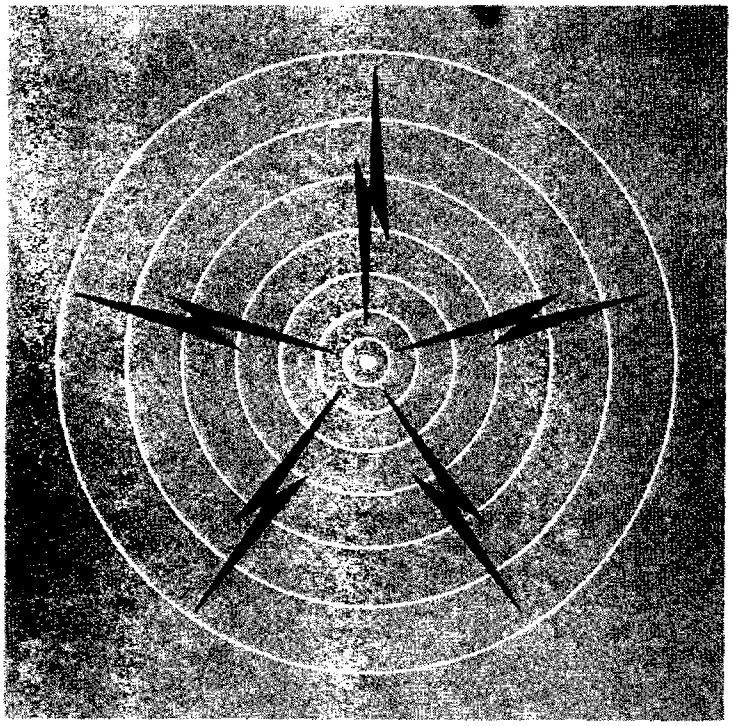
# Emergency Medical Services Communications Systems



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# 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.

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# 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.

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

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.

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;

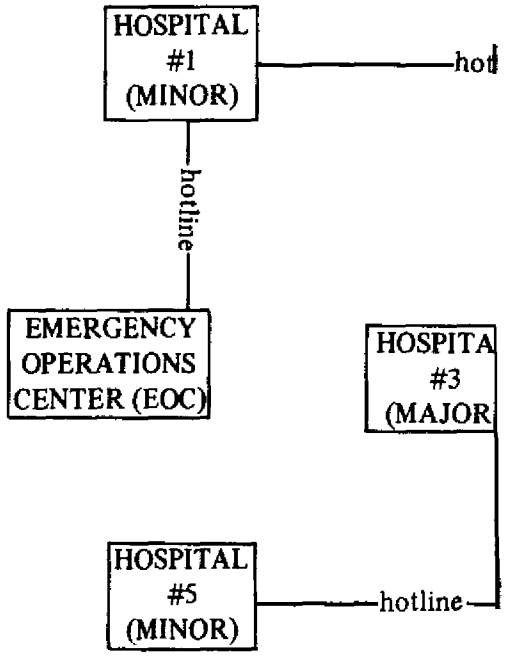
   b. The link from the ambulance when in the outlying area to the "major" hospital will be by radio to the community hospital, and then through phone patch equipment and long distance lines to the "major" hospital;

   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.

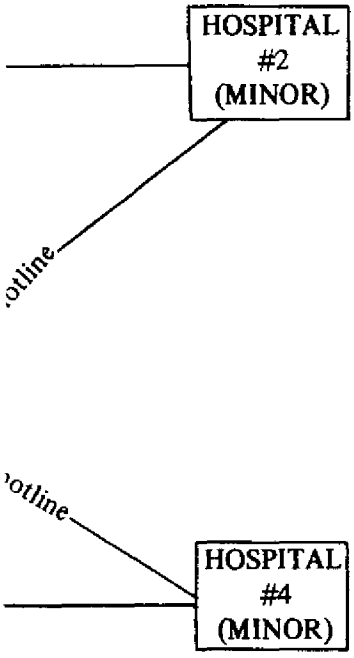
**Table 1: Communications System**

| 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. |

| HOSPITAL VHF RADIO REQUIREMENTS VHF (HIGH BAND) | | |
|---|---|---|
| ANSMIT | RECEIVE | PURPOSE |
| | 155.145 | DISPATCH |
| 55.340 | 155.340 | EMERG. FREQ. |
| 55.(F(X) | 155.(F(X) | HSKPG. FREQ. |
| 55.280 | 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 | | |
|---|---|---|
| RANSMIT | 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:

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

**TABLE 2 (Continued)**

Minor Hospital

| | |
|---|---|
| 1 VHF Two-Channel Base Station Transmitter/Receiver | - 155.340 MHz<br>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<br>2. 155.280 MHz<br>3. 155.340 MHz<br>4. (Future) |
| 1 VHF 2-channel Portable receiver | 1. 155.280 MHz<br>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

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.