

## CONTENTS

EMERGENCY MEDICAL SERVICES	1
Summary Chronology	A
Radio Frequencies for EMS	B
Communications in Support of EMS	C
OTP Letter 10/3/74	D
OTP Letter 1/31/75	E
OTP Letter 1/31/75	F
OTP Letter 1/31/75	G
NATIONAL POLICY FOR "911" EMERGENCY TELEPHONE NUMBER	2
Summary Chronology	A
The Challenge of Crime	B
Bulletin No. 73-1	C
Nine-one-one (a Handbook)	D
93rd Congress at the First Session	E
Telephony (article) 7/22/74	F
TV CAPTIONING FOR THE DEAF	3
Summary Chronology	A
FCC Public Notice	B
OTP Letter 12/2/71	C
OTP Report for the Record	D
Memorandum for M. Farrell 2/3/1972	E

OTP Letter	7/13/73	F
FCC Letter	8/1/73	G
OTP Letter	4/19/74	H
FCC Letter	5/22/74	I
Memorandum	9/11/74	J
Senate Congressional Record	2/20/75	K
POINT PAPER IN BIOLOGICAL EFFECTS PROGRAM		4
Summary Chronology		A
ERMAC Members		B
Side Effects Working Group		C
Summary of ERMAC Overview of the Program to Assess Biological Effects of Nonionizing Radiation		D
Summary - Nervous System and Behavioral Effects of Nonionizing Electromagnetic Radiations		E
Participants		F
Summary Data		G
WHO Collaborating Centre		H



A



## SUMMARY CHRONOLOGY -- EMERGENCY MEDICAL SERVICES

1. Early 1960's: Professional, lay and government organizations urge upgrading communications in support of emergency medical care.
2. January 20, 1972: President's State of the Union Message. By improving communications, transportation and training, "We must develop new ways of organizing emergency medical services."
3. March 2, 1972: President's Health message recommended "using new technologies to improve emergency care systems. . ."
4. March 1972: IRAC establishes special Ad Hoc Group (IRAC Ad Hoc 120) to undertake extensive review of communications aspects of EMS. This group was reconstituted on April 24, 1973, and on October 3, 1973, issued its report: "Communications in Support of Emergency Medical Services" (see #6.).
5. March 1972: National Academy of Sciences' National Research Council issues report from its Committee on Emergency Services. Report recommended creation of Interagency Coordinating Group on Emergency Communications be established in Executive Office under leadership of OEP (later HUD) and OTP.

6. October 3, 1973: IRAC Ad Hoc 120 releases report on communications in support of emergency medical services.

Report recommends:

- A. National EMS calling and "scene of action" frequencies be established in the VHF and UHF bands, and that use of a collective call sign be adopted.
- B. Seven paging frequencies be designated to serve both the general medical community and EMS.
- C. Seven frequencies be designated for "command and control" (including the dispatching function) communications with ambulance drivers. One pair of frequencies is made available for additional use as common "working frequencies" at a "scene of action."
- D. Twenty frequencies (i.e., ten pairs) be designated for biomedical telemetry, medical data handling (voice, digital, analog, multiplex, etc.) and doctor's talk circuits.
- E. Two frequencies be designated for hospital to resource management center communications, including hospital-to-hospital communications.
- F. An Emergency Medical Radio Service be established (similar to and having the same protection as the Police and Fire Radio Services).



7. November 9, 1973: FCC Chairman Burch praises IRAC and OTP efforts, promises quick action.
8. November 16, 1973: Congress passes "Emergency Medical Services System Act of 1973." Law makes funds available, DOT and HEW charged with implementing the Act.
9. March 13, 1974: OTP letter to FCC urges prompt action on IRAC report and recommendation.
10. June 6, 1974: DOT requests OTP develop federal standard for biomedical telemetry. This is necessary to facilitate compatibility among systems regardless of geographical area or units involved. Pending development of such a standard, DOT and HEW are holding funding of systems in abeyance.
11. July 2, 1974: FCC Report and Order (Docket 19880) draws heavily on OTP EMS Report and is in essential agreement therewith. Principal differences are in some of the nomenclature and the FCC Report provides for greater flexibility than the OTP Report had recommended.
12. January 21, 1975: IRAC endorses minimum standard for emergency medical telemetry.

13. January 31, 1975: OTP forwards standard on medical telemetry to FCC and DOT.
14. January 31, 1975: As of this date, 40 EMS communications plans from various state agencies and medical associations have been filed with the FCC.



B

OFFICE OF TELECOMMUNICATIONS POLICY  
EXECUTIVE OFFICE OF THE PRESIDENT  
WASHINGTON, D.C. 20504

September 17, 1973

TO: Executive Secretary, IRAC

FROM: L. R. Raish, Convener, Ad Hoc 120

SUBJECT: Provision of Radio Frequencies for Emergency Medical Service  
(EMS) Telecommunications Operations

On April 24, 1973, the IRAC reconstituted Ad Hoc 120 to develop recommendations as to how spectrum needs associated with emergency medical systems telecommunications should be satisfied.

In approaching its assigned task, Ad Hoc 120 undertook to deal with immediate EMS requirements and those foreseen through the early 1980's time frame. Consideration was given to the practical fact that today's equipment can be expected to still be in operating condition for the next several years. It is clear that EMS is a rapidly emerging service. It is developing at the "grass roots" level and, probably more than most other types of service, is reflective of local circumstances.

The findings of the attached report are based on broad general concepts. Accepted as inherent in EMS systems is the understanding that there is or should be a multiplicity of interactions between involved groups at the local level. The cooperation and coordination of these groups are necessary for the development and operation of an efficient emergency medical service. Telecommunications systems in support of EMS would be expected to serve the purposes of (1) getting the patient into the EMS system, (2) providing coordination within the EMS system to the patient's benefit, and (3) providing for efficient management of EMS resources. Overall, the FCC and OTP are expected to determine the telecommunications policy that may be involved, with other agencies of the Federal Government establishing operational standards and dealing with those matters under their purview.

The attached report recommends that:

1. National EMS calling and "scene of action" frequencies be established in the VHF and UHF bands, and that use of a collective call sign be adopted.

2. Seven paging frequencies be designated to serve both the general medical community and EMS.

3. Seven frequencies be designated for "command and control" (including the dispatching function) communications with ambulance

drivers. One pair of frequencies is made available for additional use as common "working frequencies" at a "scene of action".

4. Twenty frequencies (i.e., ten pairs) be designated for biomedical telemetry, medical data handling (voice, digital, analog, multiplex, etc.) and doctor's talk circuits.

5. Two frequencies be designated for hospital to resource management center communications, including hospital-to-hospital communications.

6. An Emergency Medical Radio Service be established (similar to and having the same protection as the Police and Fire Radio Services).

In arriving at the foregoing recommendations, Ad Hoc 120 first considered the possibility of allocating a "band" or "bands" of frequencies to be designated "G/NG" (i.e., joint Government and Non-Government) as exclusively for EMS telecommunications. This approach was abandoned as (a) being wasteful of spectrum space, and (b) not providing the flexibility needed for systems planning. Instead, as can be seen, a number of individual frequencies are being recommended--these to be on a "G/NG" basis, exclusively (or at least priority) for EMS use. As envisioned by Ad Hoc 120, the designation of frequencies in this manner will enable authorities within the States and local subdivisions (such authorities could range from those of a single metropolitan area to a regional area of several counties) to develop EMS system telecommunications responsive to the local needs.

Despite an expanded Federal Government involvement, Ad Hoc 120 found that EMS telecommunications is still and will remain essentially a local and/or a regional function. However, planning is essential to relate needs to goals, to prevent unnecessary duplication of effort and waste of resources, and to insure system coordination and compatibility. This "local" effort should be developed within the States and political subdivisions based on national criteria, standards, and guidelines. From a telecommunications regulatory standpoint, most of EMS is expected to continue to come under the purview of the FCC.

In his message vetoing S.504\* on August 1, 1973, the President confirmed that "localness" is the preferred course for EMS when he said:

"At my direction this administration has been engaged for the past two years in an effort to demonstrate the effectiveness of various types of emergency medical services. Some \$8 million was budgeted for this purpose last fiscal year, and \$15 million should be spent in the current fiscal year. I strongly believe

\* S.504 contained provisions that, if approved, would have favored the Federal Government in many aspects of EMS.



the federal role should be limited to such a demonstration effort, leaving the states and communities free to establish the full range of emergency services systems that best suit their varying local needs."

Account was taken of the potential of frequencies in the 900 MHz region for EMS communications. While the state-of-the-art can accommodate some EMS functions in the 900 MHz band now, the requirements to be met require a systems approach in meeting them. Accordingly, when enough firm information is available on telecommunications capabilities, growth, and planning in the 900 MHz, a new EMS study should be undertaken. In the meantime, to meet pressing needs for EMS communications, the attached report proceeds on the basis of using both 150 and 450 MHz band frequencies but with particular emphasis on the latter.

Finally, Ad Hoc 120 did not undertake to develop EMS frequency allocations or assignments on the basis of major disasters or catastrophes. Ear-marking extra frequencies for such purposes was considered unrealistic from a planning standpoint and an inefficient application of spectrum resources. In lieu, it is expected that such contingencies would be met through disaster plans and resource management by the Defense Civil Preparedness Agency which has some 3800 Emergency Operating Centers completed and in process throughout the Nation.

Ad Hoc 120 submits the attached report and recommends its approval.

Attachment





C



**EXECUTIVE OFFICE  
OF THE PRESIDENT**

## **OFFICE OF TELECOMMUNICATIONS POLICY**

**COMMUNICATIONS IN SUPPORT OF  
EMERGENCY MEDICAL SERVICES**

**NOVEMBER 1973**

COMMUNICATIONS IN SUPPORT  
OF  
EMERGENCY MEDICAL SERVICES

NOVEMBER 1973

## INTRODUCTION AND SUMMARY

In his Health Message to the Congress of March 2, 1972, President Nixon stated:

"Emergency Medical Services: By using new technologies to improve emergency care systems and by using more and better trained people to run those systems, we can save the lives of many heart attack victims and many victims of auto accidents every year. The loss to the Nation represented by these unnecessary deaths cannot be calculated. I have already allocated \$8 million in fiscal year 1972 to develop model systems and training programs and my budget proposes that \$15 million be invested for additional demonstrations in fiscal year 1973."

Emergency medical services involve initial treatment of the acutely ill and the severely injured, reporting of medical emergencies, and patient care enroute to hospital facilities. Electronic communications makes it possible to quickly and reliably link ambulances, medical personnel at the scene of an emergency, and hospital emergency facilities, to enable early diagnosis and treatment of patients.

In making it possible for Emergency Medical Service (EMS) interests to undertake communication systems planning, certain practical factors were taken into account, namely:

- EMS is a rapidly emerging service.
- EMS is developing at the "grass roots" level.
- Probably more than most other types of service, EMS is reflective of local circumstances.
- EMS communications of the future will be building from a base of existing equipment investments.

This report provides for an EMS communications system plan adaptable to both urban and rural areas. Specifically it provides for:

- Establishment on a national basis of common radio frequencies for use by EMS units at the scene of medical emergencies, wherever occurring.
- Paging systems that would be used not only for EMS but also to contact members of the general medical community.



- Dispatching and direction of ambulance operations, e.g., instructions to drivers as to which hospital to go and traffic conditions enroute.
- Communication networks for biomedical telemetry (electrocardiograms, for example), medical data handling, and special voice circuits for exclusive use by doctors.

The importance of communications to effective, affordable EMS is now firmly established. Therefore, the report includes a recommendation that an Emergency Medical Radio Service be established and accorded the same status and protection throughout the United States as Police and Fire Radio Services.

This report, prepared by the Interdepartment Radio Advisory Committee, in coordination with members of the Federal Communications Commission staff and the medical community, deals with EMS communications, including the provision of radio frequencies, as foreseen up to the early 1980's time frame. It was approved by the Director of the Office of Telecommunications Policy and forwarded to the Chairman of the Federal Communications Commission on October 3, 1973.

PART I - GENERAL

There is a ground swell of concern and interest in improving emergency medical services. This has been prompted by the realization, among other things, that (a) the Armed Forces having proved that the number of otherwise fatal combat casualties could be reduced substantially by prompt medical attention, the same concepts could be applied effectively to civilian life throughout our country, and (b) aerospace technology, with some adaptations, could make this a practical undertaking. The effectiveness of these concepts has been dramatically demonstrated by projects and programs such as the Illinois Trauma Center, the Jacksonville, Florida, Houston, Texas, and San Francisco, California EMS Systems, and the Military Assistance to Safety in Traffic (MAST) program.

In the past six years there has been an outpouring of activity among professional, lay, and governmental organizations toward upgrading emergency medical care. Concern over deaths from accidents and other medical emergencies has been expressed in legislation establishing national standards for EMS and providing funds for implementation, research and development. Technology and methodology for delivering high quality emergency medical care exists for each element of the EMS system. What is lacking in most areas of the nation is informed cooperative linkage of elements for optimum performance, and the radio frequency spectrum allocations which facilitate system development. IRAC Ad Hoc 120<sup>1</sup> undertook an extensive review of the communications aspects of EMS as a prelude to preparing recommendations regarding the radio frequencies needed therefor on a national basis.

An indication of the magnitude of the problem is revealed by the following quote from a March 1972 Report of the Committee on Emergency Medical Services of the National Academy of Sciences--National Research Council (NAS/NRC):<sup>2</sup>

"Accidental injury and acute illness generate a staggering demand on ambulance and rescue services, allied health personnel, physicians, and hospitals for the delivery of emergency medical services. Accidental injury is the leading cause of death among all persons aged 1 to 38. Each year more than 52 million U.S. citizens are injured, of whom more than 110,000 die, 11 million require bed care for a day or more, and 400,000 suffer lasting disability at

1. The Interdepartment Radio Advisory Committee (IRAC) established a special Ad Hoc group to undertake a study of and to prepare a report on Emergency Medical Service (EMS) communications. This group became known as "IRAC Ad Hoc 120".
2. Roles and Resources of Federal Agencies in Support of Comprehensive Emergency Medical Services - published by Committee on Emergency Medical Service, National Academy of Sciences-National Research Council, March 1972.

a cost of nearly \$3 billion in medical fees and hospital expenses and over \$7 billion in lost wages. Those requiring hospitalization occupy an average of 65,000 beds for 22 million-bed days under the care of 88,000 hospital personnel. This hospital load is equivalent to 130 500-bed hospitals. Of the more than 700,000 deaths from heart disease each year, the majority are due to acute myocardial infarction and more than half of these deaths occur before reaching a hospital. Approximately 40 million persons seek care each year in hospital emergency departments as a result of accidents, heart disease, stroke, poisoning, diabetic coma, convulsive disorders, and many other illnesses."

In furtherance of the foregoing quote, research by members of Ad Hoc 120 revealed certain nationwide statistics for 1972 as follows:<sup>1</sup>

EMERGENCIES ON THE NATION'S HIGHWAYS

INJURIES REQUIRING TREATMENT. . . . .	3,551,000
DEATHS. . . . .	54,862

ALL INJURIES REQUIRING TREATMENT . . . . .	51,229,000
REQUIRING BED CARE. . . . .	12,014,000
DEATHS. . . . .	114,864

HEART ATTACK DEATHS. . . . .	744,658
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With regard to these statistics, a consensus of the medical profession indicates that:

20% of the annual accidental deaths could be prevented with prompt and proper care at the accident scene and with efficient transport to a suitable medical facility.

25% of the annual cardiovascular deaths could be prevented through public education and the provision of prompt and adequate treatment.

15% of the 56,000 highway deaths could be prevented as demonstrated in Illinois by a statewide system of regional hospital trauma centers supported by a communication network and an ambulance system of highly trained attendants.<sup>2</sup> The major improvement can be expected in rural areas where 65-70% of highway deaths occur. In 1971 it was reported by the Division of Emergency Health Services of USPHS, DHEW, that while 50% of the ambulances in the country had two-way radio communications with a dispatching center, less

1. National Safety Council: Accident Facts 1972.

2. Boyd, D.R.; Mains, K.D.; and Flasher, B.A.; A Systems Approach to Statewide Emergency Medical Care, J. Trauma 13:276, 1973.



than 10% maintained such communications with hospitals or their emergency departments.<sup>1</sup>

The first 30 minutes following an injury or heart attack generally determines whether the victim will live or die.

The policy of the Administration in the area of emergency medical service is clear. In his State of the Union Message to Congress of January 20, 1972, the President said:

"We must develop new ways of organizing emergency medical services and of providing care to accident victims. By improving communications, transportation, and the training of emergency personnel, we can save many thousands of lives which would otherwise be lost to accidents and sudden illnesses. Such improvement does not even require new scientific breakthrough; it only requires that we apply our present knowledge more effectively."

The foregoing was reinforced on March 2, 1972 in the President's Health Message which stated:

"Emergency Medical Services: By using new technologies to improve emergency care systems and by using more and better trained people to run those systems, we can save the lives of many heart attack victims and many victims of auto accidents every year. The loss to the Nation represented by these unnecessary deaths cannot be calculated. I have already allocated \$8 million in fiscal year 1972 to develop model systems and training programs and my budget proposes that \$15 million be invested for additional demonstrations in fiscal year 1973."

There is hardly a Federal Government department or agency that is not involved in some aspect of EMS.<sup>2</sup> DOT, HEW, and Defense Departments<sup>3,4</sup> plus the Veterans Administration clearly have major investments and resources to be devoted to EMS. Other Federal departments and agencies with major responsibilities or interests in EMS include Justice, Labor, HUD, Agriculture, Interior, Commerce, NASA, the Special Action Office of Drug Abuse Prevention, and the Appalachian Regional Commission.

1. Ambulance Services and Hospital Emergency Departments, USPHS, HSMHA, DHEW, Rockville, Md., 1971.
2. Roles and Resources of Federal Agencies in Support of Comprehensive Emergency Medical Services" - published by the National Academy of Sciences-National Research Council, March 1972.
3. The Defense Civil Preparedness Agency has 3803 State and Local Emergency Operating Centers completed and in process throughout the nation. (See Appendix C.)
4. The Highway Safety Act of 1973 in Sections 212A and 212B requires DOT to study greater citizen involvement in highway safety programs, including accident detection, reporting, and response. While not specifically stated, EMS is assumed to be included (and clearly should be).



The NAS/NRC has recommended that an Interagency Coordinating Group on Emergency Communications be established in the Executive Office of the President under the leadership of OEP<sup>1</sup> and OTP for coordination of resources of all Federal agencies whose support of communications systems is related to the roles of emergency response agencies at the local, regional, state, and national levels.<sup>2</sup> The major EMS activities, however, will take place within the states and their political subdivisions. The capabilities developed and used on a day-to-day basis are for the most part the same resources which mobilize to meet widespread emergency and disaster needs. For communications purposes, many such operations will be under the purview of the Federal Communications Commission. Federal Government departments and agencies will be using EMS systems extensively and dovetailing their operations as appropriate with local authorities. Thus EMS systems involve an intermix of "Federal Government and non-Federal Government" interests. EMS systems further involve intermixes of public-safety capabilities, whether public or private, including volunteer agencies.

