Final Report *October 1971*

OPTIMUM UTILIZATION OF GOVERNMENT AND NON-GOVERNMENT COMMUNICATIONS RESOURCES

Prepared for:

OFFICE OF CIVIL DEFENSE
OFFICE OF THE SECRETARY OF THE ARMY
WASHINGTON, D.C. 20310

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13 ABSTRACT

A number of communication resources exist that are applicable to and available for Civil Defense emergencies to augment and substitute for common carrier and other primary communication means. This study describes the resources and comments on their applicability and the constraints on their utilization. A useful technique for providing guidance to local communication directors to assist in optimum use of communication resources is described.

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Final Report *October 1971*

Detachable Summary

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By: A. W. WIEGAND C. A. HALL, Jr. R. W. STRUNK

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DETACHABLE SUMMARY

During periods of Civil Defense emergency, the volume of communication traffic can be expected to be substantial. When the capacity of the primary communication systems is severely taxed by this high traffic volume or when some of the systems normally used are degraded or destroyed by the adverse conditions developing as a direct consequence of the emergency, some alternative communication resources will have to be employed to transmit the necessary traffic.

Many communication systems and facilities are usually available, of which some can be applied to augment or to replace the primary means. An urgent problem facing Civil Defense officials, particularly the communication officers of local governmental entities, is optimum utilization of the available resources. To accomplish this function effectively, each communication officer must be aware of the resources that exist in his area and the capabilities and limitations of these resources with regard to the anticipated requirements.

There is considerable documentation that is intended to provide guidance to officials on the employment of communication facilities and systems. To some extent, the information is scattered; in other instances it is not always in a form most suitable for the local governments to comprehend and use. Some form of guidance that will permit the optimum utilization of communication resources--guidance that can be easily applied by even the smaller governmental administrative offices possessing limited resources--is essential. With such guidance, advance planning will be simplified and facilitated.

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In this report, the communication requirements arising from a Civil Defense emergency, as envisioned in a nuclear emergency operations plan, are described. The communication services that may be available in an area are discussed, and those which might have applicability to satisfy the requirements are highlighted. After indicating some of the possible applications of matching the requirements to the resources, a device is described that is expected to be useful for providing guidance to Civil Defense communication officers and thereby assist them in their planning for and execution of the communication function under emergency conditions.

ABSTRACT

A number of communication resources exist that are applicable to and available for use in Civil Defense emergencies to augment and substitute for common carrier and other primary communication means. This study describes the resources and comments on their applicability and the constraints on their utilization. A useful technique for providing guidance to local communication directors to assist in optimizing use of communication resources is described.

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I INTRODUCTION

The Federal Civil Defense Guide* makes state and local governments responsible for developing and maintaining in operational readiness emergency communication systems. They must also establish necessary intrastate emergency communication systems, and plan for integration of existing state and local communication systems with emergency communication systems. Finally, the state and local governments are made responsible for developing plans for executing operational priorities in coordination with public (communication) carriers.

During periods of emergency, the communication resources necessary to save lives and to protect property will be heavily loaded and probably saturated. Satisfaction of the expanded requirements will necessitate augmentation of common carrier and other primary means. Because Civil Defense officials, including communication officers, will need to exploit locally available resources, some basic principles and procedures must be developed for optimum use of both the Government and non-Government communication facilities and services.

This study was initiated to:

- Identify and study the facilities and services available to state and local governments: Describe and evaluate their characteristics and their applicability to support CD emergency operations.

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*Part A, Chapter 2.

- Identify and study the industrial and commercial facilities and services that may be operating in state and local geographic areas: Describe and evaluate their characteristics and potential for supporting CD emergency operations.
- Establish the extent, operating procedures, and problems of employing the Radio Amateur Communication Emergency Service (RACES) and other amateur networks. Study the various forms of CATV systems, their design, extent, current and future application, and anticipated expansion to determine their usefulness for CD purposes.
- Assess the impact of emergency conditions on the operation and suitability of the preceding systems for CD purposes: Evaluate the technical and regulatory constraints on the systems.
- Develop outline guidance for Civil Defense communication officers to facilitate and optimize their efforts to utilize the resources available at state and local levels of government.

II METHOD OF APPROACH

After determining the nature and potential sources of other data essential to accomplishment of the study, the research effort involved review and evaluation of the communication requirements arising from CD emergency operations, especially under the concept of "in-place" protective actions. This was followed by cataloging and analyzing the communication facilities and services that now are or might become available to satisfy them.

Communication requirements were then compared with the available services in order to determine those applications that might aid in optimizing the use of available services for accomplishing the CD mission and carrying out its functions.

Constraints--technical, regulatory, and operational--were then identified and the most significant constraints were highlighted.

Existing guidance materials to aid governmental agencies were identified and evaluated, and from this evaluation a concept was developed, which was designed to consolidate the guidance, simplify it, and facilitate its application, particularly for the local levels of governmental administrative organizations with limited knowledge and resources.

The concept was then translated into a type device suggested for reproduction and distribution to CD officials to facilitate their use of available communication resources. After arriving at the principal conclusions and associated recommendations, some special areas were identified as warranting additional consideration and study to improve, even further, communication for CD emergency operations.

The overall study and the preparation of this report were the responsibility of A. W. Wiegand. Major contributors to the final report were C. A. Hall, Jr., and R. W. Strunk. Additional contributions were made by R. B. Battelle and E. N. Clark, professional staff members of the Institute, and by many officials of communication and Civil Defense agencies at all echelons of government.

III CIVIL DEFENSE EMERGENCY OPERATIONS--GENERAL

A. Background--The Civil Defense Environment

In the period during and immediately following a nuclear attack on the United States, our overall objective is to ensure national survival and recovery. To this end, those resources that survive the attack must be made available and appropriately assigned.

In a nuclear attack situation, officials must determine:

- What resources are available
- To what needs the resources can be applied
- How they can best be applied
- The extent to which the resources either are deficient or are in excess of survival needs.

There must exist detailed knowledge to permit decisions and allocations of this nature; therefore, the required information must be obtained and analyzed well in advance of the emergency.

At least a temporary breakdown of Federal control will probably occur in some areas of the nation. Accordingly, state and local governments must be prepared to employ their own and other local resources to restore their strength and economy as an essential element of eventual national recovery. The local governments must take the necessary emergency actions to provide, distribute, and use goods and services and to make optimum use of available manpower and other resources, including communication resources.

In this regard, it will often be necessary to readjust existing relationships among the agencies of a governmental administrative structure for the emergency. Any such adjustments will distort established relationships and disturb the existing rapport; they could produce unanticipated interactions within the community structure. Organizational performance patterns--stabilized and constrained by familiar facilities and surroundings and by rules, regulations, and habitual behavior--will react strongly to the multiple influences of emergency situations. Thus it is apparent that state and local governmental agencies must prepare in advance of attack for the preservation and management of their resources to be directed toward a rapid stabilization of the economy and of the preservation of government, law, and order. Contingency post-attack plans are also needed to ensure that state and local governments, even though isolated, can function rapidly and effectively to conserve the remaining resources and employ them in both the national and local interest.

There have been persistent problems in developing and maintaining plans for the conduct of emergency operations* by each level of government in the event of a nuclear emergency. These problems have persisted largely because there has been no coherent and current body of doctrine and operational concepts. This situation was rectified, however, when

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*All actions having as their objective the protection of life and property and the maintenance or restoration of essential services and facilities.

a conceptual framework[1]* was published in November 1967, and was widely circulated. In turn, the document has led to other studies that have demonstrated that the concept provides the essential framework for the development of needed plans, particularly at the local level. Reference 1 also recognizes that local areas will be those most directly concerned with emergency actions during a nuclear attack and defines an "operating zone" as the level of governmental organization performing these actions. In most cases, the operating zone will be an entire town, city, or rural county; however, some operating zones will be formed by agreement among adjacent small communities. Alternatively, zones may be formed by subdividing larger cities or urban counties into smaller areas.†

Administrative organizations of increasing complexity above the operating zone in a state include the larger city governments, the urban counties, the state regions, and finally the state government.‡ These larger organizations have the primary functions of coordinating and controlling emergency operations across local jurisdictional boundaries and of warning or advising their subordinate echelons of imminent fallout and the like arising from occurrences in other areas. These functions require that information on existing and predicted actions and conditions be available for assessment by the lower echelons, and that they be

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*Superscript numbers relate to references listed at the end of the report.

†Twenty-five square miles is considered to be the approximate maximum area of a typical operating zone.

‡"NEXTUP" will henceforth be used as the generic term for the higher echelons to avoid listing all such possibilities each time they are mentioned. This term was originally coined and defined in Ref. 2, the ALFA NEOP EOC Master Checklist (Zonal Level), April 1971.

provided appropriate direction and advice. The mechanisms for handling this information and guidance must be developed in advance.

Public safety forces will be the agencies charged primarily with performing the emergency actions. The essential actions required after the nuclear attack relate to countering the main continuing threats to life and property: fallout radiation and fire. All other operations--e.g., care of survivors and restoration of vital facilities--will be feasible only to the extent that radiation and fire situations permit.

B. Increased Readiness Actions and the Need for Advance Planning

Inevitable confusion, coupled with the complexity of the numerous actions required in the event of a nuclear emergency, will aggravate or even break down performance of the essential functions unless adequate plans are developed to guide their performance. The Emergency Phase, during which the actions we are concerned with are performed, begins with an increased readiness period during a crisis, includes the attack period and the period subsequent to attack warning or actual attack, and continues until weapon-caused fires are out and fallout radiation no longer constitutes a substantial hazard. The increased readiness period, which initiates the emergency phase, is the period of time between initiation of actions to increase readiness for emergency operations as advised by the state, and either the cessation of such readiness, a warning of imminent attack, or observation of attack effects without warning, whichever occurs first.

In the likely event that a nuclear war will be preceded by a period of heightened international tension, emergency plans would be activated and at least some increased readiness actions could be taken by local governments to improve significantly the capability to protect lives and property. For example, the sheltering capability could be improved, fire vulnerability could be reduced, and the readiness of organized forces and

the self-help capabilities of the population could be enhanced. However, if the United States were to suffer a nuclear attack with little or no warning, few if any such actions could be taken. In this event, the effectiveness of emergency operations would be essentially limited to pre-existing capabilities and levels of readiness. It should be noted that in neither of these cases would there be sufficient time for a governmental agency to initiate studies or to prepare plans. As noted earlier, these actions must be accomplished well in advance.

The effects of a nuclear attack on telecommunication facilities can be far-reaching, and may even impinge on local Civil Defense activities when other signs of weapons bursts are not locally apparent. To ensure the continued operational effectiveness or even the survival of those communication systems that are available to support Civil Defense, appropriate action to increase communication readiness is most important. It is particularly essential to predetermine and schedule actions and reactions that will result in the consolidation and reduction of communication needs.

C. Major Functions in Civil Defense

Several of the governmental functions that are performed in normal, day-to-day operations assume extreme importance during emergencies. Such situations require great flexibility in the communications systems that must support the functions.

Of the identified Civil Defense functions, some are normal governmental functions, others are regularly performed by civilian agencies or firms, and a few functions may be performed by both governments and

private elements in the community. In addition, some few functions are performed only for Civil Defense purposes.

Functions uniquely within the province of Civil Defense are those associated with nuclear attack situations: Civil Defense warning, radiological defense, and the provision of protective shelter. In the event of a nuclear attack, these functions necessarily must be coordinated with other governmental functions (e.g., fire fighting and police protection) to meet and negate (or at least reduce) the effects of the nuclear and concomitant hazards on the nation's populace. Public and private resources also would be called upon to assist in the work of saving lives, limiting damage, and speeding recovery. Table 1 indicates the allocation among the categories listed of all of the functions needed for Civil Defense as developed in Ref. 3.

Table 1

ALLOCATION OF LOCAL CIVIL DEFENSE FUNCTIONS

Function	Unique Civil Defense Functions	Normal Local Government Functions	Normal Private Agency Functions
Civil Defense warning	X		
Radiological defense	X		
Shelter	X		
Fire fighting		X	
Police		X	
Communications		X	X
Welfare		X	X
Evacuation		X	
Rescue		X	
Medical and health		X	X
Engineering		X	X
Transportation		X	X
Plant protection			X
Public utilities		X	X

Source: Ref. 3.

Since the problems arising from a nuclear attack will require prompt decision and effective actions by one or more agencies, a greater degree of cooperation between the agencies is needed. At such times, the decision-making capability must be more centralized than during normal government operation. Furthermore, because of the need for continuing interaction between the various agencies, decision-makers and their staffs must either operate in a centralized location where all have access to the same information, or direct, reliable communications must exist between the heads of agencies. These requirements make it desirable to assign unambiguously the Civil Defense functions to be performed to appropriate emergency service organizations.

Following the example of emergency service grouping employed in ALFA NEOP,[2] the operating zone organization consists of the chief executive of the local government or a Zone Controller appointed by the chief executive (either of whom normally uses the Civil Defense Director as his principal agent in carrying out his responsibilities), and five emergency operating services: Shelter, Police, Fire, Resource, and Medical. The structure organized to meet the anticipated threat may be varied by local authorities during the planning and preparation stages to meet the unique needs of the local jurisdiction.

With the organization described in Rainey,[3] the responsibilities for performing the Civil Defense functions are as shown on the following page.

This grouping has been chosen to be consistent with the events and situations described in the AFLA NEOP EOC Checklist.[3] The communication needs that result from the events that require actions for each function can now be developed with the same pattern of responsibilities set forth in the checklist.

Civil Defense Direction (Chief Executive or Zone Controller)

Civil Defense warning
Radiological defense
Communications

Shelter Service

Shelter
Welfare

Police Service

Police
Plant protection

Fire Service

Fire fighting
Rescue
Evacuation

Resource Service

Engineering
Transportation
Public utilities

Medical Service

Medical and health.

