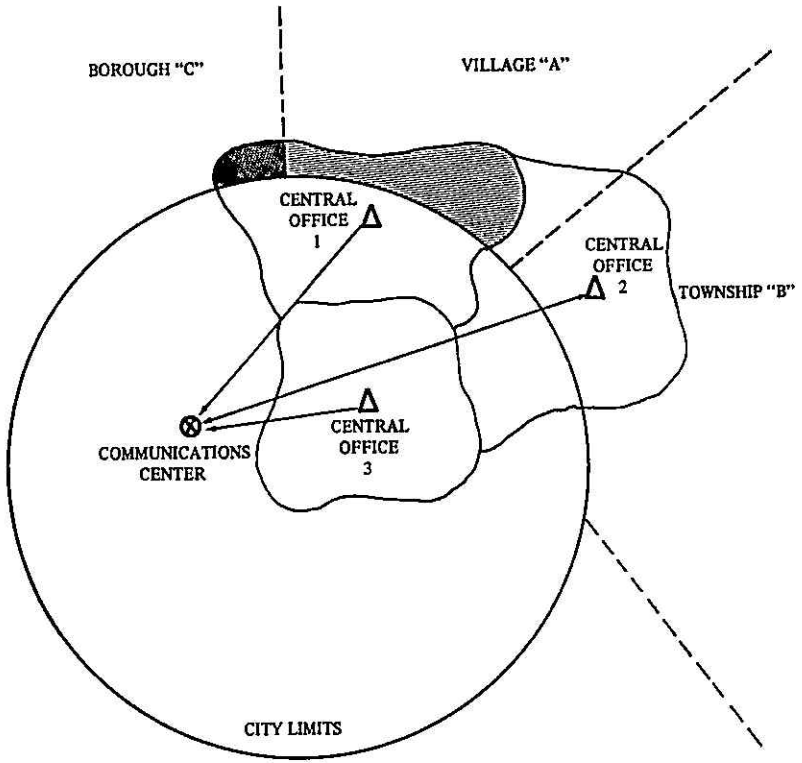
Boundaries

Technically, it is possible to design a *911-system* to serve all of the continental United States from one central dispatch center. Operationally, however, it would neither be practicable nor economically feasible. Such a dispatch center could only have computer stored knowledge of the available emergency resources. Dispatch center personnel, however, must have a personal knowledge of the resources and must keep up with changes in them. The area, therefore, comprising a *911-system,* to be efficient, does have some size limitation; but the area does not have to conform to any geographic or jurisdictional boundaries. It will, however, normally coincide with jurisdictional boundaries. A system may be comprised of any or all of the following (see Figure 1) elements:

1. Telephone Central Office Area – in larger urban areas, political jurisdictions and boundaries of telephone central office areas rarely coincide.
2. Various jurisdictional areas – a city and miscellaneous surrounding townships, boroughs, villages, etc.
3. A *911-Communications-Center* for the entire region.
4. Various public safety organization locations. (Not shown on figure 1).

frequency. The telemetered data can be transmitted in short bursts of data, say thirty seconds, interspersed with voice data interchanges between the ambulance and the fixed terminal. A refinement of this mode of operation would give the fixed terminal control of the telemetry transmission by providing the fixed station with a method of turning the telemetry transmission "on" or "off."

The Federal Communications Commission has allocated five frequency pairs in the 460 MHz region for exclusive use of biomedical telemetry systems, as shown in Table 4C.



Source: National Science Foundation

Figure 1: 911 Regional Concept

ambulance can travel. Ideally the portable unit should tie into the vehicle's communication system so that the vehicle system can function as a relay station. The need for two-way radio communication between hospital emergency room and the emergency medical technician in the ambulance is important for the care of casualties during transport to the medical facility. It also permits the ambulance crew to advise the treatment facility of the patient's condition, special requirements, estimated time of arrival, and other pertinent information.

The need for prompt communication continues into the return-to-station stage so that the dispatching center knows immediately when an ambulance is ready to begin a new cycle.

The use of two-way radio equipment is by no means limited to the dispatching center-ambulance-emergency department relationship. Other advantages of the two-way radio system are:

- Only operable communication system when the local telephone network is severely damaged, or overloaded (if line load control is not instituted) during a major disaster;
- The fastest mechanism for coordinating emergency medical activities with other disaster services in the community;
- Can provide rapid intercommunication among hospitals about the distribution of casualty loads;
- Effective in alerting medical manpower to report to meet emergency needs.

TRAINING REQUIREMENTS

Emergency medical technicians should be trained to use emergency medical communications equipment. If the system is to provide biomedical telemetry, then the technician must be trained in its use. If the emergency medical technician is not legally authorized to administer drugs and to defibrillate heart attack victims, then training in the use of the telemetry equipment would serve little purpose.

Ambulance dispatchers should have the same training as the personnel on the ambulance. The dispatcher needs this training in order to determine the true emergency medical needs of the victims and to function more intelligently with the ambulance personnel at the scene.

Training in the use of the communication equipment may be made part of the general curriculum emergency medical care or given separately. In many instances, police or fire departments can help arrange for the instruction of emergency medical technicians in the operation of communications equipment.