It is not the purpose of this report to discuss the entirety of EMS but only to develop background that would help identify the telecommunications requirements thereof that would, in turn, identify the radio frequency requirements from now through the early 1980's time frame. This general background section has been included to present some feeling for the scope and critically important nature of the subject of EMS, and to establish that the interests involved are truly "Government and non-Government".

1. Since the disestablishment of OEP in mid-1973, responsibility for planning emergency response to disasters is with the Federal Disaster Assistance Administration, Department of HUD.
2. Roles and Resources of Federal Agencies in Support of Comprehensive Emergency Medical Services - published by the National Academy of Sciences-National Research Council, March 1972.

PART II - TELECOMMUNICATIONS ANALYZED

In his testimony before the House Subcommittee on Public Health and Environment on March 15, 1973, Dr. John S. Zapp, Assistant Secretary for Legislation, HEW, described community emergency medical services as follows:

"Community emergency medical services consist of the detection and reporting of medical emergencies, initial care, transportation and care for patients enroute to hospital facilities, medical treatment for the acutely ill and severely injured within hospital emergency departments and provision of a linkage to continued care and rehabilitation. Emergency medical services are composed of elements which should be organized into a balanced system at the local level. This system is part of the community's total health care delivery system, and therefore must be planned for in conjunction with that total system and should provide immediate access to that system through appropriate diagnosis, treatment, and follow-up care."

Accepting the foregoing as a definition of EMS, the members of Ad Hoc 120 then analyzed the needs of the medical and health professions for emergency telecommunications services. In summary, these professions require telecommunications to permit:

1. Human health emergencies to be immediately reported to appropriate community agencies which manage and control health resources and services.
2. Appropriate health resources to respond to such human emergencies at anytime and wherever they may occur.
3. Recognition of the need for (and more immediate response to) health resources and services to life threatening emergencies within a time period which will insure the greatest saving of lives and limbs.
4. Health agencies and professionals to marshal their individual and collective resources (staff, equipment, supplies) and coordinate their responses in the shortest effective time to meet any human need including catastrophic events.
5. Health agencies and physicians to provide guidance and direction to others on the scene of a human emergency pending arrival of trained health personnel.

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1. Hearing before the Subcommittee on Public Health and Environment of the Committee on Interstate and Foreign Commerce, House of Representatives on the "Emergency Medical Services Act", Serial No. 93-8, March 15, 1973.



6. The coordination of emergency health services with other emergency service systems within the community through Emergency Operation Centers or other means.
7. Special health resources (emergency departments, intensive care and coronary care units, burn and trauma facilities etc.) to be utilized to their most effective degree.
8. Transmittal of all appropriate vital human physiological information necessary during any emergency to the proper monitoring and decision making health professions and their centers.
9. Collecting, recording, and documenting information on human emergencies in order that emergency health care systems can review, revise and reorganize, as necessary to meet changing conditions and needs.
10. Safe transfer of acutely and chronically ill patients between health care facilities.
11. Optimum use of health resources in preventing or mitigating adverse medical effects of human emergencies.

An analysis of these requirements in graphic form is set forth in Appendix A hereto. An EMS system provides services affecting the sequence of events. The capability of the resources and the quality of their performance relate to the results, i.e., facilitate definitive medical care and faster patient recovery.

Telecommunications in support of EMS appear to fall into the following categories:

1. Messages related to reducing response time, i.e., dispatching and controlling the movement of emergency vehicles (Radio and/or wire).
2. Messages related directly to the patient and his care, i.e., medical telemetry and a "doctor's talk" channel (Radio).
3. Extensions of both 1 and 2, above, from the emergency vehicle to the actual location of the patient, e.g., in an apartment, in a field, or on a boat, etc. (Radio).
4. Messages necessary for effective coordination and preparedness for reception of the patient, i.e., intra-hospital, hospital-to-hospital, and Resource Coordination Communications (RCC) Center (wire/radio).



5. Paging systems to call individuals and mobilize medical personnel. While these are now mostly "beep" systems, two-way portable radio paging is the desired objective (Radio).
6. Interface with police, fire, and other local government agencies (Radio and wire).
7. Disaster situations (Radio and wire).

Not included in the above are the communications that would be used for entering the emergency response system. Undoubtedly the telephone will continue to be the primary means of "reporting" an emergency medical situation remote from the hospital. The national emphasis on implementation of the universal telephone emergency number, "911"<sup>1</sup>, provides the citizen an easily remembered emergency access number. A by-product of the "911" system is expected to be a marked increase in coordination among agencies providing emergency services. This increased coordination has been taken into account in the body of our study by the frequent references to use of Resource Coordination Communications (RCC) Centers. The members of Ad Hoc 120 agreed that "reporting", being so diverse in its origins, and since "911" service was expanding anyway, should be excluded from its study because it is an entirely different subject.

A multitude of technological advances have been made in the telecommunications area (as well as in other areas) and are pertinent to EMS. Heretofore, the relation of such advances to an entire EMS system has not always been considered. Among such technological advances are:

1. Citizen access to the response system through the universal emergency telephone number ("911"), and Resource Coordination Communications (RCC) Centers to manage the dispatch of ambulances, flow of medical information, and control of action taken.
2. Digital communication units and base terminals which have encouraged the standardization of brevity codes related to patient care, dispatch, and decision making.
3. Equipment developments for "cellular modes" of communication in the 900 MHz area.
4. Telemetric monitoring of life signs of patients in medical emergencies for physicians and technicians in hospitals.
5. Specialized patient transportation units, such as mobile intensive care units.

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1. OTP Bulletin No. 73-1 of March 21, 1973, "National Policy for Emergency Telephone Number '911'."

6. Air ambulance operation using both rotary and fixed wing aircraft. Aircraft can be used for emergencies, routine transfer of patients between hospitals, transfer of patients to specialized treatment centers, or even for the transfer of vital organs and medications.
7. Minicomputers for operation in hospitals and communication centers to include management of resources, provide automatic dispatch and routing, and assist in decision making.
8. Television communications between the paramedic at the site and the hospital physician.

The members of Ad Hoc 120 made a determination that special EMS frequencies need not be provided for the interface with fire, police, or other local government services or for disaster situations. However, FCC Rules should permit these interfaces. In other words, communications (to interface with police, fire, and other local government agencies and to cope with disaster situations) should be arranged, it was felt, on the basis of "operations plans" using established resources available to "Resource Coordination Communications (RCC) Centers rather than to attempt to earmark additional separate frequencies for such purposes. Ad Hoc 120 noted that the Defense Civil Preparedness Agency has more than 3800 local Emergency Operating Centers completed and in process throughout the Nation.<sup>1</sup> There is a requirement for EMS calling, working, and "scene of action" frequencies for use when divergent EMS facilities (ambulances particularly) converge in one area or move from area to area. Frequencies for these purposes are recommended in Part IV of this report. There would be no reason why an RCC could not put fire, police, and other emergency vehicles on these frequencies for rescue communications purposes.

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1. See Appendix C.



PART III - PRESENT SPECTRUM SITUATION

To date the Federal Communications Commission has provided frequencies in the 30-50 MHz and in the 155.13-155.430 MHz bands for base and mobile operations for general emergency medical radio communications. These frequencies (32 in number) are allocated, however, as a part of the "Special Emergency Radio Service" which means that EMS must share with disaster relief agencies, school busses, beach patrols, establishments in isolated areas, and common carrier standby and repair facilities. Additionally, seven pairs of base-mobile frequencies in the 460 MHz band have been provided for ambulance-to-hospital biomedical telemetry systems.

A detailed presentation on frequencies available for EMS purposes is contained in Appendix B. As indicated therein, not only are the EMS frequencies shared with other operations in the "Special Emergency Radio Service", but there are also a number of other limitations. For example, some of the frequencies are subject to a "doughnut rule", i.e., they cannot be used by a station located within 40 miles of other stations; others must receive written clearance from licenses of all stations authorized to operate on a frequency 30 kHz from this frequency within 75 miles of the proposed EMS location. Several of the 30-50 MHz frequencies are shared not only with other "Special Emergency Radio Service Stations" but additionally with stations in the "Highway Maintenance Radio Service."

An analysis of FCC records reveals that there are 11,721 licensees for the 32 frequencies available for EMS communications. One frequency (155.340 MHz) has 1564 licensees for its use, another (155.280 MHz) has 884 licensees. As a national average there are 366.2 licensees per frequency available for EMS use.

As this report is being prepared, the FCC is undertaking Rulemaking action in an attempt to improve the medical paging situation. However, the current picture is that medical paging operations are being authorized as additional operations on some of the EMS frequencies. Thus, an already congested situation is being further aggravated by the superimposition of these tone and voice paging functions. To meet this, the FCC is considering the assignment of separate frequencies for tone paging in the "Special Emergency Radio Service", e.g., 157.450 MHz.<sup>1</sup> (Notice of Proposed Rulemaking in Docket 19643, FCC 72-1040.) Additionally, the FCC has recently allocated four frequencies in the 35-43 MHz band for one-way paging operations in the "Special Emergency Radio Service".<sup>2</sup>

The situation regarding frequencies for biomedical telemetry is brighter. The seven pairs of frequencies in the 460 MHz band have been assigned on virtually an exclusive basis for this purpose. Interference between users

1. There is doubt, however, that 157.450 MHz will be selected as it is in a Worldwide Maritime Mobile Band.
2. First Report and Order, Docket 19327 -- FCC 72508.



within a given area can be complicated. Since the number of telemetry operations is relatively small, this is not a major problem at the present, but will require close coordination as more equipment reaches the field. Sharing within a given area is a complication, but so far this has not proved to be a problem either. As indicated in Appendix B (Table 4C), there is some sharing of these 460 MHz frequencies with other than telemetry functions in the EMS, e.g., dispatching of ambulances and doctor's "talk" circuits.

The analysis made by the members of Ad Hoc 120 indicates that the radio frequency needs of EMS exceed those provided in the FCC Rules and recapitulated in Appendix B hereto. To a great degree, frequency allocations for EMS were made before later transportation and communications technologies made rapid response EMS systems possible. As a result, the present FCC rules do not facilitate systems development or the adoption of new technological advances. Besides the excessive sharing with other functions being involved, present special emergency frequency authorizations do not provide:

- for relays (except by ambulance relay) of EMS information through strategically located fixed repeaters. Where effective communications cannot be established between an ambulance and a central station, an alternate means is required.
- for the Fire, Police, and Local Government Radio Services (except for limited authorization in the 460 MHz band), to utilize EMS frequencies in emergency medical situations.
- for hospital-to-hospital radio communications in EMS situations. Under certain emergency situations, hospital-to-ambulance voice communications as well as hospital-to-hospital communications are needed to coordinate patient care.
- for an EMS "scene-of-action" or national calling frequency so that EMS vehicles from different jurisdictions can communicate with each other.
- for the often times particularly different requirements of remote and rural areas. (Often involving mountainous or otherwise hazardous terrain.)
- for the interface of EMS communications with public service agencies, such as the U.S. Coast Guard that may become involved jointly in emergency medical incidents.

- for air ambulance operations. There is growing use of air ambulances utilizing both fixed and rotary wing aircraft. These aircraft must operate in the civil air complex and also be able to communicate with the EMS system on the same basis as a ground ambulance.
- for data telemetry with commentary at VHF .
- for the use of a collective or joint call sign.



PART IV - EMS RADIO FREQUENCY REQUIREMENTS AND  
RECOMMENDED ALLOCATIONS

In considering the frequency needs for EMS, it becomes apparent that the crucial matter to observe is that telecommunications provides the means by which the various subsystems of a total EMS are brought together in a coordinated fashion. It might be said that no truly effective EMS can be formed without communications. Although many of the medical functions, ambulances, hospitals, emergency departments may exist and are in place, they have not been systematically related. Telecommunications serves this requirement; although the requirement will vary from community to community, depending on local needs.

Ad Hoc 120 identified the essential elements of a functional EMS as related to both rural and urban EMS population densities. These elements include trained personnel using appropriate diagnostic and therapeutic equipment, acting under remote medical supervision, for on-the-scene treatment (with stabilization of the patient) and, finally, transport of the patient to definitive medical care in a hospital emergency department or a physician's office. It became clear that coordination could best be managed from a centralized regional Resource Coordination Communications (RCC) Center which could receive calls and be responsible for making an appropriate response of resources, acting under medical supervision, for such on-the-scene treatment. The sophisticated requirement of such an RCC could vary depending on the community. For example, in a rural area, it may actually be the "all-night" cafe, the local telephone operator, or the sheriff's home, whereas, in a large city, it may be a complex operation involving many dispatchers and supervisory personnel.

Ad Hoc 120 tried to identify and bring into focus the special characteristics of EMS that distinguish it from the considerations that previously have been given to the Special Emergency Radio Services in general. Two features seemed prominent:

1. The need for frequencies dedicated specifically to EMS because of the critical element of time involved in delivery of life-saving procedures in most emergency medical situations, and
2. The complex interactions of large numbers of people or groups in providing emergency care. In the truest sense, the emergency medical services system becomes a "system" involving a multitude of actions and interactions between the patient, providers, consumers, and political jurisdictions, including the various Federal Government agencies and departments as described in Part I of this paper.



The EMS, while an extension of the usual health delivery system, differs in one important way. The usual direct personal doctor-patient relationship is modified to one in which the patient must be treated by trained paramedical people in the field, operating under remote physician supervision, until the patient is transported to a hospital for comprehensive medical treatment. Communications permits selection of one hospital appropriate to the condition of the patient, while the hospital can be alerted and placed in readiness for the particular case.

Several identifiable functions were found which require frequency allocations beyond those now provided in the Federal Communications Commission (FCC) Rules. The need for Government/non-Government (G/NG) spectrum allocations became obvious. The approach of Ad Hoc 120 was to consider the needs of today--using today's technology, equipment and dollars to implement EMS systems telecommunications that would be viable into the 1980's. Thus, we considered the several functional categories for possible frequency allocations. Although the number of incidents in an urban area generally establishes the number of frequencies required to prevent interference and system saturation, the distance in the rural areas influences the preferred wavelength or frequency. An additional important consequence is the need to continue use of existing communications equipment while developing and implementing the optimum system concepts.

Our concept of operation in the present consideration was that EMS must be planned and implemented at the community level. The community is defined to be the natural catchment area, or area for implementation of a total EMS system which serves the urban and rural population densities in this country. Thus, our planning is conceived of a multitude of self-sufficient EMS communities which join and span a state or several states. We proposed that allocations be made to a community on the basis of an area-wide coordinated implementation plan, using frequency coordinators required to meet the specific system requirements of that geographical area served by the community. Frequency coordination of this type is required to insure the compatibility of all public services.

Thus, we have specified maximum numbers of frequencies on a functional "need" basis, but will leave it to communities to determine operational allocations and frequency utilization within rules and policies that are determined by the FCC and the Office of Telecommunications Policy (OTP). At the same time, we have tried to recognize the need to communicate between resource management centers of adjacent communities in the time of national or other disasters.

Ad Hoc 120 borrowed from the experience of other public-service agencies and the Armed Forces in search and rescue activities to identify requirements for calling and on-scene-of-action frequencies, and a collective call sign. These will provide compatibility between adjacent EMS systems

on a nationwide basis, and also permit communications between agencies responding to emergency situations. This recommendation recognizes the need to relate to other emergency services. Experience has indicated that a common calling or emergency frequency is needed to establish initial contact, with an equally important need for scene-of-action frequencies available to coordinate activities at the scene of an emergency.

Ad Hoc 120 recommends that the following frequencies be made available on an exclusive (or at least on a priority) basis for use by both Government and non-Government (G/NG) interests for EMS functions as indicated and in a manner most appropriate to meet community needs:<sup>1</sup>

1. "National" EMS "common" calling and scene-of-action frequencies:

155.340 MHz - (15 kHz channel) reallocated from existing hospital routine and administrative communications use; however, hospitals would be qualified to continue to use 155.340 MHz as the new "common". Existing hospital usage would be moved over to another service, e.g., business radio.

463.175 MHz (25 kHz channel) - Presently unallocated.

2. Paging

43.64 MHz (20 kHz channel) - Presently a non-Government paging channel.

152.0075 MHz (15 kHz channel) - Presently a non-Government splinter channel.

150.775 MHz - Presently Government military.<sup>2</sup>

150.785 MHz - Presently Government military.<sup>2</sup>

449.950 MHz (25 kHz channeling) - Government Radiolocation and amateur band.<sup>3</sup>

449.900 MHz (25 kHz channeling) - Government Radiolocation and amateur band.<sup>3</sup>

449.850 MHz (25 kHz channeling) - Government Radiolocation and amateur band.<sup>3</sup>

1. To facilitate the administration of the "NG" aspects of EMS telecommunications, it is recommended that the Federal Communications Commission establish an "Emergency Medical Radio Service" that would be similar to and have the same protection as the Police and Fire Radio Services.
2. Limited to use with 5 watts ERP only.
3. Some area restrictions may be required due to existing Government radiolocation operations.

3. Command and Control (including dispatching) to provide communications with the ambulance driver.<sup>1</sup>

162.6625 MHz - available for use in simplex mode by emergency vehicles eligible for independent use operations. Frequency presently Government non-military.

453.175 MHz } (Paired)\* - Reallocate from "call box" in Local  
458.175 MHz } Government Service in FCC Rules.

460.550 MHz } (Paired)\* - Already assigned in FCC Rules.  
465.550 MHz }

453.025 MHz } (Paired)\* - Also available for use as "common" working  
458.025 MHz } frequencies at a "scene of action".  
Frequencies already assigned in FCC Rules.

4. Telemetry, Data Handling, and Doctor's Talk Circuits. (For use in ambulance to base (or hospital), and portable EMS units to ambulance or other relay.) (All already assigned FCC Rules.)<sup>1</sup>

460.525 MHz } (Paired)\*  
465.525 MHz }

463.00 MHz } (Paired)\*  
468.00 MHz }

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\* All 25 kHz channels.

1. Emphasis is placed on the use of 450-470 MHz band frequencies for both "command and control" and "telemetry" functions to simplify equipment planning and design of electronic systems for emergency vehicles. Telemetry is already concentrated in this band and represents an expansion upon existing authorizations. Cognizance was taken of the practical fact that in many areas separate ambulance "command and control" and "telemetry" installations would not be required--accordingly use of 450-470 MHz band frequencies permits both the "command and control" and "telemetry" functions to be carried out using a single piece of equipment (e.g., "command and control" on 453.175 MHz and "telemetry" on 458.175 MHz).

In some areas, particularly rural and mountainous areas, repeaters may be required to assure adequate EMS communication coverage. It is intended that local and/or regional authorities should engineer EMS repeater installations based on their specific requirements using frequencies from among those listed herein for "command and control" and "telemetry" functions.