Accomplishment of NEOP actions requires the interplay of manpower, facilities, and resources. This interplay is primarily dependent on communication. It will be noted that within the ALFA NEOP EOC Master Checklist, some communication responsibilities are included within the province of Direction and Control. Key elements of Warning and RADEF (radiological defense) functions also are included, along with the emergency operational information and emergency public information functions. Direction and Control is therefore structured, in part, as a service. Assignment of these functions to Direction and Control

helps to ensure high-level attention to these key facets of Civil Defense and the overall coordination of functions performed by diverse organizational entities.

Other functions are structured within the NEOP to provide for the continuation of normal activities to the extent practicable. Fire and police operations are somewhat expanded for greater emergency usefulness--for example, the gathering of RADEF readings by Fire and Police Service personnel may be required--nevertheless, the normal functions generally prevail. The Civil Defense shelter function, meshed with normal welfare department activities, provides emergency protection and recovery services for local populations. The local department of public health is projected as the coordinator of medical and health functions to produce maximum public benefit under emergency conditions.

Probably the most complex functions in NEOP are those included in the "Resource Service." The quantity, quality, and type of available resources vary between jurisdictions, zones, or geographic areas. Broadly speaking, however, the functions include those that can be provided by public works departments, public utilities, the military transportation entities, and all segments of available commerce and industry.

Although not specifically identified in ALFA NEOP, requirements for communication permeate every action listed. Without communication facilities, only limited verbal messenger information is available, decisions must be based on outdated or incomplete information, and there is no way to transmit a decision for implementation except by messenger.

IV COMMUNICATION REQUIREMENTS

A. General

Nuclear emergencies will create a dramatically hostile and unfamiliar environment. Of particular significance here is that the immediate and direct effects of blast, radiological effects, and weapons-caused fires will have catastrophic effects on the communication systems that are basic to emergency operations. Any high-level weapons bursts will greatly increase the ionization of the ionosphere in the vicinity of the burst. This ionization effect spreads with time and its impact on certain communications frequencies will persist for long periods of time. Communication, particularly long-distance radio links, will be distorted and disrupted over wide areas for hours. Weapons bursts closer to the earth's surface will result in more immediate disruption and degradation of communication: Blast and shock waves can destroy studios, radio stations, antennas, and telephone lines; fires can seriously damage communication facilities. EMP (electromagnetic pulse) effects can damage or destroy unprotected communication facilities by generating high-level voltage and current surges in communication and powerlines and equipment. Where fallout from weapon bursts occurs, communication degradation can also result from radio signal attenuation and increased noise.* Extensive reference material concerning protective actions that can be accomplished is available in other documents. The reiteration of the principal effects here is to underscore the environment in which the communication requirements are developed in this study.

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*This phenomenon, like ionization, varies with frequency but in a somewhat more complex manner.[6]

B. ALFA NEOP Checklist and BOS-Related Impacts on Communication

ALFA NEOP-FG F-1.2/2[2] is based on a joint OCD/SRI study "Nuclear Emergency Operations Planning at the Operating Level."[3] "ALFA" is defined as the plan for "in-place" protective actions (as opposed to actions associated with evacuation emergency operations) and NEOP is an acronym representing Nuclear Emergency Operations Plan. In ALFA NEOP, environmental events are keyed to trigger three kinds of actions:

- Automatic actions in response to the triggering event
- Conditional actions to be taken automatically when the conditional requirements in the action statement are satisfied
- Discretionary actions that require a judgment or decision at the time of the triggering event.

The basic situations that contain the triggering events are defined in FCDG, G-I,[1] which establishes nine Basic Operating Situations (BOS) applicable to conditions arising from a nuclear attack. The rationale for their adoption and the guidance for planning to meet each condition are also provided. The BOS standardization permits a common interpretation of the situation codes and contributes significantly to an understanding that is a necessary ingredient in planning. The BOSs outline nine generalized environmental circumstances of fire and radiation (see Figure 1). The numerical codes provide a framework that permits specific circumstances to be related to planned actions in the affected geographic areas.

The ALFA NEOP EOC Master Checklist[2] provides a flexible format with brief résumés of actions to be taken in reaction to specific events. Within this format, provision is made for BOS recognition and the relationships of nuclear attack hazards (Figure 2) to the planned actions in the checklist.

		0.5 R/hr	50 R/hr
		NEGLIGIBLE FALLOUT	MODERATE FALLOUT	SEVERE FALLOUT
NEGLIGIBLE DAMAGE OR FIRE		1	2	3
CONTROLLABLE FIRE		4	5	6
UNCONTROLLABLE FIRE		7	8	9

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FIGURE 1 BASIC OPERATING SITUATIONS

Telecommunications are subject to degradation or disruption in varying degrees under all BOS conditions. The general disruptive influences to communication for each of the nine BOS are structured in a BOS grid format and summarized in Figure 3.

Peak overpressures resulting from weapons bursts are expected to bracket the category of Controllable Fire within the 1.5 to 5.0 pounds per square inch (lb/in^2) range. These figures are indicated on the chart (Figure 4) as an aid in comprehending the extent of damage anticipated.* Heavy damage, ranging to total destruction, will occur in areas subjected to blast overpressures greater than 5 lb/in^2, and the communication facilities that might survive under these conditions would have to be housed within strong structures such as reinforced concrete bomb/blastproof shelters.

Using this environment as a guide, and ALFA NEOP as the basis for taking actions requiring communication, the communication requirements, grouped into the ALFA NEOP Services, are described in the following sections.

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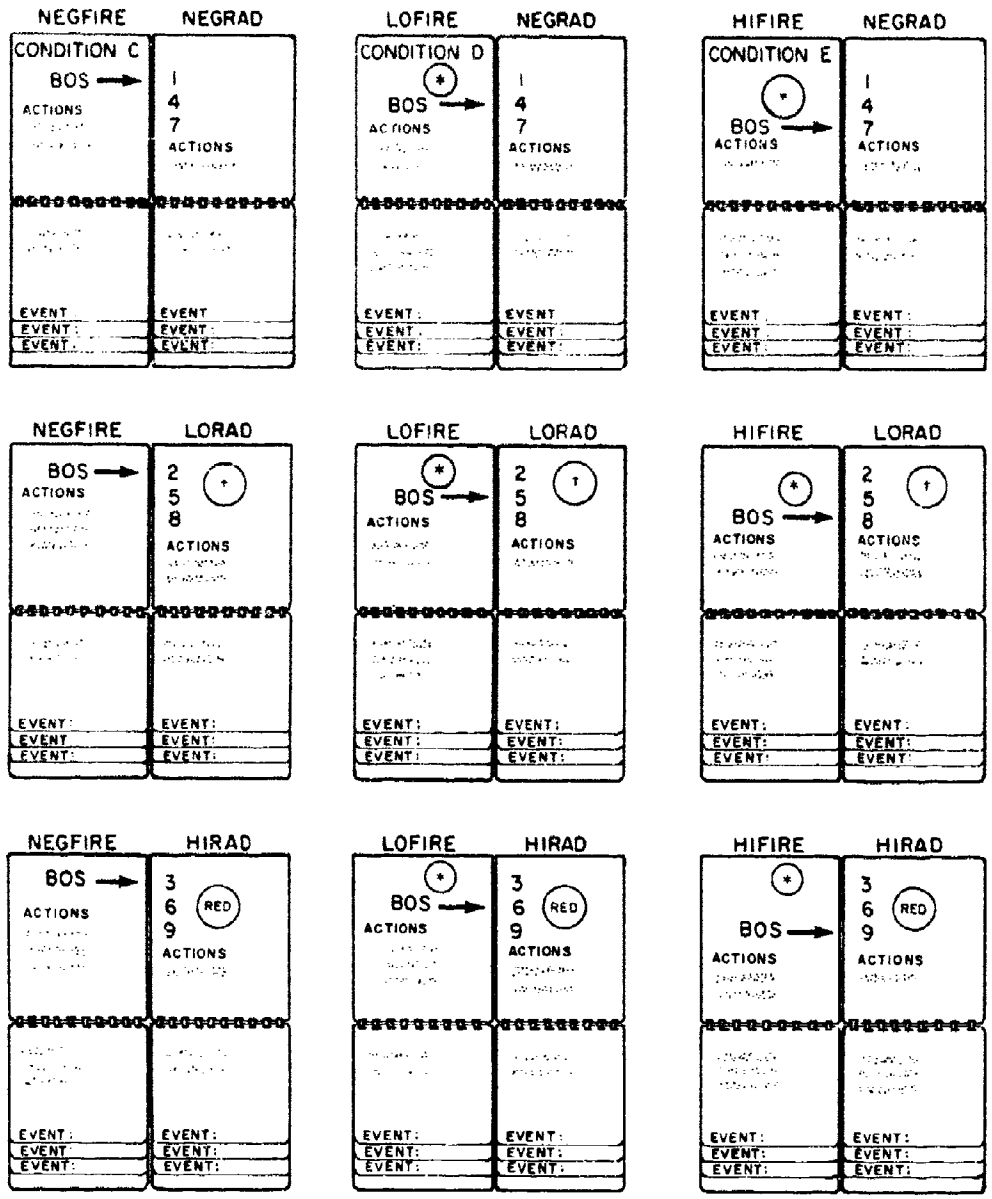
* For comparison, the nominal peak pressure generated on the ground by sonic booms is on the order of 3 lb/ft^2 (0.0208 lb/in^2).[4]



* COLOR CODED: Black, if fires are not under control. White, if fires are under control or out.

† COLOR CODED: Red, if dose rates are increasing. Yellow, if dose rates are decreasing and if that peak was less than 50 r/hr. Orange, if dose rates are decreasing if peak was greater than 50 r/hr.

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FIGURE 2 FORMAT AND CONTROL SYMBOLS OF MASTER CHECKLIST

INCREASE FALLOUT

INCREASE BLAST/FIRE/EMP

1 NEGRAD-NEGFIRE

- Local communication facilities and long-distance facilities in local area not physically damaged.
- Local communication channels subject to negligible fallout degradation.
- Long-distance communication channels subject to possible degradation or disruption by remote conditions.

2 LORAD-NEGFIRE

- Local facilities and long-distance facilities in local area not physically damaged.
- Local channels subject to moderate fallout degradation.
- Long-distance channels subject to probable degradation and disruption.

3 HIRAD-NEGFIRE

- Local facilities and long-distance facilities in local area not physically damaged.
- Local channels subject to severe fallout degradation.
- Long-distance channels subject to severe degradation and disruption.

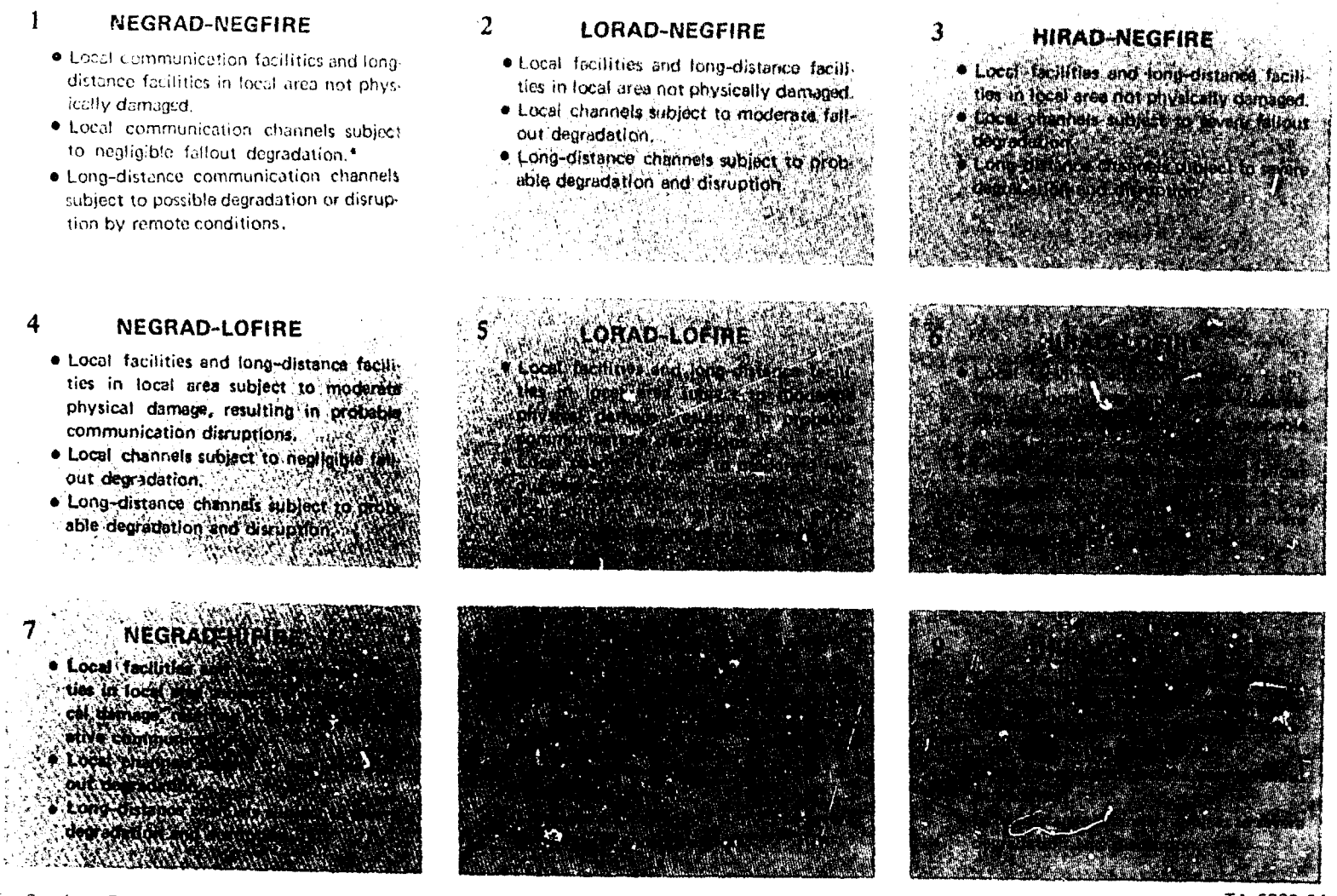
4 NEGRAD-LOFIRE

- Local facilities and long-distance facilities in local area subject to moderate physical damage, resulting in probable communication disruptions.
- Local channels subject to negligible fallout degradation.
- Long-distance channels subject to probable degradation and disruption.