EXAMPLE COMMUNITY: EMERGENCY MEDICAL COMMUNICATIONS SYSTEM

It should be emphasized that the emergency medical services communications system must not consist of an uncoordinated assemblage of equipment, but rather an equipment configuration geared to the needs of the community plan. Because there are so many differences in the emergency medical communications requirements of various community/area emergency medical services plans, *there is no one model system.* The example of a medical communications system presented in this publication, therefore, *is not a model.* It illustrates the communications hardware selected to meet the requirements of a particular system which has been well-defined by the area planning group. The system to be implemented has been defined as follows:

1. Ambulances and emergency medical technicians will be stationed at hospitals. This decision was based on three factors:
   a. Response time was not adversely affected by basing ambulances at hospitals;
   b. Capability to use emergency medical technicians to augment hospital staff when not on ambulance runs;
   c. Easier to keep emergency medical technicians current on medical techniques.
2. Area planning for the *single emergency telephone number 911* is nearing completion and the system is expected to be inaugurated soon.
3. A new Emergency Operating Center (EOC) in the city/county administration building is now being completed which is equipped with its own emergency power, water, and sanitation facilities. Police and fire dispatch services also will be operated from this location. By mutual agreement among public safety agencies, it was decided that the fire department would provide dispatching for emergency medical services. Because studies have shown that the daily ratio of medical emergency calls to population is 1:10,000, it was concluded that this community's population would not justify 24-hour-a-day dispatchers for medical emergencies only.
4. Ambulances would be equipped to provide a full range of service including care for heart cases, with medical supervision being provided through telemetry. State law permits emergency medical technicians to perform defibrillation, administer intravenous fluids, and give other pre-hospital coronary care under medical supervision. All ambulances will meet standards set forth in the recommendations of the National Academy of Sciences–National Research Council.

PART III

BIOMEDICAL TELEMETRY

Biomedical telemetry is the technique of measuring and transmitting certain vital life signs to a distant terminal. Vital life signs are assessed by monitoring the heart, lungs, brain, and temperature. Currently when the term "telemetry" is used in medical care it usually refers to the graphic presentation of heart action as expressed by an electrocardiogram. The method used to transmit electrocardiographic information to a distant point employs a reference audio tone, for example 1000 Hz, which is made to vary with the voltage generated by the action of the heart. This varying 1000 Hz tone is used to frequency modulate the radio transmitter. The signal received at the distant terminal is amplified and demodulated to produce a voltage which is an exact replica of the original. This voltage is converted to the graphic plot of the heart action.

An effective biomedical telemetry system cannot be limited to the transmission of telemetered data only. It must include channels for voice data interchange between the fixed and mobile terminals. The telemetry system may take one of several configurations depending upon the decisions made by the planning authority. If continuous telemetry data (ECG) is required by the planned system, then the ambulance must be equipped with one of the following configurations:

1. To transmit on both frequencies of a frequency pair allocated for telemetry, e.g., 463.000 and 468.000 MHz. This would require that the ambulance be equipped with two UHF transmitters and one UHF receiver. Telemetry would be transmitted to the fixed terminal on the mobile only frequency, 468.000 MHz, and voice data interchange between the fixed terminal and the ambulance would be transmitted on the base and mobile frequency, 463.000 MHz.
2. To multiplex (combine) both telemetry and voice data on the mobile only frequency of the telemetry frequency pair (468.000 MHz.) and receive voice data from the fixed terminal on the base and mobile frequency of the pair (463.000 MHz.). In addition, the fixed terminal must be equipped with demultiplexing equipment for each available channel to separate voice and telemetered data.
3. To transmit telemetry data on the mobile frequency of the telemetry frequency pair, and transmit ambulance voice data on one of the VHF frequencies, 155.340 MHz for example. (Remember that the VHF frequencies are shared with other eligible licensees.)

If the planned system does not require continuous telemetry, then the ambulance equippage will require a UHF transceiver configured to receive on the base station frequency of the frequency pair and transmit on the mobile

5. The "major" hospital in the area was established as the focal point to provide training for emergency medical technicians with physicians teaching those subjects which are medically oriented. The fire and police departments have agreed to train emergency medical technicians in radio procedures, uses, and communications techniques. Arrangements have been made to provide fire department dispatchers with basic emergency medical training so they will have a better understanding of the problems encountered and be familiar with medical terminology and procedures.

6. Agreement was reached with the "major" hospital to assume responsibility for all *ambulance–hospital* medical consultation by two-way radio. This hospital has around-the-clock physician coverage in its emergency department. Major medical specialties are available on call. It was decided that consultation with these specialists, when outside the hospital emergency department, can be handled satisfactorily by "phone patch." (Telephone to radio interconnect).

7. Concurrence was obtained on a policy which authorizes the physician in the emergency department of the "major" hospital to make the decision as to which hospital an emergency patient will be transported.

8. The planning group decided that the emergency medical services system will be supported by both fee for service and by tax funds with every effort being made to take advantage of outside funding sources. See pages 37 – 38.

9. These communities which are accessible to the city's health care delivery services but outside its political jurisdiction have expressed a desire to take advantage of the city's emergency medical services program. The communications arrangements agreed upon were:

   a. Regular long distance telephone service will be used as the common link between the "major" hospital and the hospitals in the accessible communities;

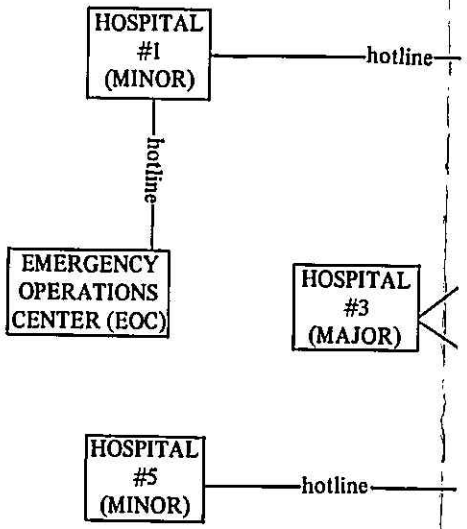
   b. The link from the ambulance when in the outlying area to the "major" hospital will be by radio to the community hospital, and then through phone patch equipment and long distance lines to the "major" hospital;

   c. If the specialist at the "major" hospital needs telemetry data it will be transmitted by telephone using an electro-cardiograph read-out-device coupled to the telephone receiving handset.

On the basis of these definitions of the system, and the fact that there are five hospitals with emergency departments and a population of approximately 250,000 in the example community, the communications system shown in Table 1 was developed.