<u>463.025 MHz</u>	}	(Paired)*
<u>468.025 MHz</u>		
<u>463.050 MHz</u>	}	(Paired)*
<u>468.050 MHz</u>		
<u>463.075 MHz</u>	}	(Paired)*
<u>468.075 MHz</u>		
<u>463.100 MHz</u>	}	(Paired)*
<u>468.100 MHz</u>		
<u>463.150 MHz</u>	}	(Paired)*
<u>468.150 MHz</u>		
<u>463.125 MHz</u>	}	(Paired)*
<u>468.125 MHz</u>		
<u>453.075 MHz</u>	}	(Paired)* - Reallocate from "call-box" in Local Government Service in FCC Rules.
<u>458.075 MHz</u>		
<u>453.125 MHz</u>	}	(Paired)* - Reallocate from "call-box" in Local Government Service in FCC Rules.
<u>458.125 MHz</u>		

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\* All 25 kHz channels.

5. Hospital to Regional Resource Coordination Communications  
(RCC) Center (Including hospital-to-hospital)

468.175 MHz (25 kHz channel) - Presently unallocated in FCC Rules.

155.280 (25 kHz channel) - Presently authorized in FCC Rules for hospital-to-hospital communications.

The foregoing radio frequency recommendations are made on the basis of requirements of a major urban area of a population density of eight million people. Statistics used were that: (a) For every million people there would be 200 daily emergency calls for ambulance services or one every seven minutes.<sup>1</sup> (b) Of these calls one-half could be life threatening. Approximately one-fourth would be for cardiovascular emergencies and 20% would be the result of accidental or other trauma. (c) About one-half of the cardiovascular calls would require telemetry, data handling or some professional guidance. (d) The average ambulance run in urban areas varies from 5 to 20 minutes but 30 or more minutes are required in rural areas where 70% of highway deaths occur. (e) In urban areas up to 70% of ambulance runs to major hospital centers will require an emergency admission.<sup>2</sup>

As regards medical paging, the foregoing recommendations are based on providing service to the entire medical community as a part of EMS—the philosophy being that a doctor would not be paged unless it were an emergency of some sort. There are an estimated 400,000 physicians in the USA of which over 300,000 are in active practice. With the present concentration of physicians in urban areas queuing of calls occurs, sometimes with delays of ten to fifteen minutes. The recommendation for paging frequencies is based on a concept that not more than 400 physicians per frequency in any one area would be realistic.

Conceptually, we anticipate that metropolitan areas will find it desirable to separate the following functional activities in terms of frequency utilization: (a) dispatching; (b) medical paging (tone/voice); (c) telemetry and other medically supervised activities; (d) interagency coordination; (e) on-the-scene communication/calling-frequencies; and (f) hospital communications related specifically to EMS. (Note - conceptual diagrams in Appendix A.)

1. Reported for 1971 by New York City Health and Hospitals Corporation, May 1972.
2. Data from EMS Division, Detroit Fire Department and the Detroit General Hospital, June 1973.



We recognize that both municipal and private services must be considered as operational components of such an area-wide EMS system and that appropriate interfaces are made best at the community level. Our planning does not require combination of efforts but does emphasize the need for a coordination of such efforts. Because of the limited number of frequencies that can be made available, coordinated EMS planning and cooperative efforts, based on a systems approach appear to be the best method of proceeding.

The utilization of frequencies for specific activities within a community will be determined after an EMS system is specified for the cities, counties and towns in the catchment area of the community. The attached diagrams present some of the typical frequency utilizations for such systems and show the various configurations possible. Each schematic is intended to present rationale for such a configuration rather than to suggest any one way or another for community planning.

Appendix A contains some illustrations of systems that could be used in a metropolitan area. For these illustrations it is assumed that entry into the "system" will be by telephone (one number, "911", or special) or by other existing communications. The function of resource management then could utilize a combination of telephone, hot line, direct line, microwave or radio. For purposes of discussion, it is assumed in some cases that the Resource Coordination Communications (RCC) Center could be functionally removed from a hospital. In other situations the "hospital" could provide all the required functions.

The dispatching is performed through a base station which dispatches emergency vehicles throughout the area for the area of the EMS. We realize that some private systems will prefer to operate in a one frequency simplex system for shared dispatching with other independent ambulance services or cities in the area. Conceptually, we expect that the large metropolitan areas would have traffic density sufficient to require that the front-end of the vehicle remain "on the dispatch" or "command and control frequency" for continued command and control. It is assumed that specialized needs for on-the-scene activities would require "disaster type of command and control" and that "telemetry" per se would be replaced by on-the-scene physicians with need to communicate as part of a triage function. By selection of a scene-of-action frequency, all mobiles and bases can switch to on-the-scene operations using existing communication equipment.

The command and control function of dispatching on a two-frequency mobile relay configuration would (a) allow units in the field to communicate also in the day-to-day operations, (b) allow routing of vehicles and initiation of a call to begin other than by telephone (hot line) as may be done if the vehicle is at a fixed location, (c) allow the dispatcher



to participate in and be in control of routing to hospitals by providing the communication link to the hospital emergency department, physicians, etc. (This assumes hospital categorization and "physician" supervision of in-the-field units), and (d) assures continued capability to communicate with a vehicle in the field as required in discontinuing a call, etc. In some rural areas with low radio traffic density, the dispatching and medical supervision could be done using one piece of equipment in either a simplex or mobile relay operation.

The interactions and communication between the EMT in the field and the supervising physician and the hospital is more complex but is still processed through the Resource Coordination Communications Center. One of the illustrations in Appendix A shows a full duplex/multiplex system with ambulance repeater as the most likely reliable system for a variety of communications. The base-to-hospital communications are by means of special telephone lines with a simplex hospital link as backup. Medical paging (one-way tone/voice) is shown for the general medical community.

We have assumed that medical supervision for the EMS will be addressed by system planning, as well as system operation, utilizing a physician(s) at the hospital and/or in remote sites in the field (his office, car, home). Physician supervision is a medical-legal requirement in most States. Because of cost and shortage of medical manpower, an EMS can be designed to have console support and strip chart confirmation at a hospital emergency department and/or coronary care unit performed by EMT's or nurses with physician judgement and advice provided at the console and/or from in the field. Conceivably house staff, such as interns and residents, would provide hospital supervision of the system with consultation from the EMS expert physician in the field. Additionally record keeping and data retrieval could be inherent to the system, but will take different configurations based on local requirements and capabilities.

We selected for description a full duplex system (multiplexing ECG and EMT voice) so as to require the minimum number of people for on-the-scene treatment of a patient using cardiopulmonary resuscitation without the requirement for pushing radio switches or holding a handset. Thus, it would be anticipated that one EMT could be totally involved, using both hands in providing assisted breathing (bag-oxygen-tube/face mask) and the other EMT would utilize both hands for external heart massage. Thus one of the EMT's would have on a headset and be engaged in full duplex communication. In order to provide full duplex communication, and in the field communication with a physician, the multiplex signal is retransmitted by the base when the physician or hospital personnel are not talking. Thus, there is full duplex capability, but push-to-talk is required by the physician supervisor. This method also provides for a continuous link so the EMT can hear himself and the ECG tone which is being sent to the physician. The audible tone modulated by the ECG gives him a way to "monitor" the patient continuously at times when the heart is beating.

As described, the hospital or physician in the field has intercept capability (through push to talk) to break in and give directions to the EMT. Similarly, the system affords communication between the hospital and the physician in the field.

It is anticipated that such four channel capability, including telemetry, would be used selectively with cases going to the doctor in the field only if there is no house staff (hence small telemetry load likely on the system) or for specialized cases requiring expert advice of experienced EMS physicians in the field.

Conceptually, the second, third and fourth simultaneous runs would be handled by a different frequency configuration of the EMS. Here we assume that a community large enough to have multiple simultaneous runs will have personnel continually in the hospital. Thus, the personnel in a fixed location may monitor 3 or 4 scopes simultaneously. In order to assure that the incorrect microphone or button is not pushed and advice sent to the wrong EMT's we have depicted only one talk-back frequency for up to 4 simultaneous runs--thus requiring identification of the EMT team in the field.

Using this approach, only one talk-back frequency is required for use of four simultaneous incidents of monitoring from the field; and only one pair of frequencies (portable/ambulance--repeater is required per incident in the field. Obviously, only one frequency is required per incident if a mobile repeater is not utilized.

The UHF link between the portable and the ambulance repeater is selected to maximize reliability of penetration from within a building or other enclosure which isolates a patient. Conceivably a combination of UHF to VHF could be utilized for this part of the system, especially since the numbers of available VHF frequencies are limited. Continued use of the present VHF Band SERS frequencies has not been overlooked. The frequencies will continue to be available for use on their present basis.

Medical paging is performed using one-way communication of tone followed by voice. The large number of physicians in the health delivery system who can be activated or called to an emergency room for continued treatment of the patient or for assembly in times of disaster requires a system which accommodates a large number of users. Thus, talk-back capability (two-way) page is not envisioned. The system depicted allows the day-to-day paging, required by physicians in the hospital or office care of their own patients. Emergency paging is performed on the same link. This assures compatibility with the EMS system and provides day-to-day use and involvement by all physicians.

The linkage between hospitals, and from hospitals to the base RCC, is provided by simplex operation on frequencies slightly removed. Special cases which require direct voice communications between persons in any hospital (radio or voice) could be patched at the RCC.

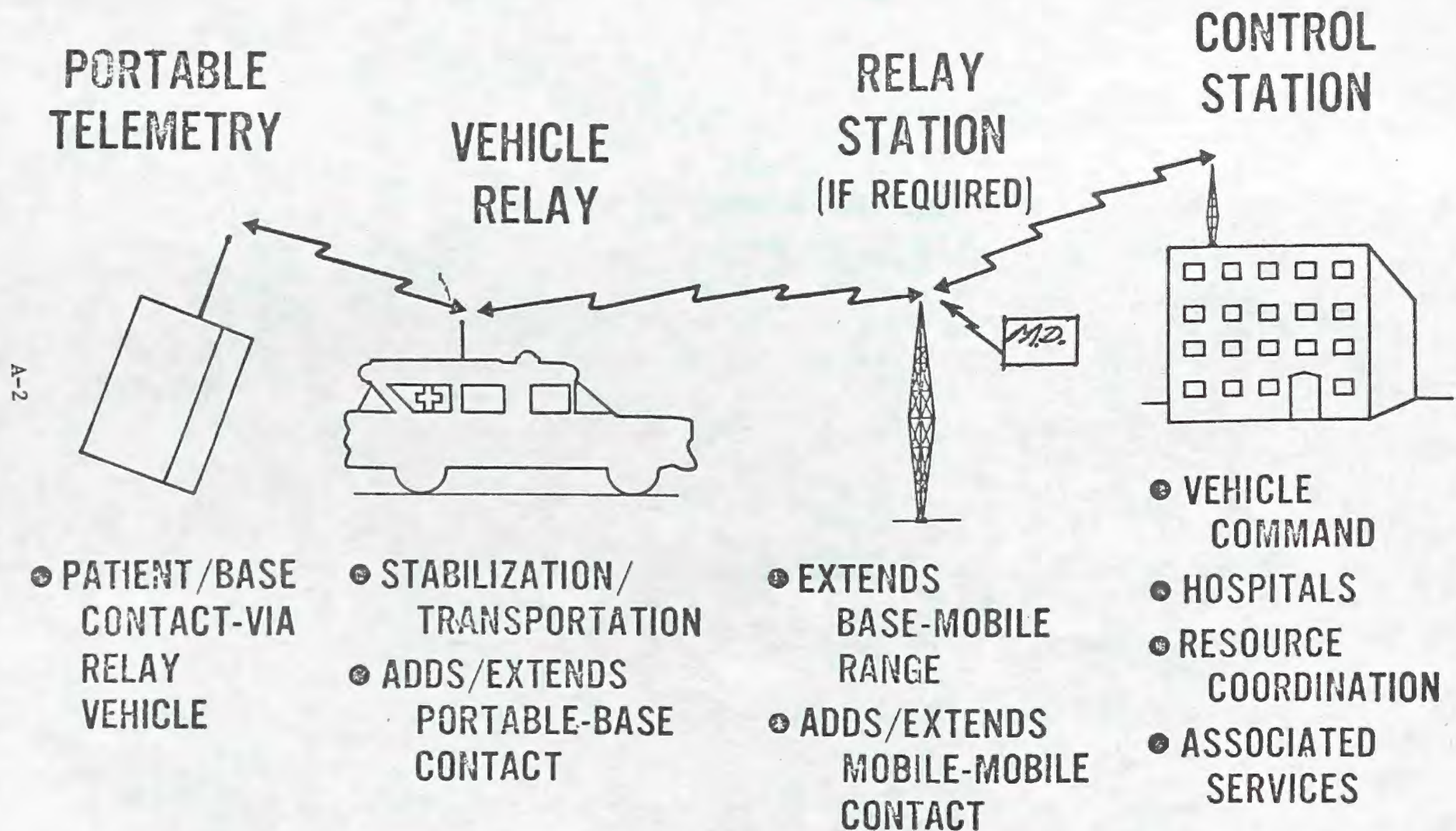
## APPENDIX A

This Appendix contains five diagrams indicating various concepts for basic Emergency Medical Service (EMS) Systems communications. It is anticipated that decisions as to which concept or combination of concepts that would be implemented in a particular state, regional, or local area would be made by the local authorities therein.

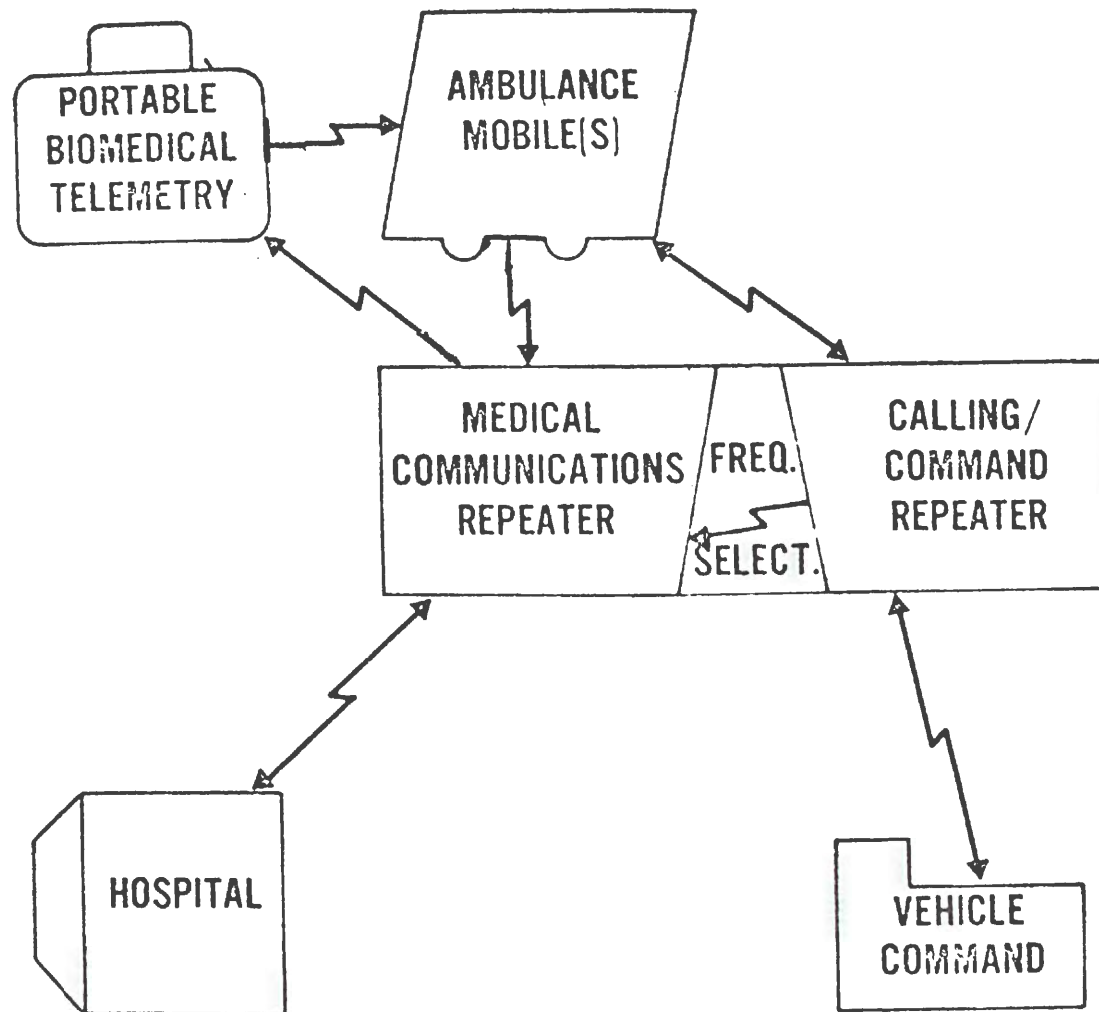
Obviously EMS Systems communications can be developed in a variety of ways. The diagrams in this Appendix are intended to illustrate some examples only.