5 LORAD-LOFIRE

6

7 NEGRAD-HIFIRE



SOURCE Stanford Research Institute

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FIGURE 3 BOS-RELATED DISRUPTIVE PHYSICAL ENVIRONMENT INFLUENCES ON COMMUNICATION

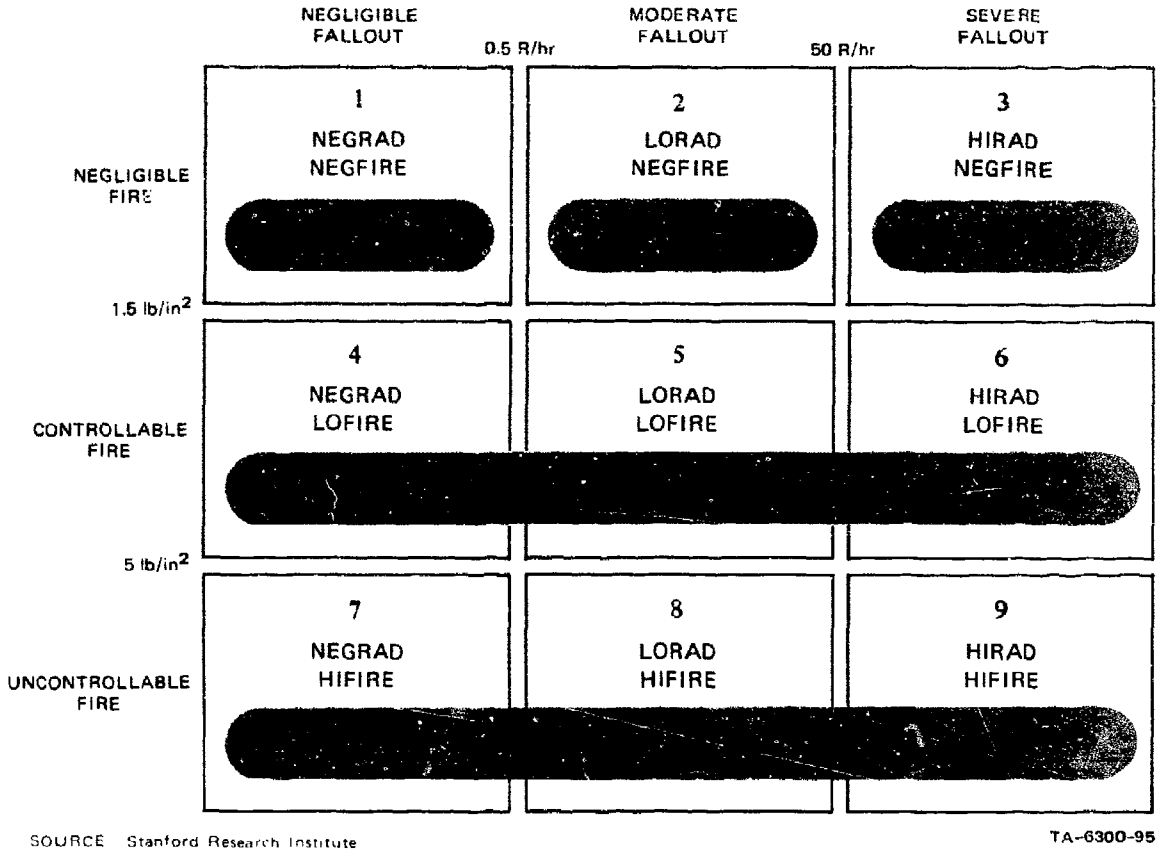


FIGURE 4 NINE BASIC OPERATING CONDITIONS VERSUS THE FIVE PLANNING CONTINGENCIES

C. Communication Requirements of Responsible Agencies and Functions

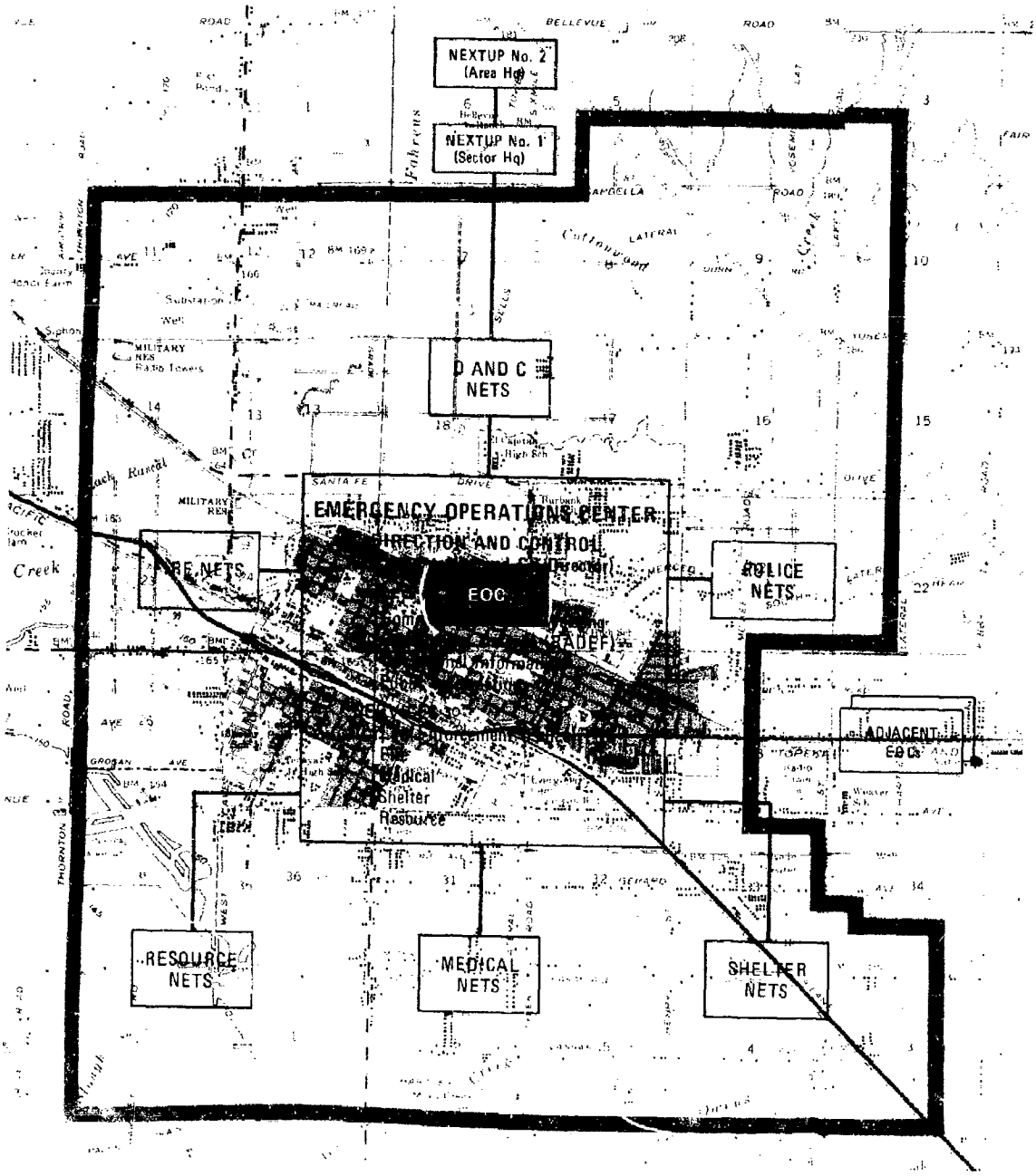
1. General

The organizational structure outlined for "Nuclear Emergency Operations Planning at the Operating Zone Level," when coupled with the allocation of organizational responsibilities, establishes a framework for structuring the communication networks to support the plan. The ALFA NEOP EOC Master Checklist treats the operating zone as an independent jurisdiction. Within this concept, therefore, the CD Director serves as an advisor to the Zone Controller--possibly the local mayor. In the zonal EOC, the Direction and Control (D&C) function is divided into staff functions: Communications and Warning, Operational Information, Radiological Defense (RADEF), and Public Information. In addition to D&C, five services complete the organizational structure within the EOC: Law Enforcement (Police), Fire, Medical, Shelter, and Resource.

Common carrier communication (telephone and telegraph) is the principal means employed and is considered to be available to all elements. The several radio communication networks required to support the five services and the D&C staff from within an EOC are indicated in Figure 5.

In developing the communication requirements expressed in terms of this structure, interactions between the various D&C elements and functions, as well as between the five services and their subordinate elements, were tabulated to ascertain the organizational interactions required. Most actions were found to depend on common carrier communication. Models outlining the radio communication links necessary to accomplish the actions outlined in the EOC Master Checklist were then structured for D&C and the five services.

The rationale employed to structure the radio communication models include the following considerations:



SOURCE Stanford Research Institute

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FIGURE 5 ALFA NEOP (Zonal Level) RADIO COMMUNICATION CONCEPT

- Radio communication capabilities will be provided primarily for the EOC and those functions or services where radio communication is normally employed:
  - police and fire departments
  - public utility services
  - between adjacent EOCs, and for the receipt of CD warnings at EOCs if the NAWAS drop is in a location other than the EOC.
- Radio communication is somewhat less predominant, but is frequently found:
  - between EOC levels and "NEXTUP" EOC levels
  - in medical services
  - in support of RADEF systems
- Radio links are found less frequently between local EOC's and EBS Stations,* or between EOCs and CD shelters.

The structure of the developed ALFA NEOP radio communication "requirements models" (represented in Figures 6-12) employ the rationale above, adjusted to reflect recommended guidance as set forth by Hall[5]--e.g., the suggestion of using radio for communication with chief executives and CD directors in mobile situations--modified by added details from minimum CD communication requirements set forth by Bledsoe and Mecozzi.[6]

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*Radio backup for communication with EBS stations is considered highly desirable. Radio broadcast communication links often exist through telephone company facilities.

These requirements models are general in nature and are graphically portrayed on an irregular zonal border background to convey an impression of geographic limits. Relationships with organizational entities outside these limits (NEXTUP or Adjacent EOC) are shown, as are the relationships with those entities that extend across borders on a multiple zone, sector, or area basis (e.g., the electric company or telephone company). The organizations that are considered to be usually available at the zonal level are identified. In addition, recognition of the likelihood of contact with additional entities is shown by symbols identified as "other." Alternative facilities or a different organizational structure in zones may require some adjustment in detail.

Communication difficulties undoubtedly will arise within any typical zone as the actions are accomplished by officials during a crisis period. The greater strains on means of communication--particularly radio--will become apparent as the attack warning is received and priority actions are required.

Directly influencing radio communication is the ALFA NEOP requirement to protect against EMP (electromagnetic pulse) by disconnecting antennas over 5 ft in length, including multistory antenna leads from transmitters and receivers, and employing mobile equipment as alternative base stations where required to maintain operational control of mobile fleets. Unless specific EMP protective equipment* have been employed, this action will effectively reduce or eliminate radio communication by base stations; meanwhile, it will require mobile base or relay stations, the details of which will have to be determined within the zone. Communication alternatives are available to support this action; nevertheless, questions arise concerning the availability of mobile base stations that could provide the radio D&C structure for local

*See OCD Technical Reports 61, 61A, and 61B.

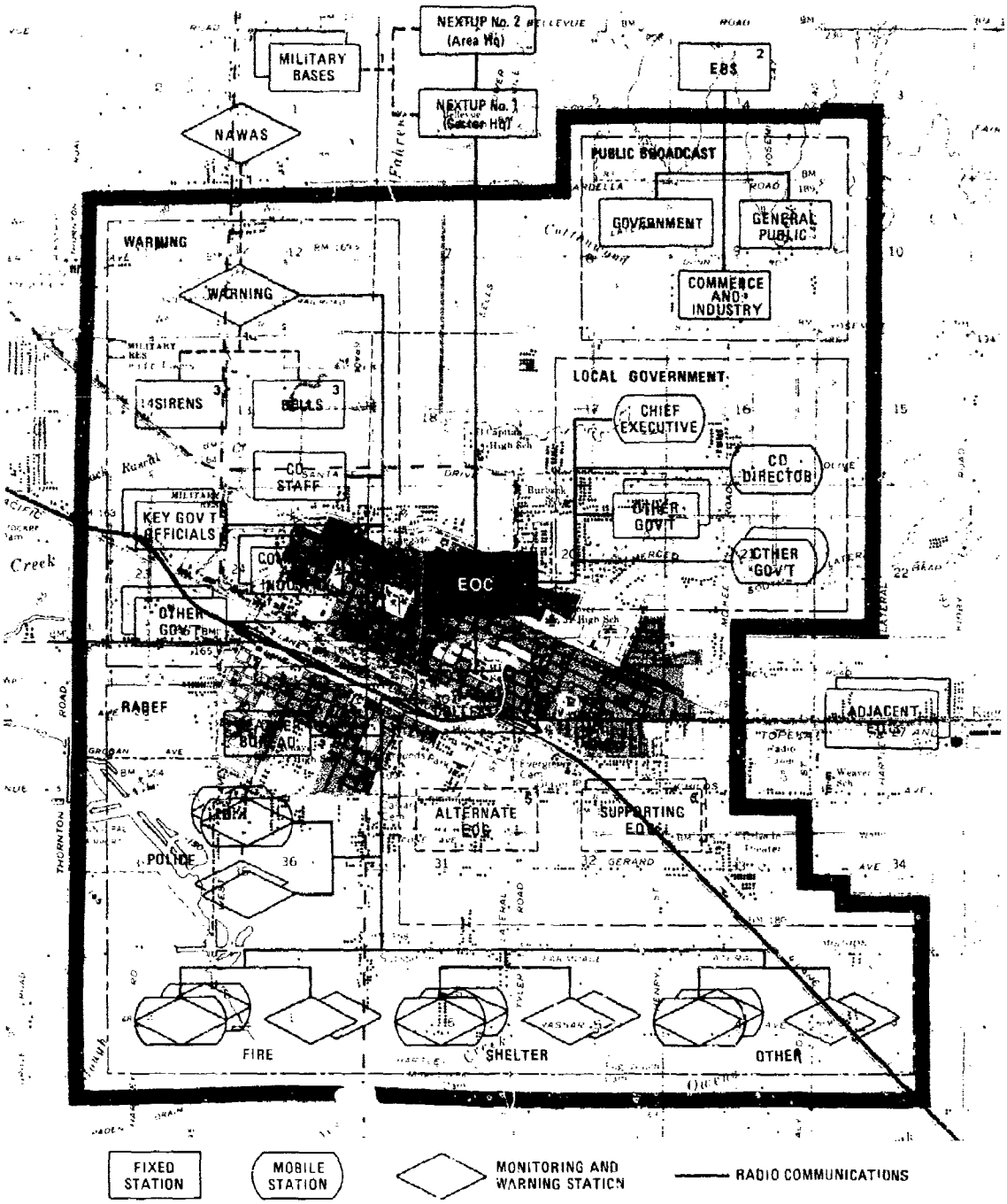
government or RADEF monitoring. Mobiles should be designated to serve these D&C radio nets as well as police, fire, medical, shelter, and resource nets.