Table 1: Communications System

HOUSEKEEPING FREQUENCIES		
FREQ.	DESIG.	ASSIGNED
155.160	F1	HOSP #1
155.205	F2	HOSP #2
155.235	F3	HOSP #3
155.265	F4	HOSP #4
155.295	F5	HOSP #5



EMERGENCY OPERATIONS CENTER		
VHF RADIO REQUIREMENTS		
TRANSMIT	RECEIVE	PURPOSE
155.145	155.145	DISPATCH
	155.280	EMERG. COORD.

intensity of illumination on this area is 100 times greater than the intensity previously existing. The gain in illumination over this one square meter area is 100. Expressed in dB, it would be ten times the logarithm of 100 (which equals 2) or 20 dB of gain. In like manner, if an antenna radiation pattern concentrates the radiated energy in a desired direction as compared to an isotropic radio frequency radiator, it is said to have gain and the amount of gain is normally expressed in dB.

The antenna system plays an extremely important part in the transmission and reception efficiency of any radio communications system. Transmission power levels are limited by FCC rules and the reception minimum usable signal level is limited by local man-made noise. The antenna system can, to some extent, compensate for these limitations. Careful antenna selection, base station antenna site selection, and antenna height all can be used to adjust the coverage area needed by the communications system. Antenna configuration also can be used to fit the radiation pattern to the shape of the service area.

(15 or 30 kHz either side of the desired frequency) can sometimes quiet a receiver sufficiently to activate its squelch circuit and turn on the audio circuit. This action is known as "falsing."

The *tone-coded squelch circuit* was developed to eliminate unwanted signals. The *tone-coded squelch circuit* is activated by a low frequency audio tone incorporated in the transmitted signal. If the received signal includes the correct tone frequency, the squelch circuit is actuated and the receiver's audio circuits are turned on permitting the transmission to be heard. These circuits have several trade names such as "Channel Guard" and "Private Line." It must be noted, however, that they do not provide a private line nor do they guard any channel. These circuits eliminate unwanted signals but their improper use can create co-channel interference. Undesired signals received simultaneously with desired signals constitute co-channel interference. If one station of two or more co-channel systems assumes it has a "clear channel" and proceeds to transmit without first listening to determine that the channel *is* clear, it can be guilty of creating co-channel interference. Tone frequencies (60-250 c/s) which are below the audio frequency passband (300-3000 c/s) are used to operate tone-coded squelch systems.

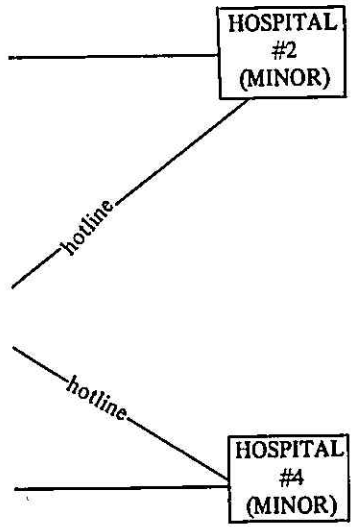
Another means of turning on the FM receiver audio circuit uses pulsed tones. This digital tone system is controlled by a digital encoder which resembles a standard telephone dial. Dialing it causes the pulsed tones to be sent out over the air, the number of pulses corresponding to the number dialed. These pulses, when received by the radio receiver and decoded by the receiver's digital decoder, turn on the audio system. If the number of pulses of the correct frequency (two or three numbers are usually dialed) corresponds to the code address of a particular receiver, its audio circuits are activated. If a hospital's code address is 525 and the ambulance driver dials 525, that hospital's receiver is turned on. It does not prevent other users from listening in, but it does not bother them with messages of no concern to them.

Antenna Systems

The term "antenna gain" is often used in descriptions of radio communications systems and equipment. This term is derived from the methods used to measure antenna performance and can be explained by an analogy using light.

Let us assume that a source of light is placed at the center of a hollow sphere having an inside surface area of 100 square meters. This light will evenly illuminate the entire inner surface of the sphere and is known as an isotropic light radiator. If a perfect reflector of the correct shape and dimensions is placed at the proper distance from the source of light, the total illumination from the light will be concentrated into one area, just as a flashlight reflector concentrates its light into a narrow beam. Assume that this light is now concentrated in an area of one square meter on the sphere's inner surface. Since all of the illumination, previously evenly distributed over the 100 square meters, is now concentrated on one square meter of surface, the

HOSPITAL VHF RADIO REQUIREMENTS VHF (HIGH BAND)		
TRANSMIT	RECEIVE	PURPOSE
	155.145	DISPATCH
155.340	155.340	EMERG. FREQ.
155.(F(X)	155.(F(X)	HSKPG. FREQ.
155.280	155.280	MAJ. HOSP. ONLY



AMBULANCE--HOSPITAL TELEMETRY RADIO REQUIREMENTS UHF (460 MHz)			
AMBULANCE		MAJOR HOSPITAL	
TRANSMIT	RECEIVE	TRANSMIT	RECEIVE
468.000	463.000	463.000	468.000
468.050	463.050	463.050	468.050
468.100	463.100	463.100	468.100

AMBULANCE VHF RADIO REQUIREMENTS		
TRANSMIT	RECEIVE	PURPOSE
155.145	155.145	DISPATCH
155.340	155.340	EMERG. FREQ.
155.280	155.280	EMERG. FREQ.

Dispatch

The dispatch function for this emergency medical services system was designed so that either a hotline or radio frequency (155.145 MHz) could be used. It was planned that dispatch would normally be carried out using the hotline in order to reduce radio "on the air" time. The hotline also would be used to notify the *major hospital* of the start of an ambulance run and the frequency or channel assigned for biomedical telemetry. Since the Emergency Operating Center serves as the command and control center for all emergency resources during any disaster, communications with the *major hospital* have been provided using cross band techniques. The *major hospital* receives on 155.145 MHz and transmits on 155.280 MHz. The Emergency Operating Center receives on 155.280 MHz and transmits on 155.145 MHz.