# ELEMENTARY EMS COMMUNICATIONS



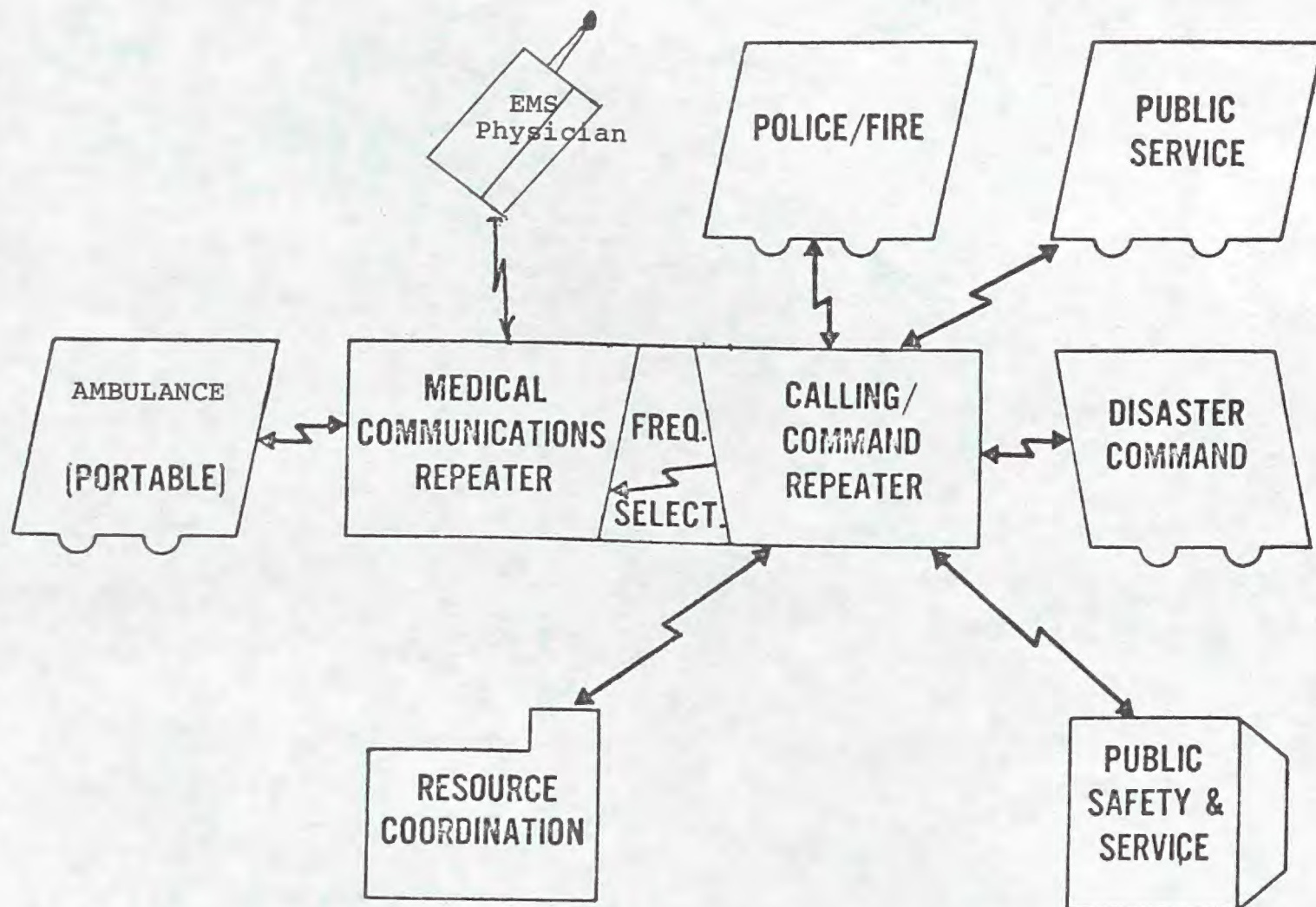
EXAMPLE OF EMS COMMUNICATIONS  
FOR  
AMBULANCE OPERATION



EXAMPLE OF COMMUNICATIONS

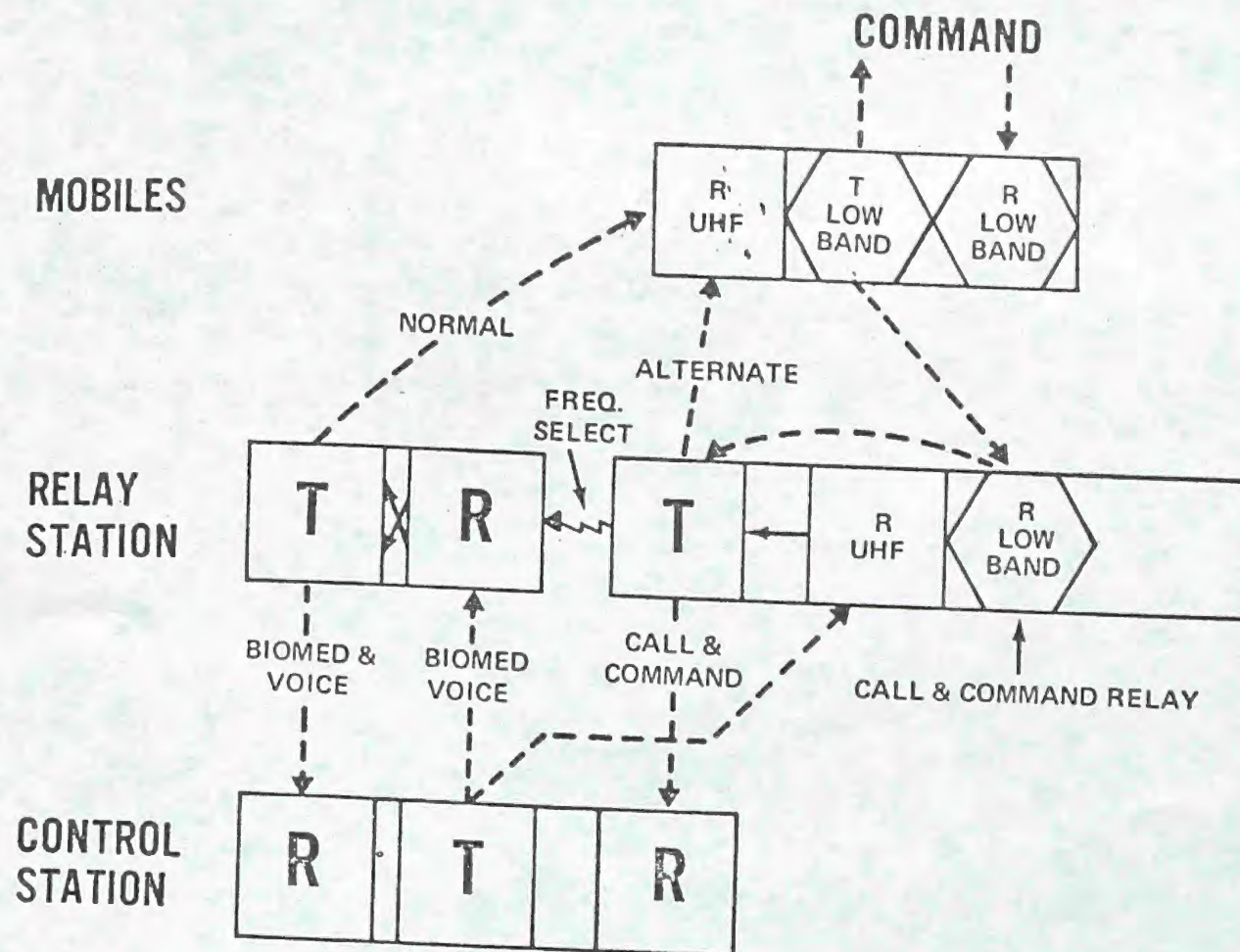
FOR

INTERFACE COORDINATION





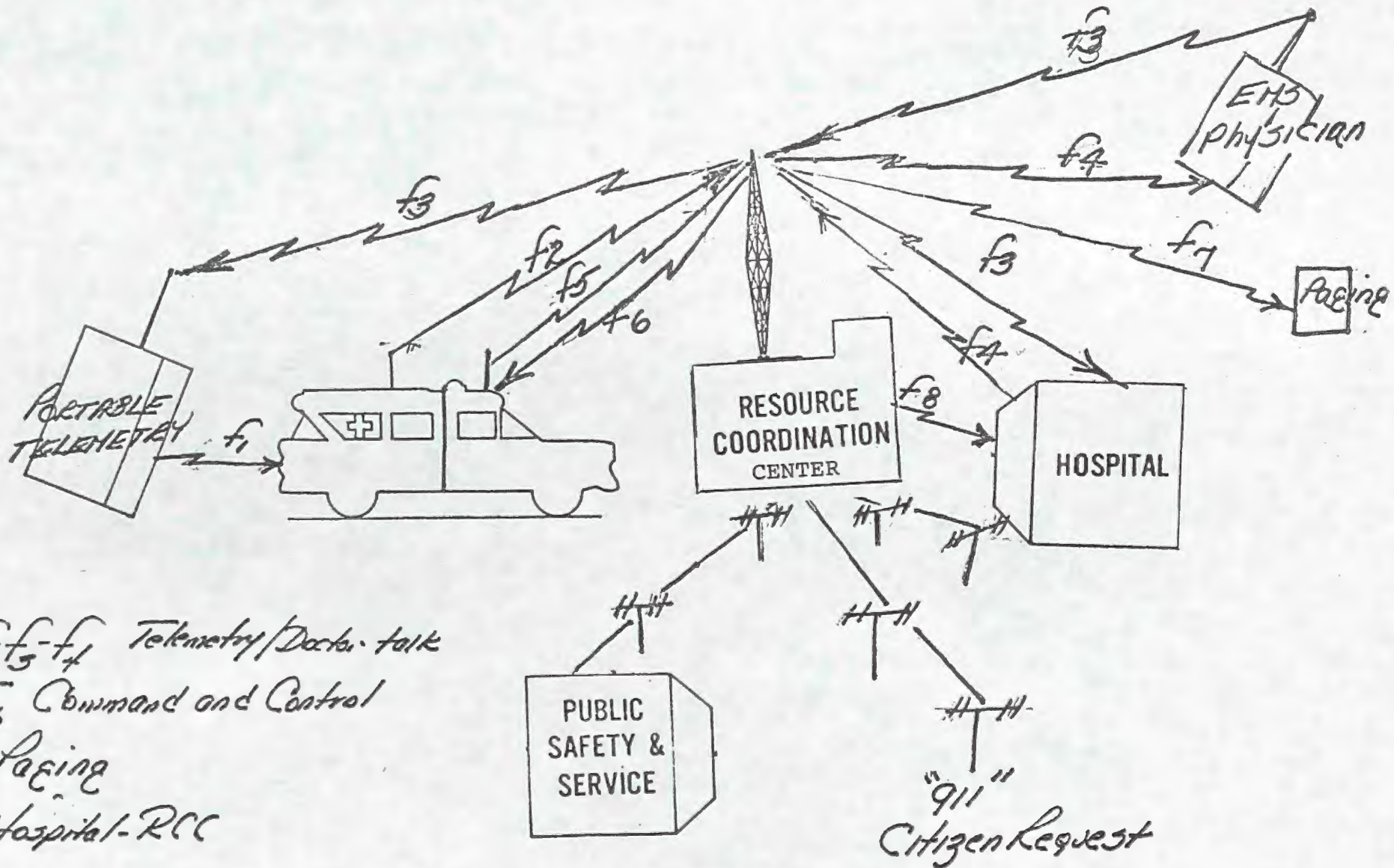
EXAMPLE OF  
TRANSITIONAL SYSTEM ACCOMMODATING  
LO BAND MOBILES



Requires addition of UHF  
Receiver in Mobile

EXAMPLE OF  
EMS COMMUNICATIONS  
FOR AN  
URBAN AREA

A-6





NOTE: The material in this appendix is quoted from DHEW Publication No. (HSM) 73-2003 of August 1972.

## APPENDIX B

### 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.



*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 available 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.

**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	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



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 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 4C (Continued)**

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**

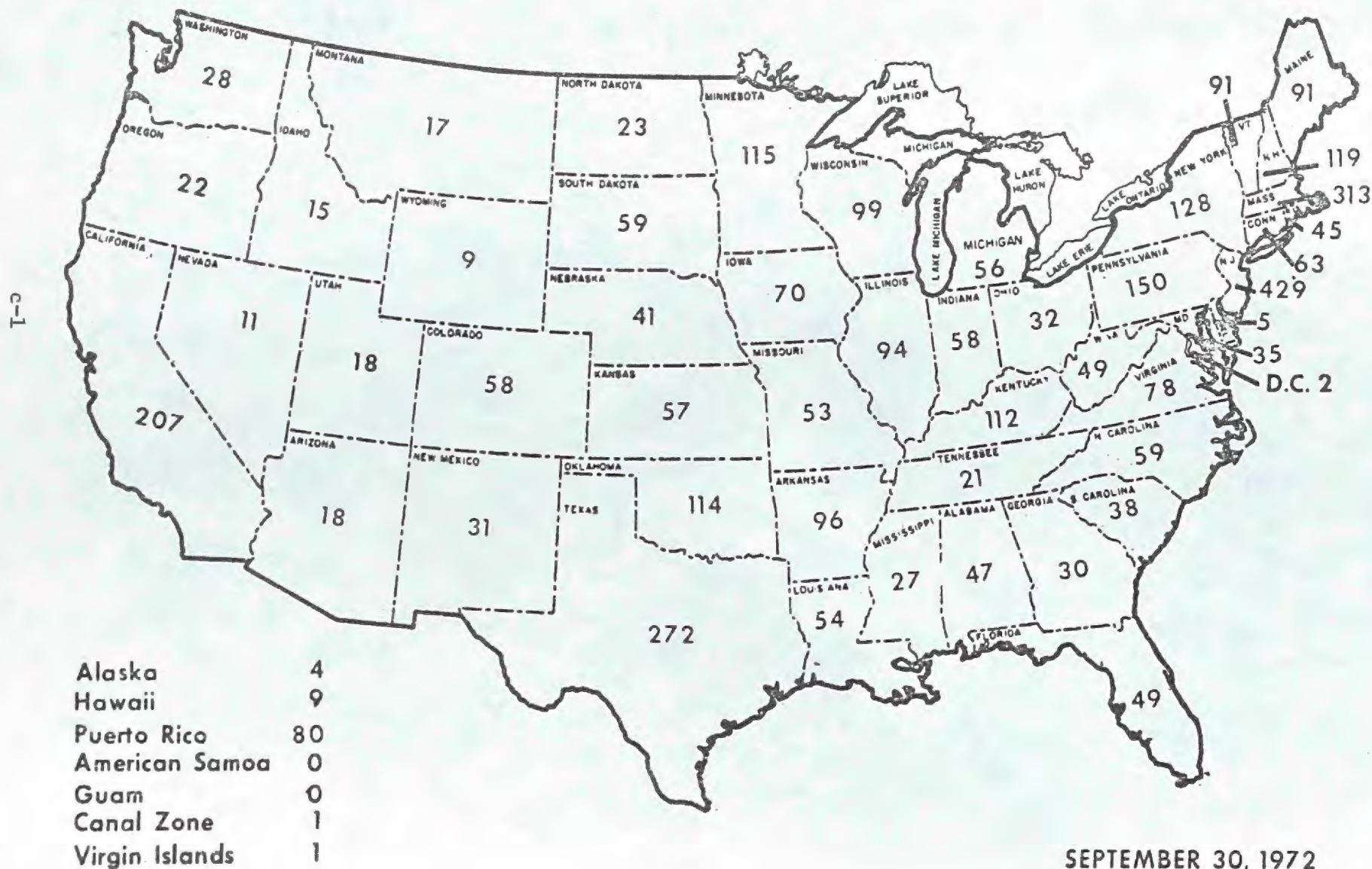
Manufacturers offer communications components for land mobile radio service which have common characteristics: virtually all use frequency modulation (FM) and all are almost completely solid state. (Transistors and Integrated Circuits (IC) are used wherever possible).

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.



# STATE & LOCAL EMERGENCY OPERATING CENTERS COMPLETED AND IN PROCESS

3,803



APPENDIX C

SEPTEMBER 30, 1972



D

3 OCT 1974

Honorable Lawton Chiles  
United States Senate  
Washington, D.C. 20510

Dear Senator Chiles:

This will acknowledge your request of September 16, 1974 that we bring you up-to-date on the progress of Emergency Medical Services (EMS). Since January 1974, both Federal and local governments have taken substantial steps toward the full implementation of EMS. Based on the OTP recommendations referred to in your letter, for example, the FCC has issued a Report and Order which allocates nearly 40 VHF and UHF frequencies for use only by emergency medical communications. The July 16, 1974 Report also encourages local initiative in the development of EMS programs. I have enclosed for your information a copy of that Report and Order.

OTP, in the meantime, continues to provide policy guidance for states and localities. Of particular mention are the on-going efforts of this Office to coordinate the promulgation of standards for medical telemetry, the interactive voice and data system which will enable doctors to receive electrocardiograph print-outs on patients-in-transit and to converse directly with the ambulance from the hospital. The group of government, industry and medical representatives convened by OTP under the Interdepartment Radio Advisory Committee plans to make its recommendations for telemetry standards to the Interagency Committee on Emergency Medical Services (ICEMS) by early 1975.

Appointment of all members of ICEMS, created by the Emergency Medical Systems Services Act of 1973, was completed just this week. By statute, ICEMS is comprised of representatives of OTP, the FCC and other government agencies and the public under the leadership of HEW. It is charged with the evaluation of Federal

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EMS programs. HEW has, to meet its own responsibility in this area, appointed a director for its new division of EMS services, Dr. David Boyd.

I am pleased that the people of your state have demonstrated over the past year such a high level of interest in EMS. If I can be of further assistance to them or to you, please let me know.

Sincerely,



John Eger  
Acting Director

Enclosure

E

OFFICE OF TELECOMMUNICATIONS POLICY

EXECUTIVE OFFICE OF THE PRESIDENT

WASHINGTON, D.C. 20504

January 31, 1975

DIRECTOR

Honorable Harold O. Buzzell  
Administrator  
Health Services Administration  
Public Health Service  
Rockville, Maryland 20852

Dear Mr. Buzzell:

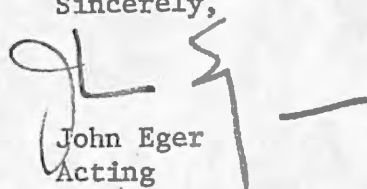
In June 1974, this office was requested by the National Highway Traffic Safety Administration to develop a federal standard for biomedical telemetry. Responsibility for developing this standard was referred to the Interdepartment Radio Advisory Committee (IRAC).

At its meeting on January 21, 1975, the IRAC endorsed the enclosed recommended minimum biomedical telemetry standard for Emergency Medical Services (enclosure 1). Also enclosed is a preliminary report providing background and documentation supporting the development of the standard (enclosure 2).



Preliminary to being incorporated into the OTP Manual of Regulations and Procedures for Radio Frequency Management, the aforementioned standard has been forwarded to the FCC for action looking toward incorporation into the FCC Rules (enclosure 3).

The assistance of HEW's staff in the development of this standard is greatly appreciated.

Sincerely,

  
John Eger  
Acting

Enclosures



F

OFFICE OF TELECOMMUNICATIONS POLICY

EXECUTIVE OFFICE OF THE PRESIDENT

WASHINGTON, D.C. 20504

January 31, 1975

DIRECTOR

Honorable James B. Gregory  
Administrator  
National Highway Traffic  
Safety Administration  
Department of Transportation  
Washington, D.C.

Dear Mr. Gregory:

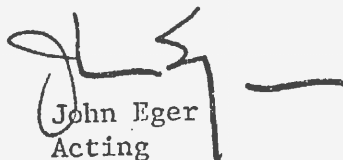
Your letter of June 6, 1974, requested this Office to develop a federal standard for biomedical telemetry. Our letter of June 14, 1974 indicated this matter was referred to the Interdepartment Radio Advisory Committee (IRAC) for action.

At its meeting on January 21, 1974, the IRAC, endorsed the enclosed recommended minimum biomedical telemetry standard for Emergency Medical Services (enclosure 1). Also enclosed is a preliminary report (enclosure 2) providing background and documentation supporting the development of the standard.

Preliminary to being incorporated into the OTP Manual of Regulations and Procedures for Radio Frequency Management, the aforementioned standard has been forwarded to the FCC for action looking toward incorporation into the FCC Rules (enclosure 3).

The assistance of the National Highway Traffic Safety staff in the development of this standard is greatly appreciated.