Another ALFA NEOP action requires the Shelter Service to establish a fire watch. The accepted technique of stationing personnel on upper levels of the taller structures to perform this function suggests the use of radio to relay information. What provision can be made to meet this requirement? Radio communication capabilities are not normally available within the Shelter Service; hence, the interaction link must be with the Fire Service, which must provide direction and leadership for this function. Again, however, suitable radio communication means should be defined. Still another ALFA NEOP action requires the Resource Service to furnish traffic engineering support to the police. A need for interaction between Street Department mobiles and Police Department mobiles is a likely result.

It is evident that the matching of available communication resources to satisfy the requirements arising from each action must be given careful, detailed attention.

2. Direction and Control

The entities with whom the D&C component of a zone must communicate are shown in Figure 6. While CD communication facilities are normally located within the EOC during an emergency period, the centers of authority (the Chief Executive or his designated representative, and the CD Director) may be initially outside the EOC; and the communication requirements remain. This would be particularly true during a major emergency build-up or crisis period.



1. Communications normally are via wire link.
2. EBS may be outside or inside the zone.
3. Warning means vary by locality.
4. High volume RADEF information collecting may be physically separated from the EOC.
5. Alternate EOC may be either inside or outside the zone.
6. Some zones may require one or more SUPPORTING EOCs.

TA-6300-97

SOURCE Stanford Research Institute

FIGURE 6 DIRECTION AND CONTROL (D & C) NETWORKS

The radio communication nets are roughly grouped in functional areas such as warning, public broadcast, RADEF, and local government--including a link to NEXTUP. Although the radio net symbols show single ties to the EOC, multiple nets may exist and the entities shown linked to the EOC may not, in fact, be able to intercommunicate directly. Central control points can be most helpful in collecting and relaying information under such circumstances. Contact with those entities not linked via radio may be available via common carrier or nonexistent.

D&C communication is required to organizations outside the zone not only for direction and control but for warning and information flow purposes as well. NEXTUP contact may be through a Sector or Area organizational link, depending upon local arrangements. Contact with military bases outside the local zone will normally be made through NEXTUP. The long-distance communication required for D&C purposes usually will be channels to adjacent EOCs or NEXTUP locations.

In brief, radio communication requirements of the D&C function include:

- Warning links intended to reach the EOC, key government officials, other government agencies, key industry locations, and other nongovernment agencies.
- An EBS (Emergency Broadcast System) outlet intended to reach the public with one-way communication.
- A RADEF net, which should include two-way communication with police, fire, and shelter RADEF units, plus other locally available RADEF units. The EOC RADEF information collecting point may be separated from the EOC to reduce the anticipated volume of EOC traffic in this functional area. In the event of separation, a radio channel should be provided from the RADEF collecting point to the EOC.

- A local government net (or nets) intended to permit EOC contact with the Chief Executive, CD Director, and other designated government personnel in mobile situations.

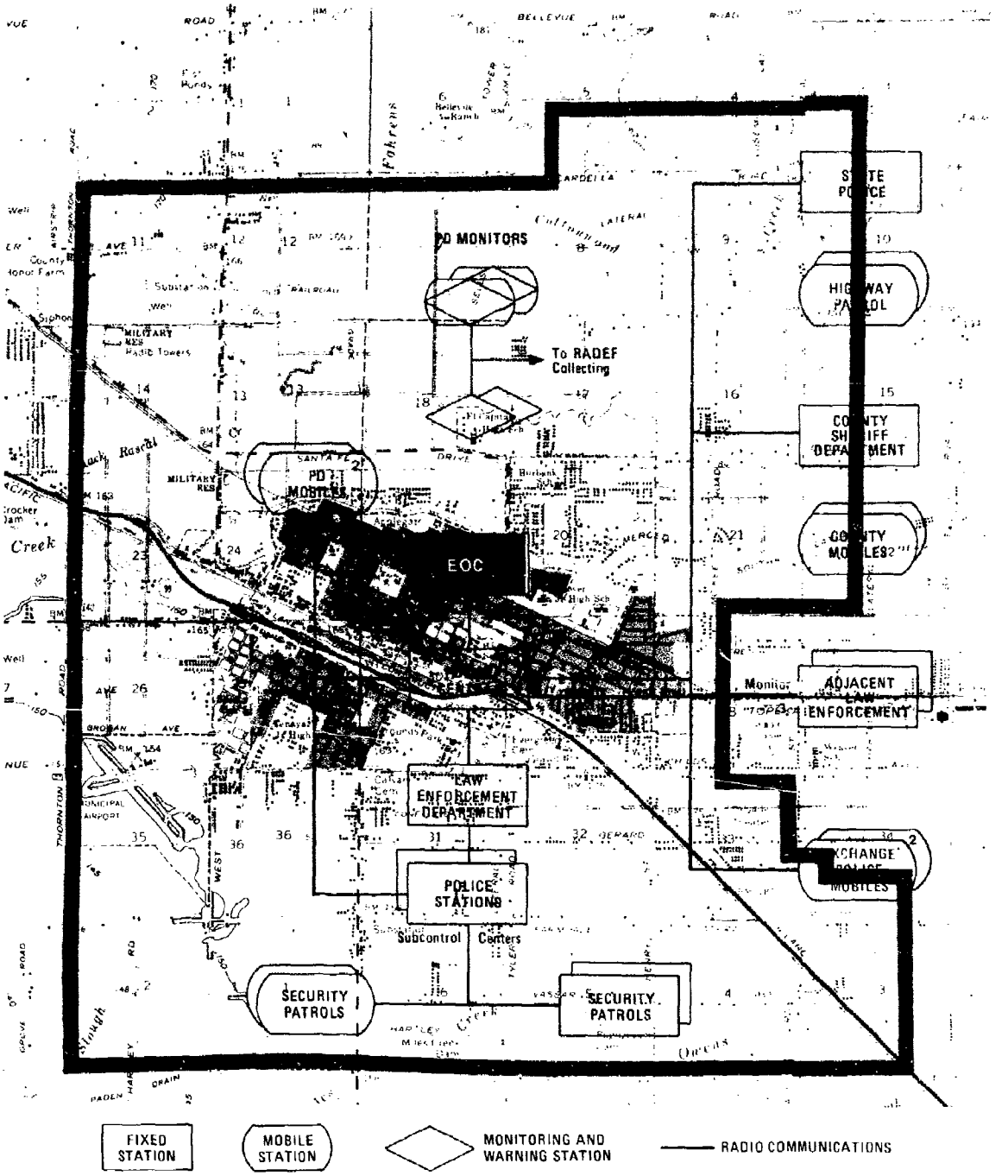
Radio will be the primary means of communication in all cases where mobile elements are represented. In all other cases radio is considered as a backup to common carrier communication.

3. Police Service

The normal functioning of Law Enforcement--performed by the Police Service--is expanded under conditions of a major emergency. However, the functions added are not too different from those normally performed during daily operations. Police responsibilities include security, traffic control, and crowd control, plus aiding CD efforts in public warnings, monitoring of RADEF conditions, and cooperation with other agencies and departments as necessary. Communication nets used by the police are expected to remain in being for use by the police.

The organizational structure and facilities of the Police Service varies from community to community, and operations may not always entail use of police stations as subcontrol centers, nor the use of a police central for overall control. Greater liaison activities within the zone and with law enforcement departments near the zone are anticipated. The elements requiring interconnection to Police Service activities are shown in Figure 7.

Except for mobiles, common carrier communication is assumed to be available to support the Police Service. Radio, nonetheless, is the primary means of communication normally used by the police. The added requirements for organizing, directing, and controlling additional security patrols, or for providing RADEF information to collecting points should not entail any major difficulties if radio equipment and channels



1. The POLICE CENTRAL may be physically separate, or be included within the LAW ENFORCEMENT DEPARTMENT or EOC structure.
2. EXCHANGE POLICE MOBILES should be capable of intercommunication and communication with zonal PD MOBILES at a disaster scene.
3. In addition to monitoring, a capability for radio communication with ADJACENT LAW ENFORCEMENT jurisdiction is desirable.

TA-6300-98

SOURCE: Stanford Research Institute

FIGURE 7 POLICE NETWORKS

can be made available to accommodate the added traffic. One-way monitoring circuits or interarea common user frequencies are recommended between adjacent law enforcement departments for use as a source of intelligence concerning conditions in surrounding areas.

The emergency radio requirements to be added to normal police communication include:

- Provision for RADEF monitoring and the input of RADEF information to the zone collecting point
- Provision for direction and control of security patrols operating throughout the shelter complex and in other areas of the zone as necessary
- Provision for one-way monitoring or interarea communication with adjacent law enforcement department activities if not already in being
- Provision for liaison with county and state police, principally for traffic monitoring and control, if not already in being.

4. Fire Service

The role of the Fire Service will be expanded in a major emergency in a manner that somewhat parallels the increased responsibilities placed on the Police Service under the ALFA NEOP. Again, however, the added functions are not too different from those normally performed during daily operations. Fire Service responsibilities will continue to include fire fighting, plus an increased role in rescue work; additional responsibilities include the direction of population relocations in collaboration with police, and assisting CD to monitor fallout conditions

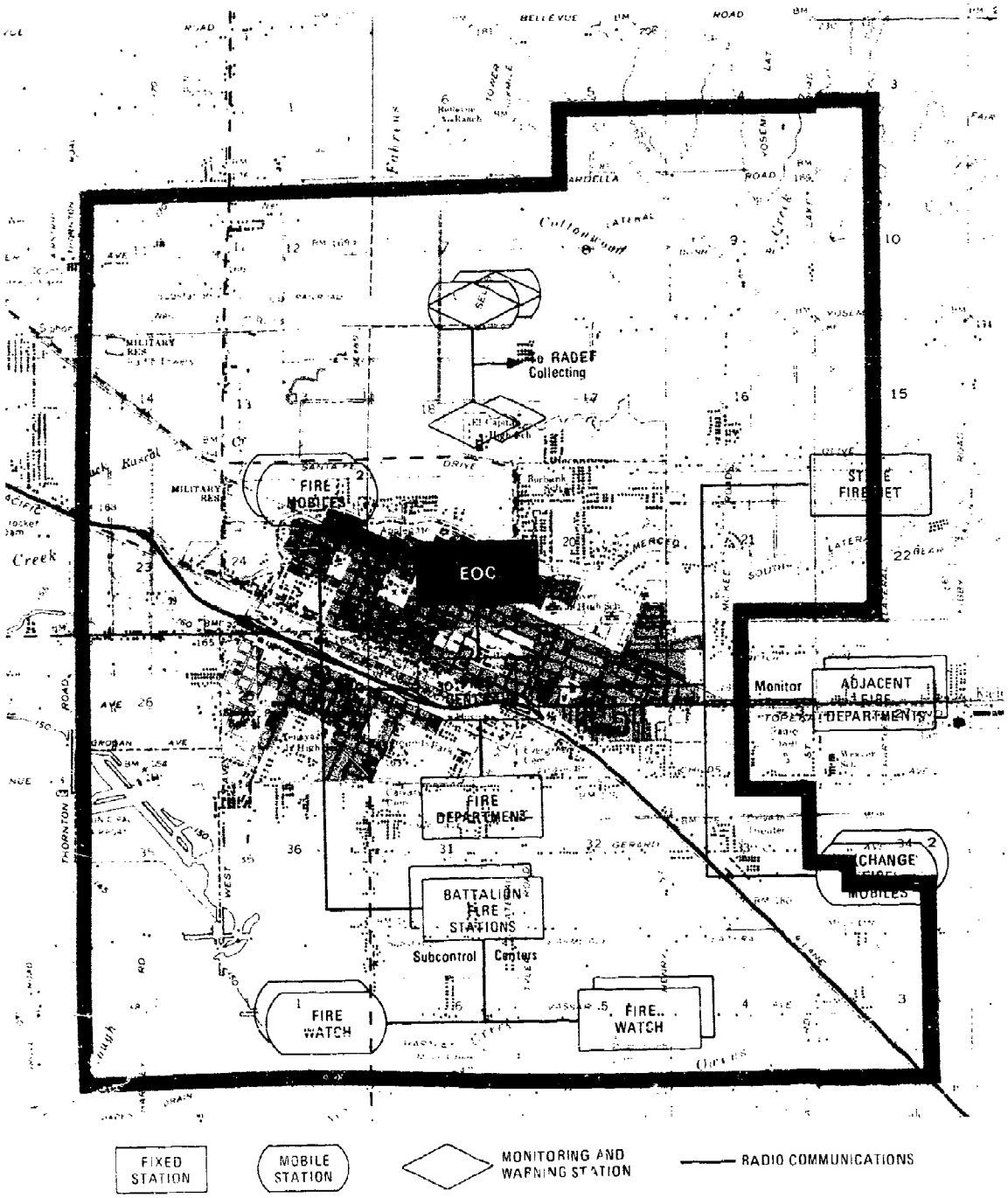
and provide public warning. Communication nets used by the Fire Service are expected to remain in being and continue to be used by the Fire Service.