Ambulance Equipment

In planning the equipment for the ambulances, the following decisions were made:

1. It was anticipated there will be occasions when consultation with the hospital emergency department is required before the patient can be moved to the ambulance. Therefore each ambulance will have a portable VHF receiver and a portable UHF transmitter in addition to the mobile equipment installed in the vehicle. This equipment will permit communication with the *major hospital* using the ambulance as a relay point.
2. Each ambulance will have a multiplexer that can be used with either the portable or vehicle communications equipment to combine voice and telemetry signals on one transmitter.
3. Each transmitter will have the capability of continuous key down operation without output signal degradation for a minimum period of two hours.
4. Three UHF frequencies were allocated for biomedical telemetry and associated voice communication. A separate VHF frequency was provided for ambulance–hospital communications not associated with biomedical telemetry. During the phase of operation when telemetry is transmitted from the portable unit, the portable UHF transmitter will transmit telemetry data and voice on one of the 463 MHz channels. The ambulance UHF communications equipment will receive on 463 MHz and retransmit on 468 MHz to the major hospital. During this mode of operation hospital instructions to the technicians will be transmitted on one of the VHF frequencies (155.280 or 155.340 MHz).

Hospital Equipment

In planning the equipment for the hospitals, the following decisions were made:

will produce an output signal consisting of SIGNAL + NOISE + DISTORTION 12 dB louder than the NOISE + DISTORTION, heard when no signal is present at the receiver antenna input terminals.

Selectivity

The selectivity of a receiver determines the extent to which the receiver can differentiate between the desired signal and undesired signals at other frequencies. For example, consider a receiver with a channel spacing stated as 30 kHz and selectivity specified as 80 dB. An undesired signal 30 kHz above or below this receiver's assigned frequency would need a power level one hundred million times greater to produce the same level of output as a signal at the desired frequency. If these figures are converted to a voltage ratio, the undesired signal would have to be 10,000 times greater to produce the same output level as the desired signal.

Spurious Response Attenuation

Reduction of spurious response in receivers and spurious radiation in transmitters has increased with improved design and components. Prior to 1948, spurious responses and radiation were responsible for a large percentage of interference. Now, except in locations where several transmitters and receivers operate simultaneously, interference from spurious response is virtually eliminated.

Intermodulation (IM) spurious responses are a more serious interference problem. This type of interference is generated in a non-linear curcuit (all transmitters and receivers have them) by the mixture of two or more signals which fall in, or near, the affected frequency. For example, a 455 MHz signal and a 300 MHz signal mix to produce intermodulation frequencies of 755 MHz and 155 MHz. The latter frequency, if created at the input of a receiver tuned to receive 155 MHz, could cause considerable interference, depending upon its power level.

Eliminating Noise and Unwanted Signals

The radio frequency channel assignment of 155.340 MHz is not a private communications link within its particular service area. This channel is shared by all stations assigned that particular frequency. For example, if five ambulances, a dispatching center, and three hospitals all share the same frequency, and each receiver responds to every transmission, Continual chatter on this channel could be annoying to those not directly concerned. This unwanted reception is termed "botherance" – the effect of undesired signals when no desired signal is being received.

The *audio squelch circuit* was devised to eliminate the continual background noise heard when no signal is being received. This circuit uses the background noise itself to turn off the receiver audio circuits when the noise level is high. Since a received signal has a quieting effect upon background noise, this effect is used to turn the audio circuit on. The audio squelch circuit eliminates background noise, but does nothing to reduce the "botherance"of unwanted signals. In addition, adjacent channel transmissions

Following are brief discussions of the terms used in Table 5.

Frequency Modulation (FM)

Commercial radio equipment used in the VHF and UHF bands for land mobile radio service is not standardized on FM which more easily eliminates random noise, interference, and fading than amplitude modulation (AM) systems.

In FM, the carrier or radio frequency wave, shifts its assigned frequency at the same rate as the voice being transmitted. If the "ah-h-h" of a verbal pause in speech has a frequency, or tone, corresponding to 600 cycles per second, the carrier frequency (155.340 MHz for example) will shift both above and below this frequency at a 600 cycle per second rate. The amount or number of cycles (hertz) that the carrier shifts depends upon the loudness of the transmitted voice.

Narrow band FM has several advantages over the AM broadcast band:

1. The FM receiver is able to suppress the noises caused by vehicle ignition systems and electrical storms.
2. Two FM stations transmitting simultaneously do not block each other. (Tuning across the broadcast band at night will demonstrate how a comparatively weak AM signal can destroy the intelligibility of a much more powerful station with squeals and whistles.) When two FM stations are received simultaneously, the stronger signal takes over and communications capability is not destroyed for both. The stronger signal take-over is known as the "capture effect."

Amplitude Modulation (AM)

In AM, the amplitude of the carrier is made to vary according to the frequency of the intelligence signal. The amount of amplitude change varies with the loudness of the modulating signal.

Sensitivity

Sensitivity in an FM system is a measure of the signal level in microvolts (1 microvolt is one-millionth of a volt) required at the receiver antenna input terminal to produce a stated output. The universally quoted sensitivity measurement is the 12 dB (decibel) SINAD method.

DECIBEL – It is useful to evaluate signal strength in terms of relative loudness as perceived by the human ear. A decibel is a unit of such measurement, being approximately the smallest degree of difference in loudness ordinarily detectable by the human ear. (Ordinary speech is about 60 decibels louder than a sound just audible to the human ear. The total range of human hearing is about 130 decibels.)