Sincerely,

  
John Eger  
Acting

Enclosures

G



OFFICE OF TELECOMMUNICATIONS POLICY

EXECUTIVE OFFICE OF THE PRESIDENT

WASHINGTON, D.C. 20504

January 31, 1975

DIRECTOR

Honorable Richard E. Wiley  
Chairman  
Federal Communications Commission  
Washington, D.C. 20554

Dear Mr. Chairman:

In October 1973, this Office forwarded to the Commission a report dealing with the spectrum support necessary to upgrade and provide for Emergency Medical Service Communications. This served as a basis for making common frequencies available for both Government and non-Government emergency medical services.

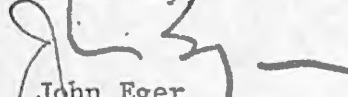
The Emergency Medical Service Act of 1973 made certain funds available for the development of comprehensive area emergency medical service systems. The Departments of Health, Education and Welfare (HEW) and Transportation (DOT) are charged with implementing the provisions of this act. In June of 1974, the Administrator, National Highway Traffic Safety Administration, requested this Office to develop a recommended standard for biomedical telemetry; such standard to facilitate compatibility and interoperability among emergency medical telecommunication systems, regardless of geographical area or units involved. DOT and HEW are holding funding of systems in abeyance, pending the promulgation and implementation of such a standard on a nationwide basis.

At its meeting of January 21, 1975, the IRAC endorsed the enclosed recommended minimum standard for emergency medical telemetry for promulgation within the Federal Government (enclosure 1). The IRAC effort had the benefit of close coordination and inputs from the Commission's staff, cognizant Government agencies (DOT, HEW, etc.), and segments of industry and the medical profession. Enclosure 2 is a preliminary report which provides background and documentation supporting the development of the above standard.

This standard is hereby forwarded to the Commission for appropriate action looking toward incorporation into the FCC Rules. Since the frequencies available nationally for emergency medical services are shared between the Government and non-Government, promulgation within the Federal Government is being held in abeyance pending such incorporation.

In view of the foregoing your earliest consideration of this matter would be appreciated.

Sincerely,

  
John Eger  
Acting

Enclosures

*RECOMMENDED*  
BIOMEDICAL TELEMETRY STANDARD  
FOR  
EMERGENCY MEDICAL SERVICE COMMUNICATIONS

Abstract

This standard defines the minimum requirements for a multiplex or non-multiplex voice/telemetry channel to assure compatibility and interoperability of portable physiologic monitoring equipment with both radio and telephone equipments and hospital emergency and display devices. Specifically, it defines a National telemetry subcarrier frequency within the voice band which is compatible with both radio and telephone transmission characteristics. This standard applies only to voice and telemetry modulation-demodulation electronic instrumentation used in emergency medical care.

Introduction

1.0 General

The portable biomedical equipment used by EMT (paramedical) personnel in advanced life support units (LSU) will generally include as a minimum, an ECG monitor, signal processing electronics, a portable radio transceiver, an acoustic telephone coupling means, and a cardiac defibrillator. The telemetry package must provide the capability of transmitting voice and/or ECG (or other physiological) signals via radio or telephone from the emergency site to a supervisory station at an appropriate Hospital Emergency Area. The capability of establishing a compatible interface with the telephone system is part of the equipment.

The IRAC Committee responsible for the development of this standard has had cooperation from the FCC, the American Heart Association, the Electronic Industries Association, National Communications System, and Industry.

## 2.0 Scope

This standard applies only to voice and telemetry sub-carrier modulation-demodulation electronic instrumentation used in emergency medical care. References are provided which indicate applicable standards for the other components of the biomedical package. This standard is intended to define only those parameters which are critical to assure compatibility and interoperability of equipments. Features beyond these minimum performance standards are optional and subject to negotiation between suppliers and system procurement agencies.

## 3.0 Purpose

This standard has been developed to assure the compatibility and interoperability of Biomedical Telemetry systems as part of Emergency Medical Services. Since many independent authorities (State, Regional, City, etc.) are planning EMS systems, it is important that a common standard be adopted to assure effective communications when equipments from different systems are required to interface. Telemetry systems may selectively allow the use of any other subcarrier or method of modulation but <sup>it</sup> must include the standard subcarrier of 1400 Hz.

## 4.0 Reference Documents (See list in Appendix).

## 5.0 Definitions

For the purpose of this standard, biomedical telemetry means telemetering of a vital life sign, such as an electrocardiogram, from an emergency patient located outside of a hospital (emergency site, ambulance, . . .) to a supervisory control point (generally located in a hospital).



## 6.0 Requirements

For Emergency Medical Services, a two-way communications link between the site of the emergency patient and a supervisory control point is required. Provision for one-way transmission of a physiologic telemetry signal from the patient to the control point is desirable and may become a requirement. The telemetry signal may be transmitted via a non-multiplexed or multiplexed channel. Requirements must be met over any combination of radio or wire (telephone) communication paths.

A standard is required to define these parameters needed to insure interoperability and compatibility between systems and components of systems.

## 7.0 Technical Parameters

The following technical parameters are hereby standardized to assure interoperability and compatibility of Emergency Medical Services Biomedical Telemetry Communication Systems:

### 7.1.1 Subcarrier

Telemetry shall be accomplished by FM modulation of a  $1400 \text{ Hz} \pm 2\%$  carrier. A positive signal shall cause an increase in subcarrier frequency.

### 7.1.2 Deviation

Deviation of the subcarrier for ECG telemetry shall be within the range of  $30 \text{ Hz/mV}$  to  $50 \text{ Hz/mV}$  referred to the patient input signal. Maximum deviation shall be  $\pm 250 \text{ Hz} \pm 10\%$ .

### 7.1.3 Multiplex Operation

Multiplexing of voice and telemetry signals shall be accomplished by a linear summation of voice and telemetry with filtering provided so as to attenuate voice signals by

13 dB in the range from 1150 to 1650 Hz. The peak amplitudes of the voice and telemetry signals shall each be  $50\% \pm 10\%$  of the peak amplitude of the composite signal. The amplitudes of the voice and telemetry signals shall be limited suitably prior to summing so that the composite signal will never exceed a specified limit or the voice exceed 50% of the total signal. This is to prevent clipping by transmission through FM radio modulators or the public telephone system. Information on clip levels is obtained from EIA and AT&T references cited in the Appendix.

#### 7.1.4 Non-multiplex Operation

All equipment capable of transmitting or receiving multiplex signals must be capable of transmitting or receiving non-multiplex signals in which only voice or telemetry are transmitted. The level of either voice or telemetry signals in the non-multiplex mode should be the same as the level of the composite multiplex signal..

#### 7.1.5 Demodulation Equipment Sensitivity

The telemetry demodulation equipment should accept standard telephone line levels and operate within specifications for signals in the range -25 dBm to +5 dBm.

#### 7.1.6 Telemetry Frequency Response

The system should be designed so that the ECG signal after telemetry can be displayed with a frequency response (3 dB) of at least 0.1 to 40 Hz.

#### 7.2 Calibration

The telemetry system shall be calibrated using a 1 mV  $\pm 5\%$  square-wave calibration signal to permit appropriate gain and deflection sensitivities of recording instruments to be adjusted.

### 7.3 Radio Specifications

Radio systems must conform to the FCC Rules and Regulations and the EIA standards referenced in the Appendix.

### 7.4 Telephone Interface

Telephone interface connections must be in accordance with filed tariffs. These may include the AT&T Technical References indicated in the Appendix.

### 7.5 Multiplex/Non-multiplex Compatibility

All equipment capable of transmitting/receiving a multiplex signal must be capable of transmitting/receiving a non-multiplex signal.



## APPENDIX

### References

- (1) Federal Communications Commission, Rules and Regulations - Medical Communication Services: Part 2 - Frequency Allocations and Radio Treaty Matters; General Rules and Regulations; Part 89 - Public Safety Radio Services.
- (2) OTP Manual of Regulations and Procedures for Radio Frequency Management. (Particularly - Minimum Standards for Land-Mobile Radio Services.)
- (3) Standards for Cardiopulmonary Resuscitation and Emergency Cardiac Care, Supplement to The Journal of the American Medical Association, February 18, 1974, Volume 227, No. 7.
- (4) Standard for DC Defibrillator Safety and Performance, A Draft Standard nearing completion by D-HEW, Public Health Service, Food and Drug Administration FDA-MDS-021-0001.
- (5) Electronic Industries Association Land-Mobile Standards: RS152B Transmitter, RS 204 Receiver, RS 210 Terminating and Signaling Equipment, RS 220 Continuous Tone Squelch, RS 237 Systems, RS 316 Portables, RS 329 Base Station Antennas, RS 374 Signalling, and RS 388 Test Conditions.
- (6) AT&T References: Bell Laboratories Record, Volume 44, No. 2, Feb. 1966 by J. L. Crouch, J. L. Faulkner, O. Loosme, and L. R. Putman, "Electrocardiogram by Telephone." Bell System Technical Journal, Dec. 1969, pg. 3337, "Physical and Transmission Characteristics of Customer Loop Plant" by Philip A. Gresh.

Bell System Technical References: Pub 41004 - Transmission Specifications for Voice Grade Private Line Data Channels; Pub 41005 - Data Communications Using the Switched Telecommunications Network; Pub 41007 - 1969-70 Switched Telecommunications Network Connection Survey (Reprints of Bell System Technical Journal Articles); Pub 41008 - Analog Parameters Affecting Voiceband Data Transmission Description of Parameters, October 1971; Pub 41803 - Acoustical Coupling for Data Transmission - Preliminary.

Also: IEEE Transactions on Communication Technology, Vol. COM-19, No. 3, page 246, June 1971, "Some Design Considerations for Narrowband Medical Telemetry over the Switched Message Network" by R. N. Watts.

(7) Core Vocabulary: "Estimate of Inherent Channel Capacity", Edith Corlis, Journal of Acoustical Society of America, Vol. 50, No. 2, Part 2, 1971, pp. 671-677.

(8) Recommendations for Standardization of Instruments in Electrocardiography and Vectorcardiography.. Report of Subcommittee on Instrumentation Committee in Electrocardiography, American Heart Association, IEEE Trans. Biomed. Eng 14:60, 1967.

OFFICE OF TELECOMMUNICATIONS POLICY  
EXECUTIVE OFFICE OF THE PRESIDENT  
WASHINGTON, D.C. 20504

PRELIMINARY REPORT OF  
BIOMEDICAL TELEMETRY STANDARD  
FOR  
EMERGENCY MEDICAL COMMUNICATIONS



Participants in  
the EMS-TS Working Party  
(Alphabetical by Group)

FEDERAL

National Communication Systems	Dennis Bodson
Dept. of Health, Educ. & Welfare	A. H. Griffiths
Veterans Administration	Raymond D. Holt
Office of Telecommunications	Joseph A. Hull
Veterans Administration	Dr. Francis Jackson
Office of Telecommunications Policy	Donald Jansky
Defense Communications Agency	Charles B. Orr
Veterans Administration	Lawrence S. Palmer
Federal Communications Commission	Alvin W. Paul
Federal Communications Commission	Frank L. Rose
Food and Drug Administration	David A. Segerson
Dept. of Commerce	Frederick Sera
Dept. of Transportation	S. J. Stephany

STATE

Florida	Larry Connell
Wisconsin	James C. Houge

HEART/HOSPITAL ASSOCIATIONS

American Heart Association	Alan Berson
American Hospital Association	G. E. Heib
American Hospital Association	Courtland E. Newman, Jr.

INDUSTRY

Motorola (EIA)	William M. Borman
Telecare, Inc.	Roy Gage
Physio-Control	Mark Gausman

Motorola (EIA)  
Pioneer Medical Systems, Inc.  
Biocom, Inc.  
Spectra Assoc., Inc.  
Motorola, Inc. (EIA)  
Atlantic Research Corp.  
RCA Corp. (EIA)  
Advanced Technology Systems, Inc.  
E. F. Johnson, Co.  
Advanced Technology Systems, Inc.  
Advanced Technology Systems, Inc.  
Fairfield Medical Products  
Electronic Industries Assoc.  
Fairfield Medical Products Corp.  
Motorola, Inc. (EIA)  
General Electric Co.  
Bell Telephone

William R. Hackett  
Leslie G. Hammer  
Harve Hanish  
David Hodgins  
Dr. Gordon James  
Jim Landoll  
Stuart Meyer  
A. D. Owen  
Bruce Pontius  
G. W. Renner  
J. J. Renner  
Ernst F. Schindele  
John Sodolski  
Jerry Wade  
Don Walker  
L. C. Watkins  
Robert N. Watts

## Preface

A request was received from the Administrator, National Highway Traffic Safety Administration, U.S. Department of Transportation (Dated June 6, 1974) by the Director, Office of Telecommunications Policy for the development of a bio-medical telemetry standard. This request cited the efforts of the New Jersey Hospital Association Radio Committee to develop a voluntary standard through the cooperation of four major manufacturers of emergency medical service equipments and since this was unsuccessful, their resultant request to the Electronic Industries Association for support in the development of such a standard. The EIA indicated interest and a desire to participate in a government standardization effort. The Interagency Committee on Emergency Medical Services Systems Act of 1973 (P.L. 93-154) also indicated need for this standard.

The above request was made on behalf of the Department of Health, Education and Welfare and the Department of Transportation. Dr. Whitehead, Director of OTP, responded to this request on June 6, 1974, accepting the responsibility and indicating his referral of this matter to the Interdepartment Radio Advisory Committee for action.



## INTRODUCTION

The Interdepartment Radio Advisory Committee (IRAC) at its meeting on June 25, 1974, referred a request (IRAC Doc. 16969/1-2.7.13) signed by the Director of OTP, and documentation to the Technical Subcommittee (TSC) of IRAC for action. This request was to develop a standard for biomedical telemetry. A Working Party of the Standards Working Group of the TSC was formed and a preliminary meeting was held on July 10 to initiate this effort.

A following statement of the problem was contained in the material referred to this committee:

*"The Department of Transportation's activities in implementing Highway Safety Program Standard No. 11, Emergency Medical Services, the Robert Wood Johnson Foundation's \$15 million national competitive grant program for EMS communications, and more recently the EMS Systems Act of 1973, have made considerable funds available and prompted effort toward the planning and establishment of comprehensive EMS systems. Communications are an essential part of this development. FCC Docket 19880 recognizes the need for additional EMS frequencies and an allocation structure to permit mutual aid and support between systems. However, the present lack of standards for telemetry modulation techniques works against these efforts. A recent survey of seventeen mobile portable medical telemetry equipments available for remote ECG transmissions reveals that they employ nine different modulated tone or subcarrier frequencies. Two manufacturers offer multiplexing modulators combining voice with ECG data. Even these use different subcarrier frequencies. Further, only three of the seventeen use a standard amount of tone frequency deviation per volt of modulating signal. The need for standardization is obvious and urgent if the EMS systems developing across the nation are to be compatible."*

The work statement adopted by this Emergency Medical Services Biomedical Telemetry Standard (EMS-TS) Working Party is given in Appendix A. In brief, the committee was to identify related standards which are applicable to biomedical telemetry applications, determine an optimum subcarrier frequency for voice/telemetry transmission on radio and telephone lines and if feasible recommend one subcarrier frequency for multiplex, non-multiplex and radio or telephone transmission, appropriate deviation sensitivity and direction to assure compatibility and interoperability, and to determine calibration procedures and waveforms which should be incorporated into a standard.

The EMS-TS Committee accepted a time constraint of producing a Committee approved standard for recommendation to IRAC by the end of the current calendar year. This time schedule is in keeping with the urgency of the release of supporting funds in the emergency medical services field, particularly by the Dept. of Health, Education and Welfare and Dept. of Transportation during the current fiscal year.

Two particularly useful documents which provided background for the EMS-TS Committee's work were the OTP report "Communications in Support of Emergency Medical Services" (EMS-8) and the FCC Notice of Proposed Rule Making, Docket 19880 (EMS-6). The first report was prepared by IRAC Ad Hoc 120 Committee and presents recommendations for the establishment of special frequency allocations for emergency medical services. It was forwarded to the FCC on October 3, 1973, and the above docket was released from FCC in December, 1973, in response to this recommendation. More than 200 formal comments were received by the FCC in response to this docket and related dockets, namely 19576 and 19643. Parts 2 and 89 of the FCC Rules and Regulations were amended in accordance with the Ad Hoc 120 report and these comments, effective August, 1974.

This ruling makes available for Government and non-Government shared use ten UHF frequency pairs for exclusive use in EMS and five UHF frequencies shared with radio call box systems for use in biomedical telemetry/voice systems.

The Committee invited participation from all federal agencies interested in this topic as well as State government representatives, representatives of the American Hospital Association, private industries, and particularly the Electronic Industries Association which subsequently accepted the commitment to make technical recommendations to the EMS-TS and coordinate their response with those industries who provide end-deliverable hardware for biomedical telemetry applications.

A particular concern of the Committee was that of establishing current and future needs as viewed by the medical community. The Veteran's Administration representative agreed

to poll a cross-section of this medical community to determine their response to an inquiry regarding the needs for biomedical telemetry both now and in the foreseeable future as it would apply to emergency medical services.

Several State governments are in the process of establishing emergency medical services throughout their jurisdictions and have supported studies of systems for emergency medical services. Inputs from these studies were solicited as valuable resources to the Committee. Five general meetings for the purpose of gathering information, discussion and exchange of information, positions, and recommendations were held. A Summary Record of each meeting was prepared and distributed to all attendees as well as to all parties contacting the Committee for information.

The following report represents the findings of the EMS-TS Committee in response to the work statement of Appendix A. A brief background of EMS requirements is presented. The technical factors which bear on the development of the required standard are described. The conclusions and recommendations of the committee are summarized, and a draft standard prepared by the committee is presented in the Appendix B of this report. This recommended standard represents a compromise of many factors but provides a means by which all biomedical telemetry systems can and will be made compatible and interoperable as emergencies require.



## BACKGROUND

Considerable background information in the form of reports, related standards and inputs from EMS communities of Federal and State governments, Medical Associations and Industry has been gathered in preparing this recommended Biomedical Telemetry National Standard. Excerpts and conclusions from that body of information which provide appropriate background for defining the requirements for biomedical communications with telemetry applicable to EMS are presented here with appropriate references.

## GENERAL CONSIDERATIONS

The following excerpts are taken from the Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECG) (EMS-13):

It has been estimated that about one million persons in the United States experience acute myocardial infarction each year. More than 650,000 die annually of ischemic heart disease. About 350,000 of these deaths occur outside the hospital, usually within two hours after the onset of symptoms. Thus, sudden death from heart attack is the most important medical emergency today. It seems probable that a large number of these deaths can be prevented by prompt, appropriate treatment. In addition, many victims who die as a result of such accidental causes as drowning, electrocution, suffocation, drug intoxication, or automobile accidents could be saved by the prompt and proper application of cardiopulmonary resuscitation and emergency cardiac care. This can best be assured by the victim's entry into an organized and effective system of emergency cardiac care.