The organizational structure and facilities of the Fire Service varies from community to community, and operations may not always entail the use of fire stations as subcontrol centers nor the use of a fire central for overall control. Greater liaison activities within the zone and with fire services near the zone are anticipated. The agencies requiring interconnection to support Fire Service activities are shown in Figure 8.

Except for mobiles, common-carrier communication is assumed to be available to support the Fire Service. Radio, however, is the primary means of communication normally used by the Fire Service. The addition of requirements for organizing, directing and controlling a fire watch, or for providing RADEF information to collecting points should not create any major difficulties if radio equipment and channels can be made available to accommodate the added traffic. One way monitoring circuits or interarea common user frequencies are recommended for use between adjacent fire departments.

The radio requirements to be added to normal Fire Service communication include:

- Provision for RADEF monitoring and input of RADEF information to the zone collecting point.
- Provision for direction and control of a fire watch operating throughout the zone.
- Provision for one-way monitoring or interarea communication with adjacent fire department activities if not already in being.



1 The FIRE CENTRAL may be physically separate, or be included within the FIRE DEPARTMENT or EOC structure.
2 EXCHANGE FIRE MOBILES should be capable of intercommunication and communication with zonal FIRE MOBILES at a disaster scene.
3 In addition to monitoring, a capability for radio communication with ADJACENT FIRE DEPARTMENTS is desirable.

TA-6300-99

SOURCE Stanford Research Institute

FIGURE 8 FIRE NETWORKS

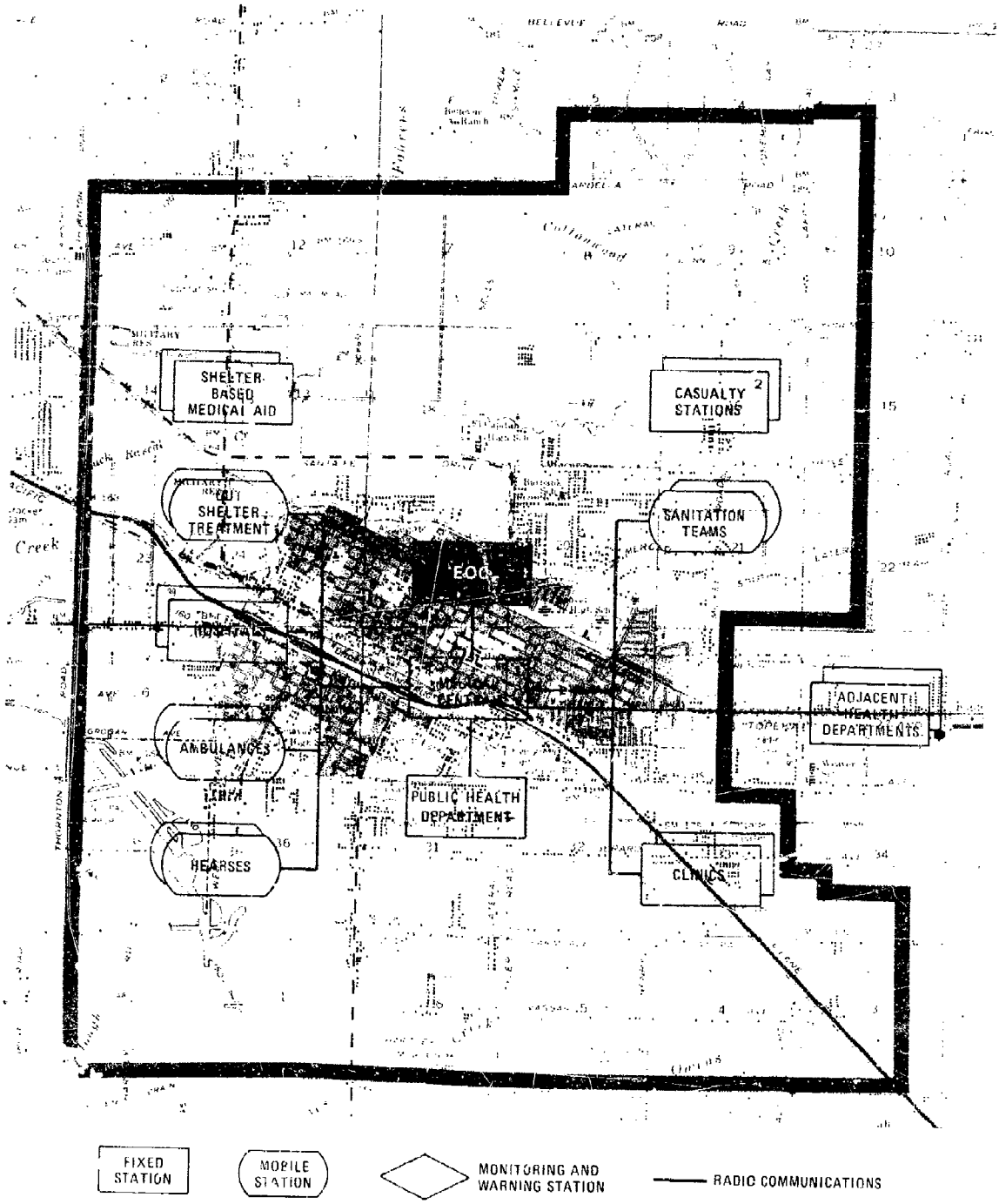
- Provision for accepting operational control of Fire Service vehicles sent into the zone from adjacent zones, as well as provision for zone vehicles to work with adjacent zones on a reciprocal basis when necessary.

5. Medical Service

A generalized Medical Service radio network organized to meet health and medical needs resulting from a major emergency is shown in Figure 9. Again, with the exception of the mobiles, communication between elements is assumed to be available via common carrier. Direction of the Medical Service is expected to be exercised by the local Public Health Department. A "Medical Central" coordination function is necessary and may be performed within the confines of the Public Health Department (this is most likely to occur during a crisis build-up period), at a separate facility (perhaps a hospital serving as a control center), or within the EOC at the time mobilization and movement to shelter are required.

The functions to be performed and the volume of actions to be accomplished by the Medical Service increase with the anticipated sequence of events outlined in the ALFA NEOP. Normal medical facilities such as hospitals and clinics, with their communication support being provided by common carrier, would be used as much as possible. Radio communication, as backup to the common carrier facilities, is considered to be highly desirable and such additional facilities should be provided as standard equipment for daily use to ensure their operability and effectiveness during emergency situations.

In the event of a nuclear attack, the Medical Service actions required to counter anticipated hazards entail the use of shelter-based medical aid teams and medical aid teams at casualty stations--including



1. The MEDICAL CENTRAL may be physically separate, or be included within the PUBLIC HEALTH DEPARTMENT or EOC structure.
2. Include aid at staging areas.

SOURCE: Stanford Research Institute

TA-6300-100

FIGURE 9 MEDICAL NETWORKS

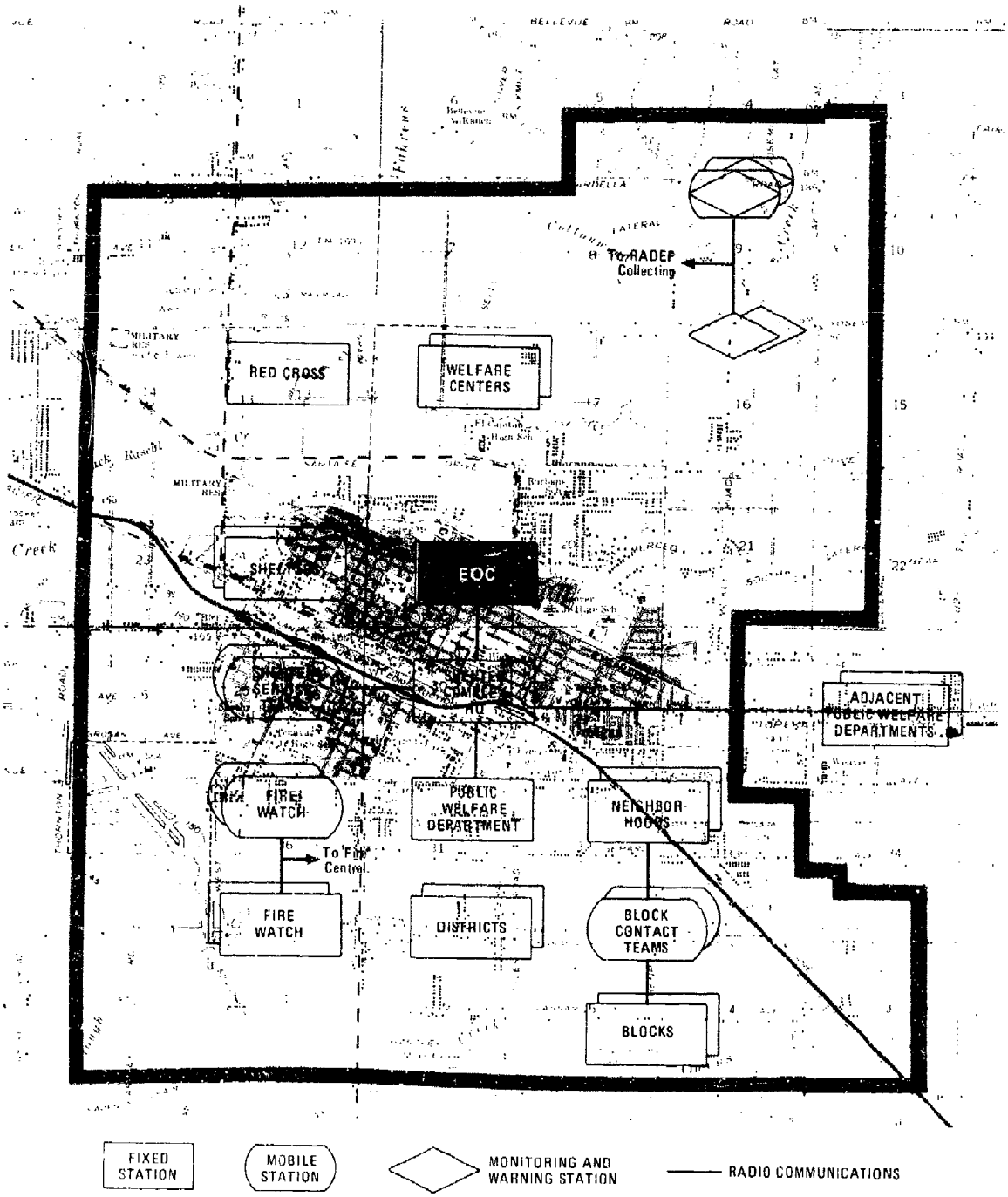
aid at Staging Areas. Communication between the Medical Central and these locations may be available via common carrier. Nonetheless, radio communication links as alternati s or for backup purposes are desirable and should be provided for.

The mobile teams--ambulances, outside-shelter aid teams, sanitation surveillance teams, and hearses (for interment)--require radio communication. Mobile links with the Medical Central generally are considered to be the most feasible means to ensure the existence of access to central information sources and for coordination and control within the limited geographic area of the zone.

Coordination with adjacent Medical Centrals is also required, and this may be accomplished via common carrier communication, or by radio through the EOC/NEXTUP link.

6. Shelter Service

On implementation of the NEOP, the Shelter Service will require considerable cadre augmentation and a structuring of organizational relationships that are not usually required until the occurrence of a major emergency. Elements that would have to be included in the Shelter Service structure are shown in Figure 10. The local Public Welfare Department is designated as the agency charged with operation of the Shelter Service. During a build-up or crisis period, direction and control of the Shelter Service may be exercised from the Department's normal location without much difficulty. Following mobilization to meet emergency needs, however, the need for operation under emergency conditions would come into being, and thus communication facilities between the various elements shown would become necessary.



1. The SHELTER COMPLEX HEADQUARTERS normally will be physically separate; however, it may be included within the PUBLIC WELFARE DEPARTMENT or EOC structure.

SOURCE Stanford Research Institute

TA-6300-101

FIGURE 10 SHELTER NETWORKS

Geographically, the operating zone may be divided into blocks, neighborhoods, and districts.* Shelters may be assumed to be scattered throughout the zone with one or more of their locations designated as Shelter Complex Headquarters. In some situations the direction and control of shelter complexes may be exercised from the EOC. Welfare Centers to serve the general public are activated as needs arise. Such centers are considered to be valuable in conjunction with the zonal Staging Areas that are planned to be used as vehicle parks and as control and relay points in moving populations from one location to another.

Communication support for most of the elements of the Shelter Service is expected to be provided by common carrier facilities. The mobile teams, however, that are organized to carry out the functions of RADEF information collection, fire watch, shelter service, and block contact, produce a set of requirements that can be satisfied effectively only by means of radio.

In summary, radio communication requirements of the Shelter Service are primarily those resulting from use of mobile teams to perform the following service functions:

- RADEF information collection
- Fire watch
- Block contact
- Shelter service.