SINAD – is an abbreviation for the ratio (SIGNAL + NOISE + DISTORTION) to (NOISE + DISTORTION) expressed in dB. A sensitivity of 0.25 microvolts for 12 dB SINAD means that a 0.25 microvolt signal

1. Demultiplexers will be installed in the *major hospital* to demodulate and separate multiplexed voice and telemetry signals.
2. Each hospital has indicated a need for a paging service. This requirement is to be satisfied by incorporating one of the alternate frequencies, F31 through F35, at each of the hospitals. These frequencies have been selected from among the eight VHF high band (155 MHz) frequencies which are *not* exclusive to hospital/ambulance service.* Each hospital will determine whether the mode of paging will be: (a) one way with alerting tone only; (b) one way with alerting tone and voice message; or (c) full two way operation. Paging equipment will operate on alternate frequencies as assigned.
3. The frequency 155.280 MHz was chosen arbitrarily to satisfy several communications needs. Using cross-banding techniques it provides a communication link between the area's medical resources and the Emergency Operating Center. It provides radio communication between the outlying community hospitals and the *major hospital* in the city. If these outlying hospitals are not grouped within radio communication range of each other, then each will have to be equipped to communicate on 155.280 MHz with the *major hospital*. If outlying hospitals are so grouped, then only one will need to be equipped for operation on this frequency. This frequency also provides an alternate ambulance/hospital communication channel.
4. The frequency 155.340 MHz was chosen to serve as the system emergency frequency. It will be used for hospital/ambulance communications when telemetry is not involved. When the ambulance communication system is being used as a repeater, 155.340 MHz will serve as the primary hospital to ambulance link. It will also be used in time of disaster for hospital to hospital communications. Each hospital has been provided with a monitor to receive 155.145 MHz–the dispatching frequency. This will permit dispatch if the hot line channel is broken.

Equipment Implementation

In Table 2, a listing has been made of the equipment to implement the emergency medical communications plan for the *example area.*

*See Table 4B on page 22.

TABLE 2

Emergency Operating Center

1 VHF Transmitter/Receiver - 155.145 MHz
1 VHF Antenna - 155.145 MHz
1 VHF Receiver - 155.280 MHz
*1 VHF Crystal Filter (15 KHz passband at 155.280 MHz)
1 VHF Antenna - 155.280 MHz
1 Antenna Tower
Remote Control Equipment to Suit EOC System Configuration

*Used to protect 155.280 MHz Receiver from 155.145 MHz Transmitter

Major Hospital

1 VHF Base Station (Transmitter/Receiver - 155.340 MHz
1 VHF Base Station Transmitter/Receiver (2 freq) - 155. - [F(X) as assigned] and 155.280 MHz
1 VHF Receiver - 155.145 MHz

3 UHF Receivers

Receive MHz
468.000
468.050
468.100

1 "3-Frequency" UHF Transmitter

Transmit MHz
463.000
463.050
463.100

2 Phone patch equipment
3 Demultiplexer, with cassette recorder
*1 Duplexer, UHF
2 VHF antennas – As required to satisfy normal and emergency operations and paging
2 UHF antennas
1 Antenna Tower
Remote Control Equipment to suit system configuration
Paging Equipment – Number and kind as determined by hospital
Telemetry read-out devices – May be combined in Demultiplexer.

*Used to protect UHF Receivers from the UHF Transmitter

5. This frequency may be assigned primarily for mobile dispatch response by ambulance and personnel operating bio-medical telemetry units in this service under an area-wide radio communications plan involving central dispatching on the associated base-mobile frequency 460.525 or 460.550 MHz. When authorized for this dispatch response purpose, this frequency may be used on a secondary basis for the purposes and in the manner set forth in limitations (1), (4), and (6).
6. Mobile stations authorized to operate on this frequency may be used to extend the range of transmission between portable telemetering units and hospitals or other medical care facilities. Each mobile station used for this purpose shall be so designed and installed that it will be activated only by means of a continuous tone device, the absence of which will deactivate the mobile transmitter. The continuous tone device is not required when the mobile station is equipped with a switch that must be activated to change the mobile unit to the automatic mode.

Available Equipment

Manufacturers offer communications components for land mobile radio service which have common characteristics: virtually all use frequency modulation (FM) and all are almost completely solid state. (Transistors and Integrated Circuits (IC) are used wherever possible).

The specifications are very similar. Practically all of this equipment exceeds the standards established by the Electronic Industries Association (EIA). Representative comparisons between the standards and manufacturers' specifications are shown in Table 5.

TABLE 5

EIA Standards And Manufacturers' Specifications

Mobile Receiver

Quantity Measured or Specified	EIA Standards 25-54 Mc/sec	EIA Standards 144-174 Mc/sec	EIA Standards 400-470 Mc/sec	Typical Manufacturers' Specifications 25-54 Mc/sec	Typical Manufacturers' Specifications 144-174 Mc/sec	Typical Manufacturers' Specifications 400-470 Mc/sec
Sensitivity (in Microvolts)	1.0	1.5	2.5	0.3	0.5	1.0
Selectivity (dB)	70	70	70	80	80	80
Spurious attenuation (dB)	85	85	80	100	100	90
IM spurious attenuation (dB)	50	50	50	60	60	60
Audio power output (watts)	1	1	1	2	2	2

Mobile Transmitter

Power output	N/A	N/A	N/A	80 watts	80 watts	60 watts
Frequency stability (%)	±002	±.0005	±.0005	±.0005	±.0005	±.0005
Spurious radiation (dB)	43 + 10 log (power output)			53 + 10 log (power output)		

Table 4C
UHF BAND RADIO FREQUENCIES
FCC Allocations – Type Radio Service by Frequency
Limited to those frequencies assigned to the
SPECIAL EMERGENCY RADIO SERVICE (SER)
for Bio-Medical Telemetry

FREQUENCY (MHz)	Class of Station(s) with Limitations*	FREQUENCY (MHz)	Class of Station(s) with Limitations
460.525	Base & Mobile (1), (2)	465.525	Mobile only (1), (5)
460.550	Base & Mobile (1), (2)	465.550	Mobile only (1), (5)
463.000	Base & Mobile (1), (3)	468.000	Mobile only (1), (4), (6)
463.025	Base & Mobile (1), (3)	468.025	Mobile only (1), (4), (6)
463.050	Base & Mobile (1), (3)	468.050	Mobile only (1), (4), (6)
463.075	Base & Mobile (1), (3)	468.075	Mobile only (1), (4), (6)
463.100	Base & Mobile (1), (3)	468.100	Mobile only (1), (4), (6)

*Limitations (numbers in parentheses above are explained)