Emergency cardiac care (ECC) is an integral part of a total, community-wide comprehensive system of emergency medical services (EMS) and should be integrated into the total system response capability for all types of life-threatening situations. The system must provide proper identification and appropriate action for all medical emergencies. However, the standards presented here concern themselves only with the principles and concepts of emergency cardiac care.

### Emergency Cardiac Care

In this statement, emergency cardiac care includes all the following elements:

1. Recognizing early warning signs of heart attacks, preventing complications, reassuring the victim, and moving him to a life support unit without delay.
2. Providing immediate basic life support at the scene, when needed.
3. Providing advanced life support as quickly as possible.
4. Transferring the stabilized victim for continued cardiac care.

Emergency transportation alone, *without life support*, does not constitute emergency cardiac care. Although transportation is an important aspect, the major emphasis of ECC is life support through stabilization of the victim *at the scene* of the life-threatening emergency. Stabilization must be maintained during transport of the victim to the site of continuing cardiac care.

Within the definition of emergency cardiac care there are two other important concepts that must be clarified—basic life support and advanced life support.

*Basic Life Support* is an emergency first aid procedure that consists of the recognition of airway obstruction, respiratory arrest and cardiac arrest, and the proper application of cardiopulmonary resuscitation (CPR). CPR consists of opening and maintaining a patent airway, providing artificial ventilation by means of rescue breathing, and providing artificial circulation by means of external cardiac compression.

*Advanced Life Support* is basic life support plus use of adjunctive equipment, intravenous fluid lifeline (infusion), drug administration, defibrillation, stabilization of the victim by cardiac monitoring, control of arrhythmias, and postresuscitation care. Also it includes establishing necessary communication to assure continuing care, and maintaining monitoring and life support until the victim has been transported and admitted to a continuing care facility. Advanced life support requires the general supervision and direction of a physician who assumes responsibility for the unit. It must have adequate communications on a 24-hour-per-day basis. This may necessitate appropriate legislation or standing orders for implementation.



To be effective, emergency cardiac care should be an integrated part of a total community-wide emergency care and communication system. It is to be based on local community needs and resources and be consistent with state and national policies. The success of such a community-wide system requires multijurisdictional participation and planning to ensure operational, as well as equipment, compatibility within that system and between adjacent systems. The initial planning of a community-wide system should be under the direction of a local community advisory council on emergency services charged with the responsibility of assessing community needs and resources, defining priorities, and planning to meet those needs. Critical evaluation of operating policies, procedures, statistics, and case reports must be a continuing responsibility of state or local governments or the council. Such an evaluation should provide the basis for modification and evolution of the system.

#### Cardiac Monitoring

Electrocardiographic (ECG) monitoring should be established immediately on all patients who present symptoms of suspected heart attack or sudden collapse.

Most sudden deaths following acute myocardial infarction are due to electrical derangement of the rhythm of the heart (dysrhythmias). Susceptibility to electrical derangement is greatest immediately following and several hours after myocardial damage or severe ischemia. It is during this critical and unstable period that patients should be under continuous and critical monitoring.

Although rhythm changes may occur abruptly and without warning, potentially lethal situations usually can be prevented by early detection and prompt treatment.

Each person providing advanced life support must have adequate training and testing to establish his capability of dysrhythmia detection and treatment. Once trained, his competency must be reenforced and examined continually. This can be accomplished through regularly scheduled assignment to hospital patient care, such as in the emergency department, coronary care unit, intensive care unit, or operating room.

ECG monitoring is a vital step in the prevention of cardiac arrest in patients with acute myocardial infarction. Personnel providing advanced life support must be familiar with monitoring equipment, including its problems and artifacts. They also must be capable of recognizing, at a minimum, the following electrocardiographic dysrhythmias:

1. Cardiac standstill (ventricular asystole).
2. Bradycardia (rate of less than 60 per minute).
3. The difference between supraventricular and ventricular rhythms.
4. Premature ventricular contractions (frequency, multifocal, and R on T).
5. Ventricular tachycardia.

#### 6. Ventricular fibrillation.

#### 7. Atrioventricular blocks of all degrees.

#### 8. Atrial fibrillation and flutter.

In addition to recognizing these dysrhythmias, all personnel must be familiar with the potential dangers inherent in each waveform and with the therapeutic regimen that is required when any one of them is present.

In situations in which the initial emergency problem is a cardiac arrest, CPR steps and techniques outlined under "Basic Life Support" should be initiated. As quickly as possible thereafter, ECG electrodes should be applied. For this purpose, a monitor-defibrillator with combination ECG electrode-defibrillator paddles is recommended. These ECG electrode-defibrillator paddles are applied to the chest and an immediate determination of the cardiac rhythm may be made.

**Emergency Medical Communications.**—Emergency medical communications is a vital element that must be integrated into any system of emergency medical services for it to function effectively. An adequate communication network for an ECC response is but one facet of total emergency medical services, but the communications system that supports emergency cardiac care also should support emergency medical service as a whole.

The communications system will help preserve life and minimize morbidity at the scene, during transit, and in the hospital emergency department. There should be careful coordination of equipment and frequencies, including subcarriers for telemetry, to facilitate both compatibility of subsystems at their interface and effective regionalization in the future.

Agreements for sharing communication channels and other forms of coordination are necessary. Emergency medical communications should be integrated into the emergency system and coordinated with such other agencies as fire, police, highway patrol, Coast Guard, and Military Assistance to Safety and Traffic.

## Part IV.—Life Support Units

A life support unit (LSU) is an integral part of a stratified system for cardiac care that is strategically located, properly identified, and has specific capability of rendering life support to patients with cardiopulmonary emergencies. Life support units can be either basic or advanced units. *Basic life support units* exist wherever there are individuals trained in CPR techniques and should be found at all patient care stations of hospitals, medical and dental offices, factories, public office buildings, and within homes and schools. *Advanced life support units*, in addition, must be able to monitor cardiac rhythms and treat cardiac dysrhythmias.

The Conference has set minimum standards for advanced life support units.

### Standards for LSU'S

**Communications.**—At a minimum, the LSU must be able to communicate directly with the agency or persons who are bringing the patient to the unit and with the facility to which they transfer the patient for continuing care. It is recommended that the LSU also be in contact with the central coordinating and dispatching authority.

### Standards for Mobile LSU'S

**Communications.**—At a minimum, two-way voice communications with the central coordinating and dispatching authority and with the continuing care unit to which the patient will be delivered is necessary initially. The unit therefore must possess the capability of communicating with one or more continuing care facilities in order to give:

1. Notification of patient's expected time of arrival.
2. Notification of patient's condition.
3. Confirmation of acceptance by facility for continuing care.
4. Consultation regarding care.

As a later phase, there can be augmentation with physician's consultation and, when appropriate, ECG telemetry offers the advantage of remote monitoring and rhythm consultation, provided that medical consultation is on-line and a part of the system.



## BIOMEDICAL SIGNATURES

In a draft report (dated 10/13/72) entitled "Emergency Medical Communications," by the Subcommittee on Emergency Medical Communications and prepared with the aid of the Committee on the Interplay of Engineering with Biology and Medicine, National Academy of Engineering (EMS-27) the following excerpt describes the requirement for ECG telemetry:

*"Although very few, if any, are currently using it, this concept of mobile, physician-based medical direction offers much promise for small communities or rural areas where hospital emergency departments and doctors are not constantly available, and where patient transport times can be as long as several hours. In urban areas, although transport times are usually shorter, the capability and procedures for providing physician-directed treatment must be available.*

*To perform this task, the ambulance EMT's require two-way voice communications with a physician. Further, advanced treatment techniques require that the physician have access to physiological data as well as the EMT's visual observations of the patient's condition. The electrocardiogram (ECG) is the only type of continuous data which needs to be provided in its original form to the consulting physician. This requires telemetry communications from the patient (e.g. a portable transmitter) and from the ambulance to the physician. Vital signs such as blood pressure, respiration rate, and pulse can be easily determined by the EMT. They require no special communications equipment other than a two-way voice channel to provide the physician with the information."*

The report (EMS-11) by Advanced Technology Systems reiterates (with references to the literature) that "The ECG signals from electrodes attached to a patient represents the most valuable biomedical data that can be transmitted to a Hospital Emergency Area." Although no clear consensus on requirements for other physiological signals could be established at this time, future requirements may include blood pressure and respiratory signatures as well.

### COMPATIBILITY OF EXISTING SYSTEMS

The survey of seventeen mobile, portable medical telemetry equipments mentioned in the Introduction, above, is summarized\* in Figure 1. Many of these systems utilize a frequency-modulated audio subcarrier as indicated, but there is a wide variation of center frequency and deviation sensitivity rendering the systems incompatible. This incompatibility does not represent a problem when all equipments in a given catchment area are supplied by the same manufacturer. In cases of major disaster or when specialized emergency facilities are required, ambulances and equipments may be required to cross over these catchment boundaries creating a serious communications problem.

\*Please note that this list recognizes suppliers of Portable Audio Modulators/Systems for remote ECG transmission. This does not mean that all manufacturers supply voice-telemetry multiplex equipment.



University of Wisconsin-Madison  
 Advisory Center for  
 Medical Technology and Systems

1500 Johnson Drive, Madison, Wisconsin 53706 - (608) 263-1575

May 1974

Some Commercial Suppliers of Portable Audio  
 Modulator/Systems for Remote ECG Transmission

<u>Manufacturer</u>	<u>Center Frequency</u>	<u>Carrier Deviation</u>	<u>Intended Bell Coupler System Compatible?</u>
*American Optical Inc.	1988 Hz	+131 Hz/millivolt (mv.)	Yes
*Bell System 603 series	1988 Hz	+131 Hz/mv.	Yes
Biocom Inc.	1800 Hz (MPX-2950 Hz)	+166 Hz/mv. N/A	No No
*Cambridge Inst. Co.	1800 Hz	+32 Hz/mv. (Adj 0-200 Hz/mv.)	Yes
*Computer Inst. Co.	1988 Hz	Not available (N/A)	Yes
*Elmed Inc.	1988 Hz	N/A	Yes
*Gould Inc.	1988 Hz	N/A	Yes
*G.E. Cardiosurgical Systems	1988 Hz	N/A	Yes
Johnnie Walker Med. Elect. (Dallons)	1300 Hz	N/A	No
*Health Tech Labs	1988 Hz	+131 Hz/mv.	Yes
Mennen-Greatbatch	2300 Hz	+100 Hz	No
Motorola	1500 Hz	+100 Hz/mv.	No
Parke-Davis/via phone	1680 Hz	+225 Hz/mv.	No
*Physio Control Corp.	1988 Hz	+131 Hz/mv.	Yes
Pioneer Medical	1250 Hz (MPX-2900 Hz)	N/A N/A	No No
SCI Systems	550 Hz-(MPX)	N/A	No
*Travenol Labs	1988 Hz	N/A	Yes

\*Center frequency of subcarrier is 1988 Hz.

Note - Many systems can be adjusted, without major modification, to be compatible with another manufacturer's equipment if this is desirable. A technical evaluation of the feasibility of this should be done before a commitment to buy equipment is made, to assure compatibility.

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FIGURE 1



## COMMUNICATIONS REQUIREMENTS

Two-way voice communications between the site of an emergency victim located outside of a hospital (emergency site, ambulance, . . .) to a supervisory control point (generally located in a hospital) is a mandatory and highest level requirement for the support of emergency medical services. Two-way communications can take the form of full-duplex channel in which there is opportunity for continuous communications in both directions between the two end points of the system. Two-way communications can also be established over a half-duplex transmission circuit which allows communications to flow in either direction sequentially but not simultaneously. A simplex channel will permit communications to flow in only one direction; that is, one can either transmit or receive over this channel, but not both. The allocations of frequencies by the FCC (EMS-6a) for voice communications are in frequency pairs so that simultaneous simplex channels can be established from the two ends of the radio communication link. This will allow simultaneous two-way communications and is equivalent to a full-duplex mode. There are extremely wide and diverse measures of performance of these voice communication systems in terms of bandwidth, signal-to-noise ratio, distortion, intelligibility, voice quality, etc.

The transmission of bi-medical telemetry data can be accomplished by modulating radio or telephone equipment which has been designed for voice transmission. The simultaneous transmission of voice and telemetry data requires the use of a multiplex technique in which a portion of the voice spectrum is blocked out and used for the transmission of the telemetry data. The electrocardiogram requires a fairly low data rate for transmission compared with voice, and can be modulated onto a subcarrier for transmission in a multiplexed mode or in a non-multiplexed mode depending upon the requirements for continuous or sequential transmission.

The nominal usable voice bandwidth for transmission over telephone lines and for transmission over the types of FM portable radio equipments most used in this application is 300-3000 Hz. Studies (EMS-32) have been made of the effect of the various spectral components of the human voice on the resultant quality and intelligibility of the reproduced speech which has been band limited by a transmission system.



These studies indicate that a cross-over point at about 1550 Hz exists in which the elimination of the spectral components of speech above or below this cross-over will produce approximately the same degradation of articulation. It is found that mistakes as to the consonantal sounds th, f and v are responsible for nearly 50 percent of the mistakes of interpretation. Generally the spectral components at the low end of the spectrum provide much of the power or intensity of the voice and contain many of the characteristics associated with speaker recognition and general voice quality. The upper end of the spectrum contributes substantially to the articulation (the reproduction of the consonant sounds mentioned above). It is clearly desirable to retain as much of the spectral content of the voice transmission as can be accommodated by the transmission systems in order to maintain the best voice communication. The human ear is an amazingly adaptive organ, however, and can interpret highly degraded voice signals with relatively low message error rates.

Quantitative measures of voice articulation and its relation to intelligibility are described in the American National Standard Methods for the calculation of the Articulation Index, ANSI S3.5-1969 (EMS-45). In this standard, one method of defining speech intelligibility requires the dividing of the spectrum into 20 segments of varying width such that each segment contributes an equal amount (5%) to the overall articulation score. Table 1 shows a distribution of these bands as presented in the above standard and taken from reference 1 (Beranek, 1947)\* of the standard. The voice is degraded by additive noise in the transmission system and articulation index is often measured by a technique in which signal-to-noise in each of these bands is measured and properly weighted to calculate an AI between 0 and 1.

It is relatively straight-forward to calculate an Articulation Index for speech if one assumes that the signal/noise ratio in each of the AI bands after demodulation is greater than 30 dB. This may be greater than normally achieved in land mobile radio services but can clearly indicate a maximum performance assuming no degradation by additive noise from the system. Details of this calculation are given in the ANSI Standard.

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\*Beranek, L.L., The design of speech communication systems. Proc. Institute of Radio Engineers, Vol. 35, 1947, pp. 880-890.



TABLE 1  
20 Frequency Bands of Equal Contribution  
to Speech Intelligibility

Band No.	Limits (Hz)	Mid-Frequency (Hz)
1	200-330	270
2	330-430	380
3	430-560	490
4	560-700	610
5	700-840	770
6	840-1000	920
7	1000-1150	1070
8	1150-1310	1230
9	1310-1480	1400
10	1480-1660	1570
11	1660-1830	1740
12	1830-2020	1920
13	2020-2240	2130
14	2240-2500	2370
15	2500-2820	2660
16	2820-3260	3000
17	3200-3650	3400
18	3650-4250	3950
19	4250-5050	4650
20	5050-6100	5600

In order to use the Articulation Index thus obtained, it is necessary to have an empirically derived relationship between Articulation Index and Intelligibility defined as the percent of syllables, words or sentences understood correctly. This relationship is a function of the experience of both the communicator and the listener and a function of the message that is being transmitted. The ANSI Standard presents a graph\* as indicated in figure 2. It will be noted that the intelligibility increases dramatically for messages which are well known to the listener. Such messages are typified by the type of communications which occur in air traffic control systems where trained pilots and communicators find no difficulty interpreting messages which a novice or untrained person would find garbled and almost completely unintelligible.

\*French, N.R. and J.C. Steinberg, Factors governing the intelligibility of speech sounds. Journal Acoustical Society of America, Vol. 19, 1947, pp. 90-119; Bell Telephone System, Technical Publication Monograph B-1436, 1947.

Kryter, K.D., Some comparisons between rhyme and PB-word intelligibility tests. J. Acoustical Society of America, Vol. 37, 1965, p. 1146.