Radio backup, if available, is considered highly desirable for interconnecting the EOC with:

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*These elements are established to carry out local emergency actions to the degree feasible in the event of loss of communication with the EOC.

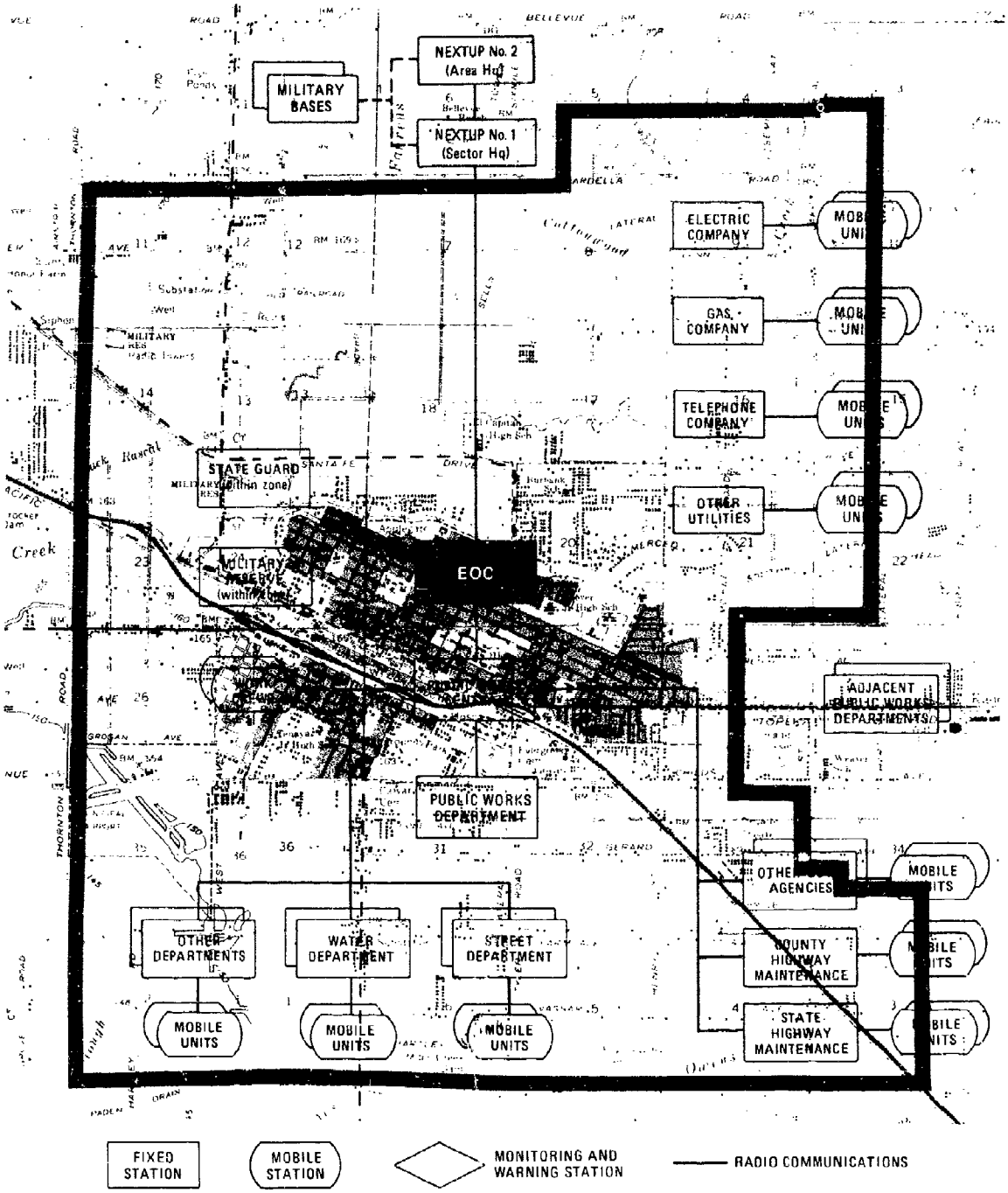
- Welfare centers at staging areas
- Shelter complex headquarters.

Additional backup links, again if they are available, would be useful between the Shelter Complex Headquarters and zonal districts or neighborhoods.

7. Resource Service

The large number of disparate agencies that may encompassed by the term "Resource Service" in any given operating zone can be estimated by analyzing the mission statement that assigns the functions to be performed by this Service: "The mission of the Resource Service is to control essential supplies and transport, maintain or restore essential services, and eliminate hazardous conditions resulting from attack...."[2] The elements generally included in the Resource Service are shown in Figures 11 and 12. The categories of organizations indicated have been divided for convenience into "Public Service" and "Supply and Transportation."

Recognition of the impact of geography on the wide range of activities included in the Resource Service is evident in the NEOP requirement that a resource management liaison group at Sector and at Area Headquarters should be established for each of the following areas: power, food, gas, construction, housing, industry, manpower, petroleum, solid fuels, transportation, water, telecommunications, and economic stabilization.

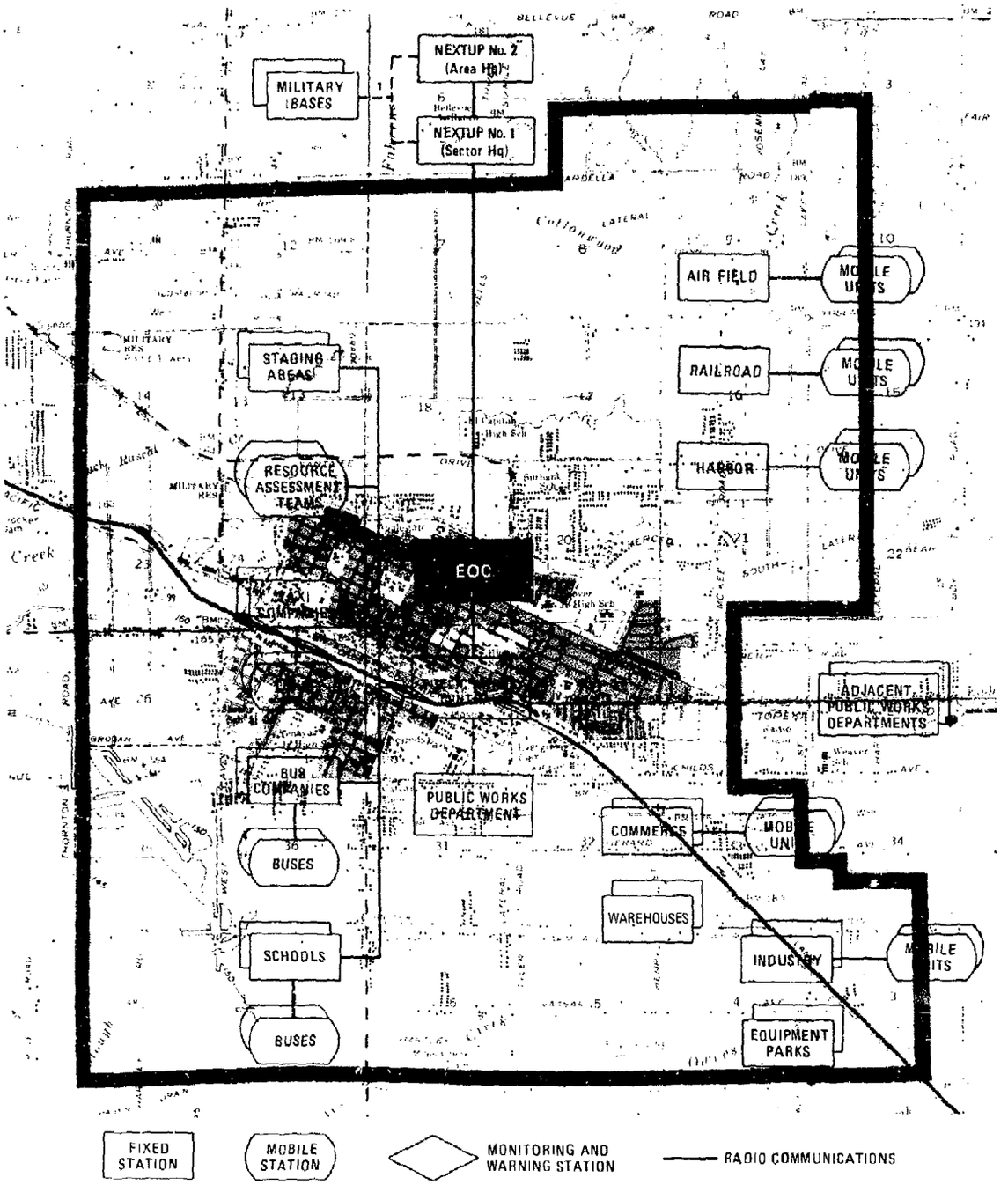


1. Communications normally are via wire link.
2. The PUBLIC WORKS CENTRAL may be physically separate, or be included within the PUBLIC WORKS DEPARTMENT or EOC structure.

TA-6300-102

SOURCE: Stanford Research Institute

FIGURE 11 RESOURCE NETWORKS: PUBLIC SERVICES



1. Communications normally are via wire link.
2. The PUBLIC WORKS CENTRAL may be physically separate, or be included within the PUBLIC WORKS DEPARTMENT or EOC structure.

TA-6300-103

SOURCE Stanford Research Institute

FIGURE 12 RESOURCE NETWORKS: SUPPLY AND TRANSPORTATION

The efficient use of the available resources in a nuclear emergency will be largely dependent on those advance preparations that result in agreements between public and private organizations that permit necessary coordinated and mutually supporting actions. The ALFA NEOP prescribes that the Resource Service, in times of emergency, coordinates supply, transportation, and service matters with private utilities and other organizations (whose operations extend beyond the zone) through Sector or Area Headquarters. Similarly, the interchange of requests for civil and military mutual aid support are to be made through Sector Headquarters.

A definite need for access to adequate radio communication facilities to supplement the common carrier links to NEXTUP is indicated by the responsibilities and requirements for coordination placed on the Resource Service. Such radio links would serve the Resource Service in a dual role; that is, both helping it to carry the heavy administrative and logistical communication traffic likely to be generated, and as a backup in the event of the loss of the common carrier service.

Requirements for radio communication with mobile elements are also shown in Figures 11 and 12. Airfield, railroad, and harbor communication may call for special considerations in some situations. Furthermore, provision must be made to accommodate the extra radio communication requirements generated by work force teams.[12] Teams of these types will be temporary in nature, and hence their communication requirements may be satisfied by temporary reassignment of other means not being used for other applications. NEOP actions calling for periodic status polling of these service units under fallout conditions, require the use of radio for effective communication.

Transportation centers at staging areas provide logical points for employment of alternate stations and mobile base stations for use

in direction and control of mobile fleets. Backup radio communication between the EOC and Transportation Centers is highly desirable to ensure the responsiveness of transportation elements.

In summary, radio communication requirements of the Resource Service include:

- Access to radio links between the EOC and NEXTUP, in addition to common carrier
- Links between the "central" and Public Works Departments using mobile radios that may be used for access to public service mobile stations in event of parent organization displacement to EOC or loss of communication with the parent organization
- Links permitting interconnection of County and State Highway Departments
- Links to work crews
- Links to resource assessment teams
- Links between the "central" and transportation entities that may be used for access to the mobiles of these organizations in event of loss of communication with parent organization
- Alternate or backup links with Transportation Centers at Staging Areas.

V FACILITIES AND SYSTEMS AVAILABLE

A. General

It is convenient to examine those facilities and systems generally available to meet Civil Defense emergency communication requirements in two categories--governmental and nongovernmental. The governmental category includes several classes of Public Safety Radio Services and other elements of national, state, and local government communication systems that could reasonably be expected to provide assistance. The availability, adaptability, and constraints involved govern the extent of possible use which ranges from very little to full utilization.

Part E, Chapter 3, Appendix 1 (Communications Planning and Assessment Techniques and Procedures) of the Federal Civil Defense Guide lists categories of communication systems that may be found in an area. The categories set forth in that document are indicated as:

A. Government Communications Systems

B. Industrial Communications Systems

C. Business and Miscellaneous Communications Systems

D. Transportation Communications Systems

E. Military Communications Systems

F. Common Carriers

G. State Agency Communications Systems

H. Federal Government Agencies

Since optimum utilization of communication facilities is more contingent upon technical characteristics and regulatory constraints than upon such categorizations as those listed above, it is more useful for the purpose of this study to classify and discuss the communication facilities in terms of the services defined and described in FCC Rules and Regulations. Accordingly, this section of the report is organized in accordance with the FCC listings.

B. Government-Owned or Leased Services

1. Public Safety Radio Services

a. General

Seven services make up the group referred to as Public Safety; the title is self-explanatory in most cases:

(1) Local Government

(2) Police

(3) Fire

(4) Highway Maintenance

(5) Forestry-Conservation

(6) Special Emergency Radio Services

(7) State Guard.

Category (6) requires some clarification: The Special Emergency Radio Services include hospitals, ambulance operators and rescue organizations, physicians and veterinarians, disaster relief organizations, rural school buses, beach patrols, establishments in isolated areas, standby communication facilities, and crews for emergency repair of public communication facilities. Although different communities and states vary,

for present purposes only Disaster Relief and School Bus authorizations are considered as possible groups that may be government owned or controlled. The remainder of the groups in the Special Emergency Service are discussed as nongovernmental activities in Section V-C.

Except for Special Emergency and State Guard services, frequencies are available for assignment in each of the three land mobile bands (Lo, 25-50 MHz; Hi, 150-174 MHz; and UHF, 450-470 MHz), plus some lower frequencies, some in the 72-76 MHz band, and some microwave frequencies. The Special Emergency Radio Service has no UHF assignments; the State Guard has no assignments in any of the land mobile bands.