1. For two frequency systems, separation between base and mobile transmission frequencies is 5 MHz.
2. The frequency may be assigned (a) to dispatch ambulances and personnel operating bio-medical telemetry units under an area-wide radio communications plan; and (b) is available also for this purpose in the Fire and Local Government Radio Services.
3. This frequency is available for assignment to hospitals (institutions or establishments offering services, facilities, and beds for use beyond 24 hours in rendering medical treatment) for communication with medical care vehicles and personnel equipped with bio-medical telemetry capability. Use of this frequency is further authorized for telemetry or voice transmissions from a portable telemetering unit to an ambulance for automatic retransmission (mobile/relay) from a patient to a hospital or other medical care facility. When using telemetry emission, the continuous carrier mode of operation is authorized for this frequency.
4. This frequency is available for assignment to operate mobile bio-medical telemetry units in ambulances and other medical care vehicles, or when hand-carried by medical personnel. Telemetry transmission may be authorized. Voice transmission may also be authorized on a secondary basis when required for the telemetering activity. When using telemetry emission, the continuous carrier mode of operation is authorized for this frequency.

TABLE 2 (Continued)

Minor Hospital

1 VHF Two-Channel Base Station Transmitter/Receiver - 155.340 MHz
155. - [F(X) as assigned]
1 VHF Receiver - 155.145 MHz
1 VHF Antenna – As required to satisfy normal and emergency operations and paging
1 Antenna Tower
Remote Control Equipment to suit system configuration
Paging Equipment – Number and kind as determined by hospital
*1 VHF Crystal Filter (15 KHz passband at 155.145)

*Used to protect 155.145 MHz receiver from 155.340 MHz and 155. - [F(X)] transmissions

Ambulance

1 VHF 4-channel mobile Transmitter/Receiver
1. 155.145 MHz
2. 155.280 MHz
3. 155.340 MHz
4. (Future)

1 VHF 2-channel Portable receiver
1. 155.280 MHz
2. 155.340 MHz

1 UHF 3-channel mobile Transmitter/Receiver

Transmit	Receive
468.000	463.000
468.050	463.050
468.100	463.100

1 UHF 3-channel Portable Transmitter

Transmit
463.000
463.050
463.100

*1 Duplexer
1 VHF Antenna
1 UHF Antenna
1 Multiplexer
2 VHF Transceiver control head–one in driver's cab and one in patient area
1 UHF Transceiver control head – in patient area
Accessories – such as headphones, boom mike, foot switch transmitter control.

*Used to protect UHF Receiver from the UHF Transmitter

Estimated Costs – Example System

For the example system described, estimated costs for equipment *excluding* installation and paging equipment are shown below. However, as time goes on these estimates might vary from system to system. The most effective purchase procedure is to advertise for competitive system bids based on prepared specifications.

FACILITY EQUIPMENT COSTS (ESTIMATED)
Installation and Paging Equipment Not Included

Emergency operating center	$ 3,500
Major hospital	25,000
Minor hospital	3,500
Ambulance	6,000

DISASTER EXERCISE

A disaster exercise is recommended as a supplemental device for examining emergency medical communications needs. This exercise may reveal flaws in the basic community disaster plan and in the communications system designed to support the plan. The disaster exercise could be performed on paper and should encompass the region, area, hospitals, and/or service within hospitals. The scenario for the "paper exercise" of the *emergency medical service system* should be complete and if possible, be based upon a previous major disaster which occurred in the area. A step-by-step analysis of the actual or imagined occurrence will show the communications needs required to place the system in operation and keep it functioning efficiently throughout the disaster cycle. Until communications are evaluated against the demands imposed by disaster conditions, the total equipment requirements may not be fully envisioned.

The exercise affords the opportunity to examine alternate communications methods and resources available in the community. For example, radio-equipped vehicles from the private sector can be used to transport less seriously injured victims. However, the community disaster plan must make provision for coordination and control, if they are to be used effectively.

Experience has shown that in any major disaster, existing emergency communications systems quickly become overloaded and effective utilization must be made of existing communications facilities in the private sector. Therefore, disaster plans must provide for maximum utilization of radio, television, and other facilities which are a part of normal commerce.

Other Communications Resources

Other potential resources for communications under disaster conditions with which the community should be aware are:

1. The Amateur Radio Public Service Corps (ARPSC)
   The Section Emergency Coordinator can advise on availability of communications resources in the area and how to involve them in your

Table 4B (Continued)

Abbreviations Used:

SER - Special Emergency Radio Service	LGR - Local Government Radio Service
FRS - Fire Radio Service	PRS - Police Radio Service
GOV - U.S. Government	PwrR - Power Radio Service
HMR - Highway Maintenance Radio Service	SIR - Special Industrial Radio Service

*Limitations (numbers in parentheses above are explained)

1. Those frequencies which are not assigned to the Special Emergency Radio Service (SER) are listed because they are possible assignments in neighboring areas which may affect licensing.
2. Applications for assignment (a) should be accompanied by a written and signed statement that licensees of all stations, authorized to operate on a frequency 30 kHz or less removed (except Special Emergency stations) within 75 miles of the proposed location, have concurred with such assignment; or (b) is accompanied by an acceptable engineering report that harmful interference to the operation of existing stations will not be caused.
3. Available for developmental operation if (a) the proposed station is located at least 40 miles from all other stations except authorized Special Emergency licensees on frequencies 30 kHz or less removed; (b) includes with the application a written and signed statement that the licensees of all stations except Special Emergency stations within 75 miles of the proposed location authorized to operate on a frequency 30 kHz or less removed, have concurred with such assignment; or (c) includes an acceptable engineering report that harmful interference will not affect the operation of existing stations (except Special Emergency stations) within the 75 mile radius; and (d) provides a written statement that licensees of all stations described in (c) have been notified of the applicant's request for the frequency assignment.
4. Available for assignment only to hospitals (institutions or establishments offering services, facilities, and beds for use beyond 24 hours in rendering medical treatment) and to those ambulances which submit a showing that they render coordination and cooperation with a hospital authorized on this frequency.