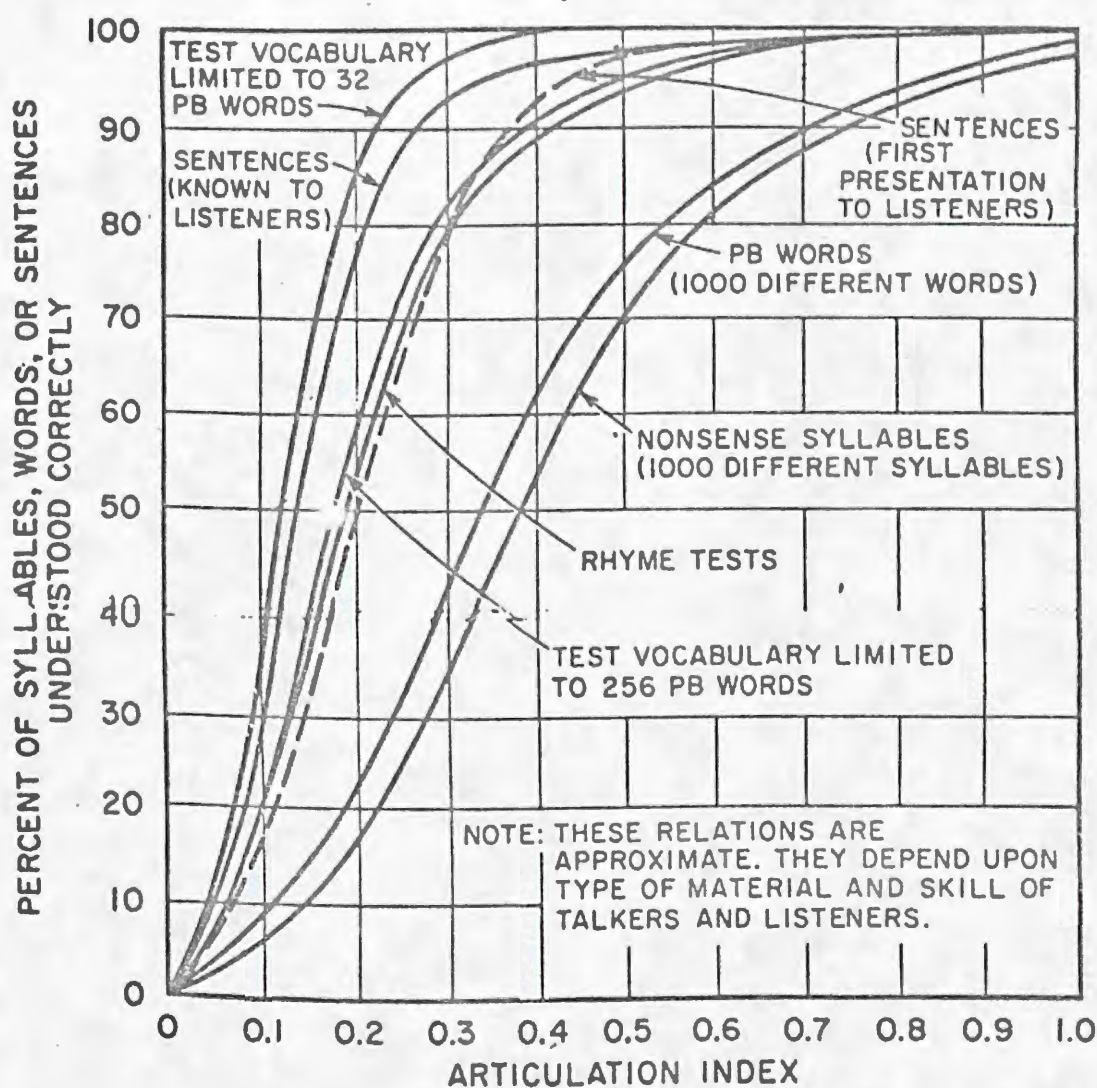
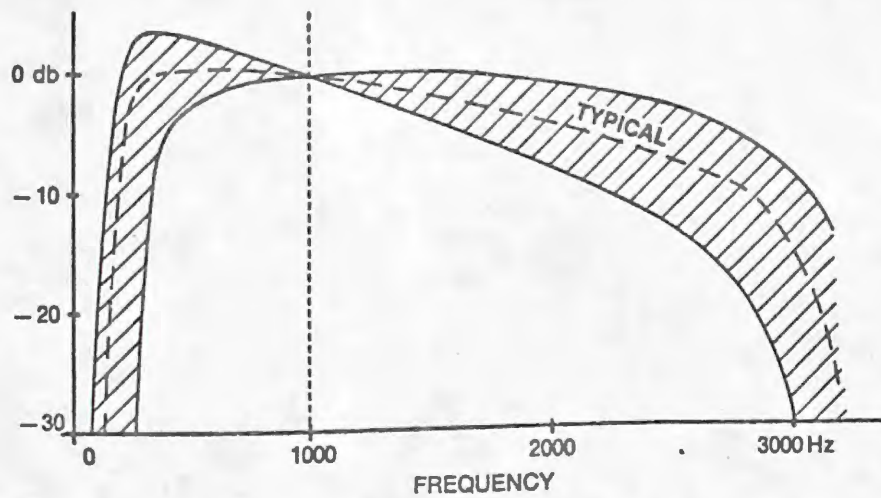


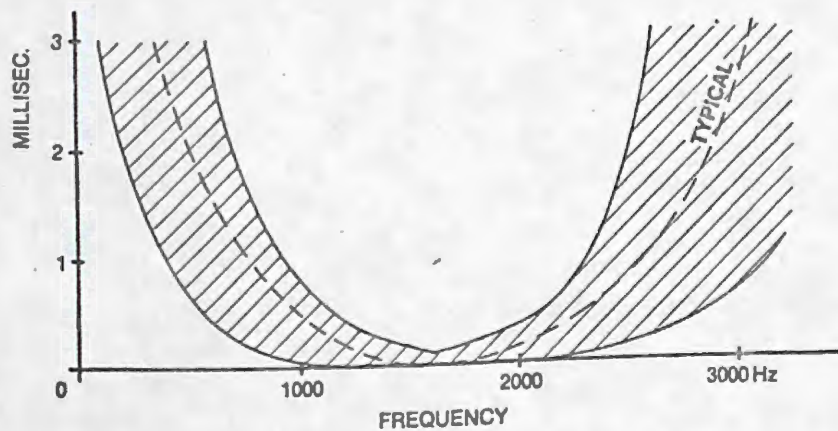
FIGURE 2. Relation Between AI and Various Measures Speech Intelligibility.

There is a need for the development of a set of subjective scoring measurements for emergency medical applications using a core vocabulary as the test message.

The attenuation and delay characteristics of telephone lines are expected to be more limiting to EMS Telemetry/Voice transmission than the similar characteristics of radio transmission when proper tuning and adjustments are made. Typical performance curves for telephone lines are shown in figure 3. Considerable variation in these performance characteristics can be expected as a function of such factors as regional



RANGE OF AMPLITUDE ATTENUATION  
(1,000 Hz is used as reference)



RANGE OF ENVELOPE DELAY

FIGURE 3. Range of Amplitude and Delay Characteristics for DDD Lines.

location, length of the transmission circuit (local loop or DDD network), and current state of maintenance. Generally the performance of these telephone lines is maintained adequate for voice transmission in all areas.

The technology exists to provide full voice quality transmission as well as biomedical telemetry over a voice grade telephone transmission circuit by the use of digital techniques. It is expected that this technology will be evolved and become available in the foreseeable future and that it may well become economically competitive with the current analog transmission systems. However, the state-of-art at the time of this study is such that the proposed standard addresses only the FM modulation techniques used in current systems.

#### LINEAR FM MODULATION

As long as only voice or biomedical telemetry is to be transmitted over a voice grade channel, the selection of sub-carrier tone frequency on which the biomedical telemetry signal will be modulated is quite arbitrary as indicated in Table 1 earlier in this report. Both the center frequency location and the deviation sensitivity can be made quite arbitrary. However, as indicated in that figure, most such non-multiplexed systems are chosen to lie in the range between 1000 and 2000 Hz. This selection is based on the fact that, for data transmission, the telephone technical references indicate that the frequency band 800 to 2450 Hz is the desirable band and transmission outside of this band is not recommended.

The EMS-TS Committee adopted the objective of establishing a single subcarrier frequency and deviation sensitivity for both multiplex and non-multiplex systems which are compatible with both radio and telephone channels. Thus the two primary constraints were that of the degradation of the voice signal for multiplex operation and the optimum location of the subcarrier frequency for transmission on telephone and radio circuits.

In linear FM modulation, the instantaneous frequency of the carrier is a function of the amplitude of the modulating signal. The rate at which the frequency changes is proportional to the rate or frequency of the modulating signal. In the generation of a frequency modulated carrier, the power spectra or distribution is contained in the center frequency and sidebands which are multiple harmonics of the driving frequency. Table 2 of this section is an illustration of the number of these harmonic sidebands as a function of the frequency and deviation ratio, that is the ratio of the maximum deviation of the carrier to the highest frequency of the modulating signal. Thus, normally the occupied bandwidth



TABLE 2  
DISTRIBUTION OF POWER IN THE FM SPECTRUM  
(Single Frequency Modulation)

$\frac{\Delta F}{f}$	CARRIER AND SIGNIFICANT SIDE FREQUENCIES EXPRESSED IN PERCENT OF TOTAL CARRIER LEVEL															REQUIRED BANDWIDTH
	$F_c$	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
0.1	99.75	4.99														2 f
0.5	93.85	24.23	3.10													4 f
1.0	76.52	44.01	11.49	1.96												6 f
2.0	22.39	57.67	35.28	12.89	3.40											8 f
3.0	26.01	33.91	48.61	30.91	13.20	4.30	1.14									12 f
4.0	39.71	6.60	36.41	43.02	28.11	13.21	4.91	1.52								14 f
5.0	17.76	32.76	4.66	36.48	39.12	26.11	13.10	5.34	1.84							16 f
6.0	15.06	27.67	24.29	11.48	35.76	36.21	24.58	12.96	5.65	2.12						18 f
7.0	30.01	0.50	30.14	16.76	15.78	34.79	33.92	23.36	12.80	5.90	2.30	0.80				22 f
8.0	17.17	23.46	11.30	29.11	10.54	18.58	33.76	32.06	22.35	12.63	6.10	2.60	0.96			24 f
9.0	9.03	24.53	14.48	18.10	26.55	5.50	20.43	32.75	30.51	21.49	12.47	6.20	2.73	1.10		26 f
10.0	25.59	4.35	25.46	5.83	21.96	23.41	1.45	21.67	31.79	29.19	20.75	2.31	6.34	2.90	1.20	28 f

for such an FM modulated carrier is determined by the highest frequency of the modulating signal and the maximum deviation allowed by the modulating circuit. A rule of thumb for selecting a deviation ratio to permit a sufficiently great input signal-to-noise ratio is that the maximum deviation of the carrier should be not less than five times the highest frequency of the modulating signal. It is, therefore, necessary to define a signal bandwidth and the maximum amplitude of the signal in order to determine the occupied spectrum for the resultant FM modulated carrier.

The American Heart Association standards for clinical ECG monitors defines a bandwidth of .05 to 100 Hz (EMS-32) as the 3 dB points of frequency response required for adequate transmission of the signals. For emergency medical services it is desirable to limit this bandwidth to a narrower frequency range for several reasons. The upper portion is subject to



power line 60 Hz interference and consequently a roll-off which eliminates this potential interference problem is desirable. The lower end of the spectrum is increased to order of 1 Hz in order to eliminate artifacts caused by muscular trauma, by inadequate or varying electrode contacts and by involuntary body motion which may be experienced in emergency medical situations. It has been demonstrated (EMS-11) that an upper frequency response of 40 Hz is quite adequate for transmitting the ECG signal with sufficient lack of distortion to determine the salient waveform characteristics of rhythm, amplitude, and shape required for EMS applications. However, the lower frequency response of 1 Hz will introduce certain distortions in the slowly varying portions of the ECG waveform which may produce artifacts that are of clinical significance. Therefore, the EMS-TS recommends that the telemetry system be capable of transmitting frequencies down to 0.1 Hz and that the bandwidth be limited if necessary by means of switches external to the telemetry modulator to provide the 1 Hz lower cutoff frequency.

Because of the pulsating nature of the ECG signal most of the energy of the driving signal is contained in spectral components that are in the range 10 Hz and below. Consequently, the occupied bandwidth of an FM carrier modulated by an ECG signal is not as wide as expected from full modulation by the upper cutoff frequency of 40 Hz because of the small amplitude of the high frequency components of the signal. The Committee was able to arrive at recommendations for deviation sensitivity in the range 35 to 50 Hz/mV. Inputs from the American Heart Association Standards Representative (EMS-3b) indicated that 90-95% of the EMS cardiac conditions. Extreme cases may reach levels of 8-9 mV in 2-3% of such cases. Thus assuming a + 5 mV peak signal and a 50 Hz/mV deviation sensitivity the maximum deviation of the carrier would be + 250 Hz. Limiting the bandwidth to 40 Hz satisfies the condition that the maximum deviation is greater than 5 times the maximum frequency and the fact that the amplitude of the higher frequency components is very small, Table 2 shows that the occupied spectrum of the resultant modulated carrier is contained within a 500 Hz bandwidth. Thus the linear FM modulated ECG telemetry signal will occupy a minimum of 500 Hz bandwidth within the voice spectrum of an FM multiplex system.

#### LINEAR FM MULTIPLEX SYSTEMS

Three characteristic voice/telemetry multiplex systems have been built and operated in field applications of EMS systems. They are characterized by the location of the 500 Hz



band for the telemetry signal. A high-band system with subcarrier at 2300 Hz is marketed by Pioneer, Inc.; a mid-band system with subcarrier at 1400 Hz is marketed by Motorola, Inc. and a low-band system with subcarrier at 550 Hz is marketed by Telecare, Inc. Each of these systems were considered as a possible standard. Each system has been demonstrated to provide satisfactory performance for EMS applications. The telemetry performance of each system is entirely adequate. Although considerable concern regarding the effects of attenuation and phase characteristics of telephone channels has been expressed, no statistically significant data are available at present to substantiate or eliminate this concern.

Much discussion on these three candidate systems centered on the quality and articulation or intelligibility of the resultant multiplexed voice. From Table 1 above, one notes that a 300-3000 Hz limitation on channel bandwidth, eliminates bands 1, 17, 18, 19, and 20, at least, giving a maximum articulation score of 0.75. This gives an intelligibility score of about 0.98 in accordance with Figure 2 for sentences known to listeners. For the high-band case, bands 13, 14, 15, and 16 are also eliminated, giving an AI of 0.55 which again gives very good intelligibility for known sentences and for nonsense syllables gives an intelligibility of 0.75. The mid-band case which has a notch filter eliminating the band 1150 to 1650 Hz eliminates bands 8, 9, and 10 which gives an AI of 0.60. This provides roughly the same intelligibility for known sentences and a score of about 0.80 for nonsense syllables. The low-band system with a high-pass filter cut-off at 800 Hz eliminates bands 2, 3, 4, and 5 giving an AI of 0.55 giving the same intelligibility by this method as the high-band case. These numbers are approximate (assuming absence of noise) as verified by the reader (using Table 2 and Figure 2), but illustrate that all three systems give good intelligibility for "sentences known to the listener." Extensive testing would be required to establish quantitative differences for EMS applications.

The naturalness or voice quality, which includes speaker recognition, is expected to be superior for the mid-band and high-band systems. Table 3 lists advantages and disadvantages of the three systems selected from the discussions and demonstrations of the EMS-TS.

This discussion was presented to illustrate that none of the systems appear technically superior in any major way. From the standpoint of possible interference with control functions of telephone and radio systems, the high-band system has some disadvantage. From the standpoint of unknown telephone line performance characteristics and effects of acoustic



TABLE 3. Comparison of Three Systems

ADVANTAGES	DISADVANTAGES
<p><u>High-band</u>            Good voice quality, i.e. speaker recognition, pleasing tonal quality.</p> <p>Large number of multiplex systems currently employed.</p> <p>No problems from harmonic distortion of the sub-carrier.</p>	<p>Loss of large section of voice spectrum contributing to intelligibility.</p> <p>May interfere with satellite receiver system control tones.</p> <p>Could interfere with telephone signalling frequencies.</p>
<p><u>Mid-band</u>            Located in the center of the telephone transmission characteristics.</p> <p>Largest number of non-multiplex systems can be readily modified to operate here.</p>	<p>Filter design methods are not as broadly known although no more complex or expensive than filters used in other systems.</p> <p>Relatively few multiplex systems currently operating at this frequency.</p>
<p><u>Low-band</u>            Retains the spectra of speech which contribute to high intelligibility.</p>	<p>Uncertainties inherent in the low frequency response characteristics of the telephone network.</p> <p>Possible interference with continuous tone coded squelch systems (CTC SS) used for selective calling in land-mobile radio systems.</p> <p>Elimination of power spectrum of speech.</p> <p>Requires a special digital tracking filter to eliminate 2nd harmonic of the subcarrier. (These problems may be greatly amplified by the non-linear acoustic transducer used in telephone coupling.)</p>

coupler distortion at low frequencies, the low-band system has disadvantage. From the standpoint of compatibility with existing non-multiplex systems the mid-band system is advantageous.

The EIA Subcommittee agreed to bring together the manufacturers of end-deliverable emergency medical communication systems and make a recommendation from the combined EIA Committee and this group of manufacturers to the EMS-TS regarding optimum technical factors for a National Standard. They agreed to address the question of selecting a subcarrier frequency, the deviation sensitivity, the deviation direction, how the deviation is to be defined, the maximum input signal, the bandwidth of ECG signal (signal characteristic) and a recommended calibration signal. The conclusions and recommendation of this Committee were:

- 1) No significant technical factors are currently available and demonstrated through experience, to provide a strong rationale for the selection of one of these systems to the exclusion of the other two.
- 2) All three types of systems have been demonstrated to work and will provide satisfactory operational multiplex systems.
- 3) In view of the preponderance of non-multiplex systems which are already in the field (and perhaps will continue to be the dominant mode of biomedical telemetry) and the fact that the systems are to be compatible with both radio and telephone line circuitry and in the light of possible interference with signalling tones and signalling frequencies at both ends of the voice spectrum, it was the recommendation of the EIA that a National Standard be adopted using the characteristics of a mid-band system as shown in their recommendation in Table 4.
- 4) This standard should be made mandatory for all systems, but systems operating at other subcarriers such as 2300 Hz or 550 Hz be permitted to operate as long as the system is capable of switching to the National Standard to operate in a compatible mode when necessary.
- 5) Other methods of modulation are also to be allowed in order that innovation and improvements in the performance of such telemetry systems can be encouraged while achieving the goal of compatibility and interoperability at this national subcarrier frequency for emergency situations where foreign equipments



TABLE 4

Preliminary Copy of EIA Recommendations to IRACOn EMS Standards (Subject to EIA Legal Review)

On September 15, 1974, an Ad Hoc Committee of the Electronic Industries Association voted to recommend the following EMS radio telemetry FM/FM modulated subcarrier method. This recommendation will be presented to IRAC on October 22, 1974, for their consideration.

1.
  - (a) The subcarrier shall be 1400 Hz.
  - (b) Subcarrier deviation sensitivity --- 30-50Hz/mV.
  - (c) Minimum ECG linear dynamic range at input from patient cable ---  $\pm 5$ mV.
  - (d) Minimum ECG system bandwidth to display 1-40 Hz at 3 db.
  - (e) A positive input signal shall create an increase in subcarrier frequency.
  - (f) Calibration shall be 1 mV  $\pm$  5%.
2. None of the factors considered precluded the use of either the proposed 2300 Hz or 550 Hz subcarrier.
3. Telemetry systems may selectively allow the use of any other subcarrier or method of modulation, but must include the standard subcarrier of 1400 Hz.



from other catchment areas may be required to work into common base receiving stations and supervisory control points.

When these recommendations were presented to the EMS-TS Committee, objections (EMS-35) were raised regarding the adequate documentation of the recommendations. A request was made that demonstrations of the low-band (Telecare) and mid-band (Motorola) systems be given to the Committee. These demonstrations were arranged for the Nov. 15 meeting and a technical presentation based on the contents of the report (EMS-45) was presented at this meeting. Both systems were demonstrated in a multiplex mode and non-multiplex mode for comparison of the voice quality and intelligibility. In the case of the mid-band system, the notch-filter in the receiving station was not removable in the non-multiplex (voice-only) demonstration. Both systems were operated through an ambulance repeater and operated in direct transmission modes from the portable units to the base receiving units. ECG signals were derived from simulator generators ("chicken hearts"). No discernable degradation of the signals were introduced by the radio relay. These demonstrations confirmed the EIA position that both systems perform satisfactorily and produce acceptable voice quality. The ECG signals were varied over wide ranges of pulse rates and showed no degradation. No intermodulation distortions caused by voice interference were apparent in either system's ECG signals.

Following these presentations and the ensuing technical discussions the federal government representatives on the EMS-TS Committee were requested to vote on the acceptance or rejection of the EIA recommendations. This vote was unanimously in favor of accepting the recommendation.