Availability of Public Safety Radio Services to CD emergency operations is stated in Paragraph 89.17 of the FCC Rules and Regulations:

> A station licensed under this part may transmit communications necessary for the implementation of civil defense activities assigned such station by the local civil defense authorities during an actual or simulated emergency, including drills and tests; provided, that such communications relate to the activity or activities which form the basis of the licensee's eligibility in the radio service in which authorized.

A more liberal interpretation on the use of Public Safety Radio Services for Civil Defense functions was set forth by FCC Commissioner Loevinger on 19 April 1968, in a letter to the Iowa Director of Civil Defense, who had asked whether Civil Defense administrative, command and control-type communication could be assigned as a Civil Defense function to a Public Safety Radio Service. An affirmative answer was given with the following limitations:

- The function must have been assigned by an authority having jurisdiction over both the Civil Defense activity and the Public Safety system concerned. At state level this might be the governor or his designee. At

local level it might be the mayor, manager, or other official meeting the jurisdictional requirement.

- The function must be contained in an established Civil Defense operational plan.
- The function must not preempt the use of the radio system in the discharge of departmental duties not contained in the Civil Defense plan.

Another paragraph of special interest to CD activities is found in the FCC Rules and Regulations, Paragraph 89.159, quoted below:

> During an emergency requiring a l. al communication center, any authorized mobile transmitter may be operated temporarily as a base station at a fixed location for a period not to exceed ten days. If operation for a longer period is required, such operation must be specifically authorized.

This paragraph provides considerable flexibility in the use of a mobile station at an alternate EOC or other communication center as an interim base station at fixed location pending the establishment of a regular base station.

b. Local Government Radio Service

Territories, possessions, states, counties, cities, towns, and similar governmental elements are eligible for Local Government Radio Service authorizations that permit communication essential to the official activities of the licensee.

Local government base stations are authorized communication with local government mobile stations; both base and mobile stations are authorized to intercommunicate with other base and mobile stations in the Public Safety Radio Services and to transmit to receivers at fixed locations. Local government fixed stations also may communicate with

other Public Safety fixed stations. This service, therefore, enjoys a wide flexibility of use and its primary communication authorization concerning official activities of government permit its employment in Civil Defense operations as a government activity.

c. Police Radio Service

Eligible licensees for Police Radio Service are states, territories, possessions, counties, cities, towns, and other governmental institutions authorized by law to provide their own police protection. This service exists in almost every community and is normally required for its basic purpose in Civil Defense emergencies, viz., law enforcement.

d. Fire Radio Service

Fire Radio Service is authorized to the same governmental entities as is Police Radio Service, providing the entities are charged with specific fire protection activities.

e. Highway Maintenance Radio Service

Similar to the foregoing services, authorizations for Highway Maintenance Radio Service may be issued to states, territories, possessions, counties, cities and towns; however, authorized communication is limited to that essential to the official highway activities of the licensee.

f. Forestry-Conservation Radio Service

The Forestry-Conservation Radio Service is also similar to the above services but is limited to those governmental entities having specific forestry-conservation activities.

g. [illegible] Emergency Radio Service

Of the nine eligible groups in the Special Emergency Radio Service, it is possible that Disaster Relief and certain school bus organizations may be government owned or controlled. The School Bus group is limited to those school buses having regular routes into rural areas. If the buses are nongovernment, the applicant must define the authority under which he operates the buses and the tenure of any contractual agreement. This group is restricted to the transmission of messages pertaining to safety of life or property, or urgent messages relating to inoperative buses while on regular runs.

Disaster Relief organizations are authorized to use radio if they have an emergency communication plan requiring its use. Again, this group--like the rural School Bus group--is authorized communication related to the safety of life and property; in addition, Disaster Relief may handle communication pertaining to the establishment and maintenance of temporary relief facilities and the alleviation of the emergency.

h. State Guard Radio Service

Duly constituted official state guards--or comparable organizations of a state, territory, possession, or the District of Columbia--may obtain authorizations in the State Guard Radio Service; when authorized, these organizations may transmit emergency communications relating to public safety and the protection of life and property. Training periods are also authorized. No land mobile band frequencies are authorized; in fact, only one frequency (2726 kHz) is generally authorized on a shared basis with the Special Emergency Radio Service. A second frequency between 2505-3500 kHz may also be made available in a particular state with adequate justification.*

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*See p. 118 for comments on other possible exploitation of state military forces in our area.

1. Summary

The Public Safety Radio services provide a diverse and important application to Civil Defense emergency communication. The constraints are not prohibitive, and most of the services are widely available. The crucial consideration here, as in other services, is to provide access to these communication assets from the point of control of emergency operations--the EOC.

2. Military Bases

Planning jurisdictions located near military bases should establish liaison with the post/base/station communication officers, as well as the major tenant units' communicators. While military bases and units have prescribed emergency missions in the event of a national emergency or war, there are many areas of mutual interest and cooperation--including communication--that are of great interest to both the civilian community and the armed forces. The normal military communication facilities are not available to civilian sources; however, in extreme emergencies, it may be possible for the military base to accept and transmit traffic for the community. Certainly, the possibility should be explored.

Practically every Army, Navy, and Air Force installation has a MARS (Military Affiliate Radio System) station on post whose priority missions include handling Civil Defense emergency traffic.* Liaison should be established and arrangements made for a radio link to the MARS station from the EOC. One solution that has been adopted is a 50 MHz, 144 MHz, or a 420 MHz amateur-band point-to-point circuit. Another adequate solution is negotiated loan of a military radio, preferably netted with the MARS station in the installation command net. Such circuit

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*See Section V-C-7 for a discussion of MARS.

linking the military bases and the community can provide current information on items of vital interest to the area such as casualty figures, location of fires and degree of control, fallout, amount of destruction and emergency assistance requirements. The link to the MARS station would normally be used for message traffic to higher and adjacent governmental levels. Normal telephone service would also be used, of course; however, if disruptions occur or line load control is imposed, radio would become the primary means of communication.

The Radio Amateur Civil Emergency Service (RACES)* is authorized two frequencies (3997 kHz and 53.3 MHz for initial military contact) that can also be used to provide the link to the base. 3997 kHz is in the top end of the amateur 80-meter band and would normally be used for SSB radiotelephone, lower sideband. 53.3 MHz is in the amateur 6-meter band and, if narrow-band frequency modulation is used, will intercommunicate with most of the Army's tactical FM voice radios, as well as many different models of Navy, Marine, and Air Force voice radios. Local arrangements and tests should be completed in each area.

3. Other Governmental Agencies

There are numerous agencies, branches, departments, local offices, and elements of local, county, state region, state, and Federal governmental entities that are located throughout the United States. Most of these elements rely on regular dial telephone service, often supplemented by Wide Area Trunking System (WATS), Autovon, and Autodin. Some of the agencies, however, use mobile radiotelephone, some have teletype available, and all of them will generally be most cooperative to local Civil Defense representatives.

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*Discussed in Section V-C-7.

[illegible] frequencies used by the federal governmental agencies are not normally available (except as blocks as indicated in Vol. II of the FCC Rules and Regulations), the problem of utilization remains one of ascertaining the existence of the radio communication facilities, obtaining the technical details, determining applicability to a Civil Defense emergency communication requirement, and then developing a method of obtaining access to the system.

C. Nongovernment-Owned or Leased Communication Facilities and Systems

1. Radio Broadcast Services

a. General

The Radio Broadcast Services include the standard AM broadcast stations, FM (both broadcast and noncommercial educational FM), television (broadcast and educational), and the international broadcast stations. The Emergency Action Notification System (EAN), and the Emergency Broadcast System (EBS) are important parts of this service. We are not concerned on the state and local levels with the international broadcast services; although their HF (high frequency) ground wave can extend out to perhaps 30 miles. Therefore, they could conceivably serve a special requirement in the vicinity of their transmitter sites. Other than this, no further consideration will be given this service. The normal functions of the standard AM broadcast, FM broadcast, and television broadcast services are so commonly known that further discussion is deemed unnecessary.

b. Noncommercial Educational FM and TV

Discussions of noncommercial Educational FM and TV Broadcast Services are combined together here because, except for obvious differences in frequency and transmission characteristics, their operational functions, rules, and limitations are very similar. Licenses are

awarded to eligible educational organizations, either publicly supported or privately controlled, which may then transmit programs directed to specific schools for use in connection with regular courses or educational, cultural, or entertainment programs to the general public. The stations may broadcast programs produced by, at the expense of, or furnished by others if the only consideration received by the licensee is reimbursement of costs of producing and broadcasting the program.

The noncommercial educational stations, like their commercial counterparts, have blanket FCC permission for total (if necessary) commitment of their communication facilities during emergency conditions of a local, regional, or national nature. Examples are given by the FCC* of emergency situations that might warrant immediate or delayed response by the licensee: "Tornadoes, hurricanes, floods, tidal waves, earthquakes, icing conditions, heavy snows, widespread fires, discharge of toxic gases, widespread power failures, industrial explosions, and civil disorders. . . . In addition, and if requested by responsible public officials, emergency point-to-point messages may be transmitted for the purpose of requesting or dispatching aid and assisting in rescue operations." Reports to the FCC are required following each period of emergency operation.

c. Experimental, Auxiliary, Special, and Program Distribution Services

This area includes experimental television and facsimile broadcast stations; developmental and remote pickup broadcast stations; aural broadcast STL (Studio-Transmitter Links), and intercity relay stations; television auxiliary broadcast, broadcast translater, and broadcast booster, stations; the instructional television fixed service; community antenna relay stations; and cable television systems (CATV).

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* Including paragraphs 73.98, 73.298, 73.597, 73.675 of FCC Rules and Regulations.

Except for CATV and remote pickup broadcast circuits, these services are all highly specialized and of limited use to the general public as emergency communication facilities. CATV is discussed in some detail in Section V-C-2.

Experimental and developmental stations are seldom able to define their operating capabilities over a protracted period; thus they are difficult to fit into any well-defined, long-term Civil Defense communication plan. Nonetheless, they are authorized to assist in emergencies and would undoubtedly be valuable during any emergency. Their transitory status, however, reduces the desirability of assigning them a firm mission in plans.

The remainder of the services operate in the microwave region, generally with directional antennas and specific receiving locations. Their capabilities are probably not general enough to be of widespread value, although they are authorized emergency communication and the mobile stations should be considered as potentially useful. In any event, their existence should be documented and analyzed to ascertain if access can be obtained to these facilities and if they can be utilized during an emergency. As an example, remote pickup broadcast base and mobile stations offer a significant capability. Frequencies available include allocations in the 1600 kHz, 25-26 MHz, 152-162 MHz, and the 450-456 MHz bands; such stations are authorized to transmit emergency messages related to the safety of life and property with a priority over all other transmissions. Base stations (normally at transmitter or studio sites), mobile stations, and portable stations (treated as mobile stations) are licensed. Those remote pickup stations associated with broadcasting stations participating in the EBS (Emergency Broadcast System) may be used for warnings or instructions pertaining to war, threats of war, public peril, or other national, state, or local emergencies and for periodic tests or drills to ensure circuit reliability. An obvious application

would be using a remote pickup broadcast station to provide a radio circuit (primary or backup) for the EBS program loop from the EOC to the EBS.* Since the base station for the remote pickup circuit already contains technical provision for simultaneous (live) broadcast of the program material arriving over the remote pickup circuit, it is admirably suited for this purpose.

2. Cable Television (CATV)†

CATV started as a broadband, one-way communication system, but is moving toward a two-way capability. Idle bands are sometimes available within its passband. Generally, a CATV system consists of the receiving system ("head-end" equipment) and the distribution system, which carries the signals to the individual subscribers.

The head-end site includes a number of receiving antennas, usually mounted on a tower or located at a fairly high elevation in order to achieve a high received signal strength. Electronic equipment amplifies the incoming signals and, if necessary, converts them to different channels for better system operation and freedom from various types of interference.

Of importance to this discussion is the distribution system between the head end and the subscribers. A main trunk line connects the head-end site to the community. It consists of high-quality coaxial cable with repeater amplifiers (main trunk amplifiers) spaced along the cable or a community antenna relay (CAR) link(s). The main trunk line is generally routed over the shortest possible path between

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*This application is specifically authorized in paragraph 74.432 d. (4) i and ii of Vol. III, Part 74 of the FCC Rules and Regulations.

†Current usage for the former "Community Antenna Television."

the head end and one or several distribution points, or hubs. The feeder (distribution) system connects the hub to the subscribers via coaxial cable. The hubs and feeder system are of principal concern to us here. The feeder system spreads out from hubs to provide service in a city, and distribution amplifiers are spaced as required along each feeder to maintain signal levels within prescribed limits.

A typical distribution amplifier has a bandwidth of 50 to 220 MHz or perhaps 250 MHz. The system is equalized to ±0.25 dB over the pass band and gain and phase adjustments are provided at intervals along the system to compensate for loss variations at different frequencies. A CATV system, then, is a well-engineered, nonradiating, VHF, communication system with widespread distribution. Even the unidirectional systems can be useful in Civil Defense.

Two-way communication is essential to most CD employment. However, command and control communications from superior to subordinate agencies is more important than in the reverse direction, and should have the highest possible grade of service. This can be compared with communication within a Naval task group where communication down the chain of command has such high priority that split-frequency operation (two one-way circuits) is commonly employed. The commander has instant access to his channel at all times, since replies, receipts for messages, and reports are on a different channel. The same philosophy can be usefully applied to communication in a CD organization throughout its organizational "chain of command."

Split-frequency radio communication within a CD organization is not desirable because of the lack of available frequencies. CATV, however, could provide some of the advantages of both the telephone system and the radio broadcast principle, if certain major problems could be overcome. The problems are best highlighted by a description of the concept.