Table 4A (Continued)

*Limitations (numbers in parentheses on preceding page are explained)

1. Those frequencies which are not assigned to the Special Emergency Radio Service (SER) are listed because they are possible assignments in neighboring areas which may affect licensing.
2. This frequency is shared with the Highway Maintenance Radio Service.
3. Available for assignment: Provided that until further order of the Federal Communications Commission, application is accompanied by a written and signed statement that licensees of all stations–*excluding Special Emergency stations*–located within the radius of 75 miles of the proposed location, and authorized to operate on a frequency 30 kHz or less removed, have concurred with such assignment, or is accompanied by an acceptable engineering report indicating that harmful interference to the operation of such existing stations will not be caused.
4. This frequency is reserved for assignment only to national organizations established for disaster relief purposes.

Table 4B
HIGH BAND VHF RADIO FREQUENCIES
FCC Allocations – Type Radio Service by Frequency
Limited to those frequencies assigned to the
SPECIAL EMERGENCY RADIO SERVICE (SER)
and adjacent frequencies

FREQUENCY (MHz)	SER with limitations*	OTHER ALLOCATIONS	FREQUENCY (MHz)	SER with limitations*	OTHER ALLOCATIONS
155.130		PRS	155.295	x (3)	
155.145		LGR	155.310		PRS
155.160	x (2)		155.325	x (3), (4)	
155.175	x (3)		155.340	x (2), (4)	
155.190		PRS	155.355	x (3), (4)	
155.205	x (3)		155.370		PRS
155.220	x (2)		155.385	x (3), (4)	
155.235	x (3)		155.400	x (2), (4)	
155.250		PRS	155.415		PRS
155.265	x (3)		155.430		PRS
155.280	x (2)				

disaster emergency medical communications plan. Contact the ARPSC at the American Radio Relay League, Inc., Newington, Connecticut 06111.

2. The Radio Amateur Civil Emergency Service (RACES)
   Contact civil defense officials for further information on this communication resource.
3. Business Radio Service systems, (such as taxi dispatching and trucking services)
   Contact individual companies for further information on these resources.
4. Commercial Broadcast Services (Television and Radio)
   Contact television and radio station managers to work out details of communications responsibilities to the public preceding, during, and following any disaster.

Summary

Principles of Planning Emergency Medical Communications

1. Define organization, performance standards, and geographical boundaries of the system.
2. Inventory local resources.
3. Determine communications needs necessary to satisfy the system.
4. Assess resources and needs together to determine the most economical method of satisfying system requirements:
   a. Avoid duplication of effort and function;
   b. Avoid duplication of facilities and equipment wherever possible;
   c. System must be used regularly and often to be effective.
5. Combine medical, fire, and police requirements wherever possible and feasible.
6. Consider ways of effecting savings by actions such as:
   a. Making large-scale equipment purchases;
   b. Centralizing maintenance when the system is large enough.

Table 4A
LOW BAND VHF RADIO FREQUENCIES
FCC Allocations – Type Radio Service by Frequency
Limited to those frequencies assigned to the
SPECIAL EMERGENCY RADIO SERVICE (SER)
and adjacent frequencies

FREQUENCY (MHz)	SER with limitations*	OTHER ALLOCATIONS	FREQUENCY (MHz)	SER with limitations*	OTHER ALLOCATIONS
33.00		GOV	46.00	x (3)	
33.02	x (2)	HMR	46.02		PRS
33.04	x		46.04	x (3)	
33.06	x (2)	HMR	46.06		FRS
33.08	x		47.40		HMR
33.10	x (2)	HMR	47.42	x (4)	
33.12		SIR	47.44		SIR
37.88		PwrR	47.46	x	
37.90	x (2)	HMR	47.48		SIR
37.92		HMR	47.50	x	
37.94	x (2)	HMR	47.52		SIR
37.96		HMR	47.54	x	
37.98	x (2)	HMR	47.56		SIR
38.00		GOV	47.58	x	
45.90		PRS	47.60		SIR
45.92	x (3)		47.62	x	
45.94		PRS	47.64		SIR
45.96	x (3)		47.66	x	
45.98		PRS	47.68		SIR

Abbreviations Used:

SER - Special Emergency Radio Service
FRS - Fire Radio Service
GOV - U.S. Government
HMR - Highway Maintenance Radio Service
LGR - Local Government Radio Service
PRS - Police Radio Service
PwrR - Power Radio Service
SIR - Special Industrial Radio Service

Special Emergency and Local Government Radio Services, in addition to the Fire Radio Service, for this purpose. (No other 460 MHz frequency is available for dispatching ambulance telemetry systems.) The two mobile-only frequencies, 465.525 and 465.550 MHz, also are availble under an area-wide communication plan for central dispatching which will permit their use of telemetry when they are needed for the latter purpose. These communications plans may incorporate a single licensee dispatching multiple telemetry systems, or a group of licensees operating independent or shared telemetry systems, or both. The object is to encourage and maximize the most effective use of the limited number of frequencies available for these purposes in a given area.

Permissible Communications

FCC regulations permit the following uses of the frequencies allocated to the special emergency radio service:

Hospitals — Except for test transmissions stations licensed to hospitals may be used only for the transmission of messages necessary for the rendition of an efficient hospital service.

Ambulance Operators and Rescue Organizations — Except for test transmissions stations licensed to ambulance operators or rescue squads may be used only for the transmission of messages pertaining to the safety of life or property and urgent messages necessary for the rendition of an efficient ambulance or emergency rescue service.

Test Transmissions

Tests may be conducted by any licensed station as required for proper station and system maintenance, but such tests shall be kept to a minimum and precautions shall be taken to avoid interference to other stations.

PART II

TECHNICAL INFORMATION ON RADIO COMMUNICATIONS

The radio-frequency spectrum is a national and international resource in the public domain. Since 1906, international administrative radio conferences have controlled the orderly development of this vital natural resource through carefully planned frequency allocations to various radio services.