CONCLUSIONS

The EMS-TS Committee reached a number of conclusions which are recorded in the meeting Summary Records (EMS-1, a, b, c, and d) which are summarized here:

- 1) Communications including biomedical telemetry may be requirement for emergency medical services.
- 2) Two-way voice communication is the number-one requirement for the emergency medical services communications.
- 3) New technology exists for the development of digital data and digital voice communications but such systems are not now demonstrated and the work of this Committee should be restricted to linear FM modulated subcarrier systems.
- 4) The standard should be developed in such a way as not to limit future developments and innovation, it should also provide for future telemetry needs if possible (ECG only physiological signature required at present).
- 5) If possible the standard should provide a common subcarrier tone frequency and other characteristics which would make multiplex and nonmultiplex telemetry systems compatible.
- 6) The subcarrier should be selected for optimum performance on both radio and telephone transmission systems.
- 7) Multiplex links for continuous telemetry and voice transmission may be desirable if adequate performance and cost criteria can be met.
- 8) The medical community agrees that well-trained EMT and supervisory control personnel are primary objectives of emergency medical services.
- 9) The purpose of biomedical telemetry and communications in emergency medical services is to support the stabilization and rescue of critically ill and injured accident victims. The sophistication and complexity of the resultant equipment must not interfere with this medical care and rescue operation.
- 10) It is technically feasible to select a single audio subcarrier frequency for FM biomedical-telemetry applications in EMS which will assure compatibility



and interoperability of both multiplexed and non-multiplexed systems on both radio and telephone transmission circuits.

#### RECOMMENDATIONS

- 1) It is the recommendation of the EMS-TS Committee that a National standard subcarrier frequency and associated parameters be adopted for FM multiplex and non-multiplex biomedical telemetry systems for use in emergency medical communications. The proposed standard is contained in Appendix B of this report.
- 2) It is recommended that this standard be approved by IRAC for inclusion in the OTP Manual of Regulations and Procedures for Radio Frequency Management.
- 3) It is recommended that this standard be approved by the Federal Telecommunications Standards Committee (FTSC) for adoption as a Federal Standard to be promulgated by the General Services Administration.
- 4) It is requested that this standard be forwarded to the Federal Communications Commission for their use in the type-acceptance of equipments for commercial use in EMS applications.
- 5) It is recommended that the additional parameters contained in the detailed subsystem specifications for the Transmit Signal Processor (TSP) and Receive Signal Processor (RSP) contained in Appendix C of this report be adopted by the community in response to the above standard. (It should be emphasized that the TSP and RSP are conceptual and do not necessarily correspond to actual pieces of hardware. Depending on the equipment design, some or all of the interface points referred to in the specification may or may not exist as physical junctions. Signal levels and impedance levels for these interface points, where specified, apply only to equipment which has input or output connectors at these points. It is not the intention of this specification to require multiplex capability.)
- 6) It is recommended that a continuing Federal authority be established as the developing agency for cognizance and review of this standard and for the development of other than linear FM techniques for EMS applications (e.g., PCM systems). Three possible agencies occur to this Committee:



- a) The OTP/IRAC through its Permanent Working Group on Standards (TSCS).
- b) The National Communications System through the FTSC.
- c) The Department of Health, Education, and Welfare through the Food and Drug Administration as part of its program of standardization of medical devices.

#### BIBLIOGRAPHY

The following bibliography of reports, technical documentation, position papers, and correspondence\* has been received and reviewed in preparation of the recommended standard by this Committee. Copies of these reports and correspondence are available at the office of:

Mr. Donald Jansky, Chairman  
Technical Subcommittee/IRAC  
Office of Telecommunications Policy  
1800 G Street, N.W.  
Washington, D.C. 20504  
(202) 395-5623

or

Mr. Joseph A. Hull, Chairman  
Standards Working Group/TSC/IRAC  
Office of Telecommunications  
Institute for Telecommunication Sciences  
325 Broadway  
Boulder, Colorado 80302  
(303) 499-1000, x-4136.

\*Note: A summary of the responses of the medical community is being prepared by the Veteran's Administration Representative. This, along with copies of actual responses, will become a part of this bibliography.

## EMS DOCUMENT LOG

EMS-1. Agenda, Organizing Meeting (Attachments: Meeting Notice and Work Statement).

- 1a. Second Meeting Notice, Agenda, Attendees, Summary Record.
- 1b. Third Meeting " " " "
- 1c. Fourth Meeting " " " "
- 1d. Fifth Meeting " " " "

EMS-2. Emergency Medical Services Radio Telemetry Requirements - J.J. Renner, Advanced Technology Systems, Inc.

A draft position paper by Advanced Technology Systems on specifications for a biomedical telemetry system.

EMS-3. Emergency Medical Services Fast Response, Early Treatment of Medical Emergencies - John J. Renner, Advanced Technology Systems, Inc.

A description of the common system approach for EMS communications.

EMS-4. Telemetry and Physician/Rescue Personnel Communication - Dept. of Transportation (NHTSA).

A final report on a demonstration project designed to determine the feasibility of supplying advanced emergency medical care in the field by paramedical personnel and to assess the results of the training and improved communications.

EMS-5. Electronic Equipment Dictionary and Buyers' Guide - Equipment, Biomedical.

A listing of medical electronic equipment manufacturers along with a functional description of available equipment.

EMS-6. Draft Report and Order for the Establishment of Emergency Medical Radio Services under Part 89 of the Commission's Rules - FCC Docket 19880.

- 6a. Federal Communications Commission Medical Communications Services Rules and Regulation.

EMS-7. Telemetry Standards Study - State of Florida (L. Connell)

A work statement intended for use in a request for proposal by the State of Florida. (Work has not been funded pending results of this committee effort.)

## EMS Document Log - Page 2

EMS-8. Communications in Support of Emergency Medical Services -  
OTP.

Report of IRAC Ad Hoc 120 Committee submitted to FCC,  
October 3, 1973.

EMS-9. EMS: The Concept and Coronary Care - William F. Renner, M.D.  
The Union Memorial Hospital (May 20, 1973).

A summary paper points up some problem areas: frequency allocation structure, standards of performance for biomedical telemetry. Technical factors influencing reliability of transmission, and medico-legal considerations. Also presents a summary of statistics on heart attack cases. A bibliography with 13 references.

EMS-10. Summary Report on Emergency Medical Communications for the  
FCC - Advanced Technology Systems, Inc. (February 1974).

Expands and details many recommendations of EMS-8 and makes recommendations to be included in EMS 6a.

EMS-11. Emergency Medical Services Requirements for Electrocardiograms - Advanced Technology Systems, Inc.

A paper with extensive references, which evaluates the characteristics of ECGs most suitable for use in EMS. It treats the relationship between information content and bandwidth requirements.

EMS-12. Medical Device Electromagnetic Interference Standard, DHEW,  
Food and Drug Administration (A Work Statement for a contract with McDonnell-Douglass).

The objective of this project is to research, evaluate and document performance parameters and methods of test for use in an electromagnetic compatibility (EMC) standard for medical devices.

EMS-13. Standards for Cardiopulmonary Resuscitation (CPR) and  
Emergency Cardiac Care (ECC), Supplement to JAMA (Journal of the American Medical Association) Feb. 18, 1974.

Portions of this standard indicate requirements for communications.

EMS-14. The Emergency Care Research Institute, Background material  
on the ECRI and copy of Statement of J.J. Nobel, M.D.,  
Director, ECRI, to Subcommittee on Health of the Committee  
on Labor and Public Welfare U.S. Senate, 93rd Congress,  
Sept. 14 and 17, 1973.



## EMS Document Log - Page 3.

EMS-15. Background material for Item 7 above - Florida (L. Connell).

This material includes: a questionnaire sent to five telemetry system suppliers, State of Florida, General Services Communication Division approach to developing a biomedical telemetry standard, list of pre-hospital patient monitoring biomedical telemetry system suppliers and a description of their subcarrier configuration, and correspondence from Pioneer Medical Systems, Inc., and a Specification, City of Clearwater, Florida, for a UHF Voice/Telemetry Communications/Emergency Medical Services System.

EMS-16. AT&T Technical Reference, Data Sets 603A, 603B and 603D.

These data sets operate with a subcarrier frequency of 1988 Hz, a deviation of  $\pm 262$  Hz and maintains a reverse channel signal tone at 187 Hz.

EMS-17. A Study for DC Defibrillator Safety and Performance by Univ. of Utah, Contract with Food and Drug Admin.

Portions of this draft standard provide information on the portable ECG requirements and recommended vibration and shock standards.

EMS-18. Land-Mobile Standards of the Engineering Department of the EIA.

These standards include RS152B Transmitter, RS204 Receiver, RS210 Terminating and Signaling Equipment, RS220 Continuous Tone Squelch, RS237 Systems, RS316 Portables, RS329 Base Station Antennas, RS374 Signaling, RS388 Test Conditions.

EMS-19. Memorandum to Ad Hoc Standards Committees from Fred B. Vogt, M.D. (Driftwood, Texas) re "Thoughts on the Establishment of Standards," August 12, 1974.

This is a response to a request from Dr. Jackson of this committee (EMS-22) and also responds to Mr. Connell's questionnaire to the suppliers.

EMS-20. Letter from Francis Jackson (VA) to Dr. Sam L. Pool (NASA/Houston) re professional needs for physiologic telemetry, August 22, 1974.EMS-21. Telecare, Inc. response to L. Connell re his Questionnaire.

This response contains a complete description of the Telecare Emergency System and a news release from General Electric describing the Telecare system installed at Houston, Texas.

## EMS Document Log - Page 4

EMS-22. VA Questionnaire to four M.D.s.

EMS-23. Spectra Associates Inc. letter to J.A. Hull re EMSCS Communication Telemetry Standard Committee Activity.

This letter contains comments on the 335 Hz telemetry carrier frequency proposed by Advanced Technology Systems which was mentioned in the Second Summary Record (EMS 1a).

EMS-24. Fairfield Medtac Emergency Medical Communications.

These are draft notes describing a digital modulation technique for a telemetry channel and an EMS communication system with the trade name MEDTAC (Medical Totally Advanced Communication). A position paper addressed to this committee has been promised by the company, Fairfield Medical Products Stamford, Connecticut.

EMS-25. Telecare, Inc. paper prepared for EMS Committee and general information on Telecare, Inc. paramedical suitcase and its application in EMS systems.

This is a partial response to Mr. Connell's inquiry. A more quantitatively oriented analysis and more data from the Houston system and laboratory tests have been promised.

EMS-26. NSA Specifications for Privacy Equipment.

These specifications are preliminary (many details are not included). They deal with interface to telephone and radio equipments.

EMS-27. James C. Houge (Univ. of Wisconsin) Submissions: Format for an Area Plan (State of Wisconsin) for Emergency Medical Services Communications; EMS Communications/Telemetry Planning Guide; Excerpt from Draft report of NAE on Emergency Medical Communications; Summary of Meeting (2/15/74) of persons involved in paramedical systems; and a list of commercial suppliers of portable audio modulator/systems for remote ECG transmission.

EMS-28. Inter-Agency Commission on Emergency Medical Care memo to Hospital Administrators, New Jersey State First Aid Council, Ambulance Squads, Boards of Chosen Freeholders re moratorium on procurement of equipment.

This memo documents the non-interoperability of several manufacturer's equipments which utilize biomedical telemetry.



## EMS Document Log - Page 5

- EMS-29. Letter of 9-16-74 from Fairfield Medical Products Corp. to J. A. Hull.

A position paper recommending that a given technique (FM modulated subcarrier) be specified as completely as possible with provisions for any new technique to be submitted and approved and similarly completely specified. Also recommends 3 frequency operation (VHF-UHF) to simplify portable equipment.

- EMS-30. Letter of 9-11-74 from Motorola Inc. to L. Connell.

Comments from Motorola on inquiry sent by Mr. Connell "Subcarrier and deviation standards will help solve the compatibility problem, but systems coordination, area planning, and common sense on the behalf of the buyer is still the best way of doing things."

- EMS-31. Letter of 9-15-74 from L. Connell, Florida to J. A. Hull.

Comments on Mr. Connell's questionnaire from Biocom, Inc. "The function of all of our paraphenalia and technical expertise is to enhance the decision making process to render prompt and effective treatment. Let's not clutter this up with gadgetry."

- EMS-32. Advanced Technology Systems, Inc. Reference Material bearing upon selection of subcarrier for ECG when multiplexed with voice on a voice-grade channel (10-1-74).

Selected documents and extracts submitted to Chairman, EMS-TS and EIA Committee on EMS.

- EMS-33. Communication from FCC 10-24-74.

A suggested change in the draft standard distributed at the Fourth meeting.

- EMS-34. Biomedical Telemetry Standard for Emergency Medical Service Communications, DHEW, Food and Drug Administration. (10-25-74)

A rewrite of the draft standard distributed at the Fourth EMS-TS Committee Meeting.

- EMS-35. Memorandum to: EIA and IRAC Committees on Biomedical Telemetry Standards, Advanced Technology Systems, Inc. (10-25-74).

ATS comments on the Resolution of the EIA Committee regarding Biomedical Telemetry Standards. Summary of comments made by Mr. Renner at the Fourth Meeting in which he objected to the recommendations made by the EIA Committee.



## EMS Document Log - Page 6

- EMS-36. Correspondence to Chairman, EMS-TS Committee, Fred B. Vogt, M.D. (10-29-74).  
A letter of concern regarding the content of the proposed standard and indicating his intent to publish an article commenting on the actions of this Committee.
- EMS-37. Correspondence to Mr. John J. Renner, ATS from R. N. Watts, Bell Laboratories. (10-30-74).  
Mr. Watts comments on the material contained in EMS-3 above.
- EMS-38. Comments and a recommended Biomedical Telemetry Standard for Emergency Medical Service Communications, Fairfield Medical Products Corp. (10-31-74)  
A rewrite of the draft standard distributed at the Fourth meeting plus some additional position statements from Fairfield.
- EMS-39. Comments on the draft standard from Spectra Associates, Inc. (10-31-74).  
Comments directed at specific sections of the draft were made along with some suggested additions.
- EMS-40. Multiplexed Bio-Telemetry and Voice for EMS, Advanced Technology Systems, Inc. (11-1-74).  
A suggested standard from ATS in lieu of proposed draft.
- EMS-41. Comments on draft standard from National Communications System, Technology and Standards (11-6-74).  
This contains suggested changes in the draft standard.
- EMS-42. Comments and suggested changes in draft from Motorola, Inc. (11-7-74).  
Notes and suggested revisions from W. R. Hackett of Motorola.
- EMS-43. Comments and suggested changes in draft from State of Florida, Dept. of General Services. (11-7-74)  
Several comments on the draft are contained here along with a concern regarding tolerances.
- EMS-44. Comments and suggested changes on the draft from Univ. of Wisconsin-Madison, Advisory Center for Medical Technology and Systems (11-15-74)  
Comments on specific sections of draft.

## EMS Document Log - Page 7

EMS-45. Technical Analysis of ECG-Voice Multiplex Systems, Motorola, Inc. (11-15-74).

This is a report, prepared by Dr. Gordon W. James, on behalf of the EIA Committee intended to document the basis for recommending the mid-band subcarrier frequency as a National Standard.

EMS-46. Interim Report to Chairman, Task Group on Standards for Telemetry from Veterans Administration (11-15-74).

Copies of correspondence from several members of the medical community in response to a questionnaire sent to them by Francis C. Jackson, M.D., VA representative of the EMS-TS Committee. He also prepared a brief summary contained here.

EMS-47. Letter to Chairman, EMS-TS from FCC (11-20-74).

Request to incorporate a statement into standard indicating continued interest in establishing the optimum system performance at other than 1400 Hz sub-carrier frequency.

EMS-48. Comments on 11-15-74 draft standard by National Communication System, Technology and Standards. (11-20-74).

These comments apply to second draft distributed on 11-15-74.

EMS-49. Letter to Chairman, EMS-TS from Fred B. Vogt, M.D. (11-20-74).

A request for documentation of the basis on which the EMS-TS made its decision to recommend 1400 Hz including the manner in which this decision was reached.

EMS-50. Communication to Chairman, EMS-TS from State of Florida, Dept. of General Services (11-21-74).

This contains a response from Commercial Electronics and Communications, Inc. to the questionnaire mentioned in EMS-15 above.

EMS-51. Respose to the draft distributed 11-15-74 from Physio-Control (11-25-74).

This contains a concern regarding the referencing of FDA-MDS-021-0001 draft standard and recommends a change in Sections 6.2 and 6.3.4 of the draft.

## EMS Document Log - Page 8

EMS-52. Letter dated Oct. 31, 1974 from A. S. Berson, VA to  
J. A. Hull.

Comments on EMS-34.

EMS-53. Letter dated Nov. 26, 1974 from G.J. Wade, Fairfield Medical  
Products. Corp.

A recommended Biomedical Telemetry Standard for Emergency  
Medical Service Communications.

EMS-54. Letter dated December 6, 1974 from A. S. Berson, VA to  
J. A. Hull.

Comments on draft standard circulated at Nov. 15 meeting.



## APPENDIX A

## STATEMENT OF WORK FOR BIOMEDICAL TELEMETRY STANDARD

PHASE I

1. CONDUCT A SURVEY AND STUDY OF OTHER TELEMETRY STANDARDS IN ALL AREAS WHICH MAY BE APPLICABLE TO BIOMEDICAL TELEMETRY TECHNIQUES.
2. DETERMINE REQUIREMENTS FOR THE SUBCARRIER TONE FREQUENCY OR FREQUENCIES WHICH WOULD BEST MEET THE FREQUENCY RESPONSE TRANSMISSION CHARACTERISTICS OF THE AVERAGE TELEPHONE LINE IN THE UNITED STATES.
3. DETERMINE REQUIREMENTS FOR THE AMOUNT OF SUBCARRIER DEVIATION NECESSARY TO SATISFY SIGNAL-TO-NOISE RATIO REQUIREMENTS.
4. DETERMINE THE FEASIBILITY OF ESTABLISHING ONE SUBCARRIER FREQUENCY AS A STANDARD TO BE USED FOR BOTH VOICE AND TELEMETRY MULTIPLEXED SYSTEMS AND TELEMETRY ONLY SYSTEMS.
5. DETERMINE CALIBRATION PROCEDURES AND WAVEFORMS WHICH SHOULD BE INCORPORATED IN THE STANDARD.
6. PREPARE A REPORT ON THE FINDINGS OF THE PHASE I EFFORT CONTAINING DATA TO BE INCLUDED IN A BIOMEDICAL TELEMETRY TRANSMISSION STANDARD.

PHASE II

PREPARE A DRAFT FEDERAL STANDARD ON BIOMEDICAL TELEMETRY TRANSMISSION WHICH INCORPORATES THE BEST COMPROMISE OF ALL FACTORS AND FINDINGS OF THE PHASE I EFFORT.

APPENDIX B  
Biomedical Telemetry Standard  
for  
Emergency Medical Service Communications

See attachment to cover memo to the Executive Secretary  
of IRAC.



## APPENDIX C

Detailed Specifications for  
Transmit Signal Processor and Receive Signal Processor

Note: The detailed specifications of signal levels, impedances, and tolerances of these subsystem interface parameters are being coordinated with the EMS-TS Committee. This appendix will be a part of the final report of the EMS-TS Committee and will be a valuable addendum to the standard useful to both the system engineering communities and procuring communities, and the industry which must supply the necessary hardware.





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