The Federal Communications Commission (FCC), established by Act of Congress in 1934, controls frequency allocations in the United States to various non-government radio services and licensed individuals.

Frequency Spectrum

"Radio waves" are confined to that portion of the electromagnetic frequency spectrum extending from 3 kilo Hertz (3,000 Hertz or 3,000 cycles per second) to approximately 3,000 Giga Hertz or three trillion cycles per second. See Table 3. Since a normal voice channel requires a minimum of about 3,000 cycles/second (Hertz) of band width, it would appear that the radio frequency spectrum has about one billion voice channels available for assignment. Such is not the case. Many of the frequency bands are either inappropriate for land mobile use or are already assigned for other purposes.

Table 3: Radio Spectrum Frequency Bands

Band Designations		
Very Low Frequency (VLF)	3-30 kc/sec	(kHz)*
Low Frequency (LF)	30-300 kc/sec	(kHz)
Medium Frequency (MF)	300-3,000 kc/sec	(kHz)
High Frequency (HF)	3-30 Mc/sec	(MHz)
Ultra High Frequency (UHF)	300-3,000 Mc/sec	(MHz)
Super High Frequency (SHF)	3-30 Gc/sec	(GHz)
Extremely High Frequency (EHF)	30-300 Gc/sec	(GHz)
	300-3,000 Gc/sec	(GHz)
	or 3 Tc/sec	(THz)

* Abbreviations generally used are:

Hertz (Hz)	=	cycles/second (C/sec)
Kilo (k)	=	1,000
Mega (M)	=	1,000,000
Giga (G)	=	1,000,000,000
Tera (T)	=	1,000,000,000,000

Frequency Bands

1. *Very Low (VLF), Low (LF), and Medium Frequency Bands (MF)*

These frequencies, located below 3,000 kHz, were the first of the radio portion of the electromagnetic frequency spectrum to be developed and exploited. They are not used extensively for land mobile services because their transmitting antennas require rather large dimensions and were occupied for broadcast, maritime mobile, and radio navigation services long before the land mobile services needed spectrum space.

2. *High Frequency Band (HF)*

The HF portion of the spectrum is not used in the land mobile service because of its great range – sometimes thousands of miles – brought about by the presence of ionization layers in the upper atmosphere which reflect or refract these frequencies and return them to earth.

3. *Very High Frequency Band (VHF)*

The VHF band contains many of the frequencies available to the land mobile radio services which include emergency medical services communications. See Tables 4-A and 4-B. Arbitrarily, this band has been subdivided into what is commonly referred to as Low-Band (30-50 MHz) and High-Band (150-175 MHz) frequencies.

The low-band frequencies are characterized by somewhat greater normal range than high-band frequencies. When ionospheric conditions are favorable, the range may extend to 2,000 miles or more. These bursts of extreme range are unpredictable since ionospheric conditions change with time of day, with the time of year, and with the level of solar activity. These conditions can plague the land mobile service with "skip" interference and provide the amateur radio operator with excellent "DX" or long distance communication capability.

The high-band frequencies are almost totally free of "skip" interference, but achieve less normal range. At these higher frequencies vehicle antennas have smaller dimensions and noise levels are somewhat lower than those experienced in the low-band frequencies.

4. *Ultra-High Frequency Band (UHF)*

The UHF band assignments for land mobile radio service are in the 450-470 MHz range and the FCC has recently allocated seven frequency pairs in this band for use by biomedical telemetry systems. See Table 4-C. At these frequencies communications are completely free of "skip" interference and the noise level is low. Because radio waves are reflected from the earth and solid structures such as buildings, the UHF band exhibits better penetration in dense metropolitan areas. UHF band radio waves can be received quite well inside buildings with large windows. The UHF band has a shorter range than the VHF band; and energy at these higher frequencies is more readily absorbed by trees and foliage.

The radio frequency spectrum above 450-470 MHz and within the UHF band has not yet been used extensively for land mobile service. However, the mounting pressure for more frequencies may result in the opening of this portion of the spectrum to the land mobile service.

5. *Super High (SHF) and Extremely High Frequencies (EHF)*

The difficulty and expense involved in generating these frequencies at the required power levels generally limits their use for mobile communications at this time.

Emergency Radio Frequency Assignments

At the present time, except for two frequencies in the Medium Frequency (MF) band, the FCC has set aside VHF band assignments for general emergency medical radio communications and UHF band assignments for ambulance to hospital telemetry systems. Tables 4-A and 4-B show the VHF frequencies which are available to the Special Emergency Radio Service which includes hospitals, ambulance and rescue organizations, physicians and veterinarians, disaster relief agencies, school buses, beach patrols, establishments in isolated areas, and common carrier standby and repair facilities. The UHF frequencies can be assigned for biomedical telemetry operations to eligible licensees in the Fire, Local Government, and Special Emergency Radio Services (hospital, ambulance operators or rescue squads).

The Federal Communications Commission* has provided seven base-mobile frequency pairs in the 460 MHz band for these operations. See Table 4-C. In summarizing the rule changes adopted March 23, 1972 to establish ambulance to hospital biomedical telemetry systems the Commission stated:

> *All of these frequencies are available in the Special Emergency Radio Service. The mobile frequencies are primarily assignable for telemetry transmissions, but supplemental voice operations related to the telemetry activity may also be conducted on mobile frequencies. The five base-designated frequencies 463.000 through 463.100 MHz are assignable for hospital to vehicle voice communications regarding the telemetry activity. They may also be used to accommodate the need for portable telemetering from patients before they can be placed into ambulances to telemeter from the patients through ambulance radios to a hospital (portable to mobile/mobile-relay). The two base-designated frequencies 460.525 and 460.550 MHz are assignable only for central dispatching of ambulance telemetry systems under an area-wide communication plan for coordinated use of telemetry frequencies. They may be assigned in the*

*Federal Communications Commission, Report and Order, Docket No. 19261, released March 29, 1972.