To elaborate, typical feeder line amplifiers have a pass band from 50 to 220 MHz (or slightly higher). The VHF television channels occupy from 54 to 72 MHz, 76 to 88 MHz, and from 174 to 216 MHz; the FM broadcast band occupies from 88 to 108 MHz. A 12-channel-plus-FM CATV system provides spectrum space from 50 to 54 MHz, 72 to 76 MHz, 108 to 174 MHz, and some space above TV channel 13. Thus, approximately 78 MHz of space exists that could provide more than 15,000 3-kHz voice channels with liberal guard bands, or 3,500 20-kHz FM channels, provided suitable equipment were available to use this space. Even if the proposed 28 CATV channels plus FM allocations are standardized, there still remains sufficient unassigned space for some 300 20-kHz FM voice channels in the 50-250 MHz pass band.

To implement this concept, each city with a CATV system could reserve a portion of the cable spectrum for its own purposes. The best choice would be in the band between 150 and 174 MHz because existing land mobile equipment operates in this band, and could be applied to the CATV system with proper adaptation. Since nonradiating signals are sent over the cable, external radio interference is unlikely. However, care must be taken to ensure noninterference with other signals in the cable.

For a detailed example of this use of CATV, suppose the fire department of a city having a CATV installation uses 154.130 MHz, FM modulated, for normal communication between Fire Dispatch and the various fire stations. During CD operations, Fire Dispatch becomes a part of the EOC and most of the fire stations will probably become Alternate Disaster District Headquarters (ADDHQs). If the EOC were to use the CATV cable for the Fire Service command traffic on 154.130 MHz FM, and the ADDHQ were to use the radio link on the same frequency for the return traffic, the principle of split-frequency operation could be achieved, provided further that the ADDHQ transmitter were physically remote from

its associated receiver (that is connected to the CATV system), or that the receiver is extremely well shielded, or both. Spectrum congestion could be alleviated rather than exacerbated because one direction of traffic has been taken off the air. This assumes that the EOC can access the CATV cable with a properly modified Fire Dispatch transmitter, and that each fire station has a CATV drop. Although both assumptions can be resolved, there are several technical problems involved in this type of operation. First, most land mobile equipment is of the transceiver type, i.e., a combination transmitter and receiver in which one or more elements (or stages) are common to both transmitter and receiver, although the common elements perform different functions in each mode. Thus, a unit cannot receive while it is transmitting, and vice versa. Another problem relates to the "push-to-talk" operation of these sets, and their use of a single antenna that is automatically switched between transmit and receive modes. Even if two transceivers are used at each terminal to achieve split frequency operation, the transmitter output of one transceiver pair at the EOC must be heavily attenuated to prevent overloading the CATV system, and the receiver in the other set must be permanently connected to the antenna. At the ADDHQ, one receiver antenna input of a transceiver pair must be permanently connected to the CATV cable while the transmitter of the other transceiver must be connected to its normal antenna.

A more economical alternative would be to provide an inexpensive receiver at the EOC and the fire stations. In this case, only one transceiver would be required at each location. The EOC could continuously transmit (without interruption) to all outstations over CATV, while the outstations would be able to engage in regular net operation between themselves (with the EOC monitoring) or to transmit (one at a time) to the EOC even while the EOC is transmitting. The requirement for transmitter-receiver separation and thorough shielding remains.

Gaining access to the CATV cable can be accomplished in a variety of ways, many of which involve considerable expense and extra equipment that would be used only during emergency conditions. For example, the channel (or group or supergroup) telephone terminal approach could be used. This requires considerable common equipment both at the sending and receiving terminals--clearly too expensive. The more basic concept outlined above requires (at the most) an extra receiver at terminals and relatively inexpensive equipment at the sending terminal (which, for practicality, should be the CATV hub).* Access to the CATV hub can be via normal telephone channels from any location in the city. The required number of FM transmitters* can then be installed in the hub. Note that these transmitters must be suitably modified to provide very low power (nominally -6 dBm). A further advantage of locating the transmitters at the hub is that the outputs from a group of transmitters can be combined into one composite amplifier* for better regulation of the signal input level to the cable system.

One CATV equipment manufacturer makes an FM-band composite amplifier, retailing for around $100, that accepts up to 14 FM signals and conditions the composite signal to the proper level. Changing the composite amplifier to accept the hi band land mobile frequencies is technically feasible. Several manufacturers of FM industrial radio equipment were approached for estimates on costs for the low-level FM transmitters. In many cases, existing equipment (less the output stage) would be adequate, although modification to the transmitter would be required. The cost estimates ranged from a low of about $80 up to slightly over $200 for separate low-level FM transmitters.

The requirement for a CATV drop in the necessary CD locations should be made a condition in the award of a CATV franchise.

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*Note that no fully configured commercial devices or kits presently available, although it is technically feasible and can be accomplished by qualified persons.

The nonradiating principle of this use of CATV can be extended even further. Consider the case where a forest products manufacturer (with a base station and several mobiles) is designated as a shelter complex headquarters (SCHQ). The mobiles could be assigned to the various shelters supervised by the SCHQ. Normal over-the-air two-way communication can be conducted during emergency conditions. If there were an FM low-level transmitter on the proper frequency at the CATV hub and telephone lines between the hub and the SCHQ base station, the base station could broadcast to the shelters and the shelters could reply via radio on a half duplex basis, again provided extensive modifications are made to the transceivers. More importantly, the EOC or the appropriate ADDHQ can also transmit, via cable, to any or all of the shelters. They may be prohibited from using the particular frequency over the air, but with proper authorization they can use the CATV cable.

An obvious expansion of this plan uses as many land-mobile radio services as necessary (or as many as are available with adequate protection factors) to furnish communication between the EOC and the various echelons of organization. This reduces the concern of the CD director/coordinator regarding not only the provision of adequate communication facilities, but also of the logistics of these communication facilities. Basic expenses to the city are the cost of the CATV drops, extra receivers, and purchase and installation of the FM low-level transmitters and composite amplifiers at the CATV hub. Systems using amplitude modulation (AM) may also be included. In this last case, separate composite amplifiers would be required.

The above considerations involving CATV have almost exclusively addressed one-way CATV systems. Just prior to the completion of this

report (September 1971) the Federal Communications Commission approved a plan to modify several aspects of CATV, and forwarded the plan to Congress for comment prior to planned implementation in March 1972. Further, the Office of Telecommunications Policy (OTP) was structuring an Administration Policy on CATV that will provide a new perspective on such elements as industry structure, common carrier versus limited carrier status, the degree, level, and type of regulation, copyright in the broadest sense, access, ownership, public service uses and the effect on broadcasters and on the special classes of viewers. OTP is reported to view this development as, perhaps, the most significant nationwide domestic issue of this decade.

Among the changes contemplated are:

- In the 50 largest cities, the FCC would require CATVs to carry at least three local network stations and three local independent stations. A station that complied could then carry programs from two distant stations.
- In the smaller of the 100 largest cities, a station must offer three networks and two independents, but would also be permitted to carry two distant stations
- If a CATV station could only provide three local channels, it could carry three distant stations, but no more than a total of six
- The smallest cities would be provided with three network and one independent channel
- All new CATV systems installed after March 1972 will be two-way systems
- Provision for more nonbroadcast services than were possible before, e.g.:

- Education
- Local features
- Information retrieval from libraries
- Daily shopping
- Link to computers, banks
- Instant polling and voting
- Security systems transmission line to response forces
- Broadband, two-way, switchable communication systems
- Local public safety communication channels.

In the light of these rapidly expanding developments, serious attention should be given to several of the areas associated with the CATV improved capabilities. It would appear that local Civil Defense emergency communication and warning systems are destined to undergo significant, perhaps radical change in the near future.

3. Maritime Radio Services

a. Land Stations in the Maritime Services

Stations in the maritime radio service include Public Class and Limited Class Coast Stations; shore radio location, radio navigation, and radar stations; marine fixed, control, and repeater stations; and shipyard base and mobile stations.

The Public Class Coast Stations may communicate with any ship or aircraft station in the maritime mobile service or with any land station for the purpose of transmission or reception of safety communication to or from a ship or aircraft station. In addition, the Public Class Stations may communicate with public, aeronautical, or government ship or aircraft public service stations for the transmission or reception of public correspondence. The Limited Class Coast Stations are

used for operation, control, or maintenance of a harbor, port, or waterway; docking, direction, or servicing of commercial or government vessels; furnishing of ship departure and arrival notification; or operation of bridges, structures, or other installations that require radio communication with vessels for safety and navigation. Functions of the other types of land maritime stations are self-explanatory.

All land maritime radio stations are authorized to use the station during periods of emergency to communicate in a manner other than that specified in their license, provided the FCC is kept informed and concurs in the need for such operation.

Most of the frequency allocations for these services are in the LF, MF, or HF bands; a small block of frequencies exists between 156 and 162 MHz. From a Civil Defense standpoint, operation on the LF or MF bands requires equipment that is generally not on hand and is too expensive to purchase. On the HF band, cross-frequency operation is specially authorized, using RACES transmitters at EOC and the maritime transmitters at those stations. Tunable HF receivers are readily available at all communication stations. The VHF frequencies would fit in easily with the CD plans--if an area is fortunate enough to have a land maritime station operating in that band. Otherwise, 144-MHz amateur links can be established between the EOC and the maritime base.

Shipyard base and mobile stations may communicate only on one of three frequencies near 156 MHz. They are authorized communication concerning the immediate safety of life or property when the use of other communication facilities might be less effective. Considering the logistic support that can be afforded by shipyards, this service would be a welcome addition to any CD plan.

b. Shipboard Maritime Services

Stations in the maritime mobile service are licensed according to the class of station as designated below:

- Public ship stations authorized to employ telegraphy for public correspondence (three categories)
- Public ship stations not authorized to employ telegraphy for public correspondence; this includes limited ship stations, marine utility stations, survival craft stations, radio location stations, and radio navigation stations.

The categories for the first classification are set by the hours of service provided by the station. Stations in the second classification are generally licensed only for voice communication, although the survival craft stations may be authorized to use telegraphy in addition to voice.

Mobile maritime stations are authorized to participate in emergency communication in a fashion similar to that for the land maritime services. But, like the land maritime services, the mobile ship stations owe first responsibility to the maritime services, and hence are an unlikely source of dependable communication assistance for CD purposes for any extended period of time. Moreover, their mobility militates against inclusion in a firm communication plan for any locality unless a complex link, EOC-to-coastal station-to-ship, is feasible.

4. Aviation Radio Services

Aviation services are primarily for the safe, expeditious, and economical operation of aircraft. They include the aeronautical fixed service, aeronautical mobile service, aeronautical radio navigation service, and (secondarily) the handling of public correspondence to and from

aircraft. All communication of stations in the aeronautical mobile service is considered essential to the safe operation of aircraft and has priority over public correspondence.

Except for the Civil Air Patrol, very little outside assistance can be rendered by any aviation services station, mobile or land, during periods of emergency. During such periods, they have other priority commitments. However, the use of the Civil Air Patrol is often included in Civil Defense planning for this period. Communication with the CAP operations center and flying elements is usally effected through the RACES operation center within an EOC.

The aeronautical fixed stations provide, on a routine basis, all necessary nonpublic point-to-point communication service pertaining to safety, regularity, and economy of flight. They are required, however, ". . . to transmit without charge or discrimination all necessary messages in time of public emergency which involve the safety of life and property."* This represents a possible outlet for emergency messages, one that must be included in CD planning for the air services but which may be of marginal value to land services. The fixed stations' prime responsibility lies with the aviation services; a preponderance of their efforts will be required to meet this responsibility.

5. Land Mobile Radio Systems

a. General

The land mobile radio systems are generally considered to be composed of four groups of services: the Public Safety, Industrial, Land Transportation, and Domestic Public groups. There are more than

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*FCC Rules and Regulations, Subpart L, Paragraph 87.453.

1,900 individual, assignable frequencies for the three groups, most lying within three wide bands--20 to 50, 150 to 174, and 450 to 470 MHz--commonly called the Lo, Hi, and UHF bands, respectively. Some geographical restrictions, applicable to some of the frequencies, reduce the available channels slightly for any one area. The greater New York City area, for example, was shown by Dayharsh, Yang, and Vincent[7] to have 1,671 channels available, of which 941 were assigned: 355 channels in the Lo band, 395 in the Hi band, and 191 in the UHF band.

b. Public Safety Radio Services

Most of the Public Safety Radio Services have been briefly described as government systems in Part B of this section. The remaining elements of Public Safety Services are seven groups of Special Emergency Radio Services. Hospitals, ambulances and rescue organizations, physicians/veterinarians, and beach patrols are generally self explanatory. The fifth group, "Establishments in isolated areas," authorizes a radio service of two fixed stations where public communication facilities are not available and where the use of radio is the only feasible means of establishing communication with a local community or other source of emergency assistance. Only emergency communication is permitted, together with minimal tests.

"Communication standby facilities," available to communication common carriers, are limited to fixed stations and may only be used during periods when the normal circuits are inoperative due to circumstances beyond the control of the operator.

The last group of Special Emergency Services is that element of communication common carriers that effect emergency repair of public communication. They are authorized to operate base, mobile, and fixed stations.

The application of these services is apparent--hospitals, ambulances, rescue organizations, and physicians/veterinarians lend themselves admirably to Health and Welfare functions during emergencies, while those licensees in isolated areas, common carrier standby, and emergency repair services will generally have a far more limited application.

c. Industrial Radio Service

Ten services make up this group; the titles again are mostly self-explanatory:

(1) Power
(2) Petroleum
(3) Forest Products
(4) Motion Picture
(5) Relay Press
(6) Special Industrial
(7) Business
(8) Industrial Radio Location
(9) Manufacturer's
(10) Telephone Maintenance Radio Service.

Category (6), Special Industrial, includes diverse activities: farm and ranch operators; construction firms engaged in the building of roads, bridges, sewers, pipelines, or airfields; water, gas, oil or power production, collection, or distribution systems; mining operations, including exploration for and development of mining properties; commercial business operations rendering certain specialized services essential to industrial operations or public health, such as plowing, soil conditioning, seeding, fertilizing or harvesting for agricultural or forestry activities, the spraying or dusting of insecticides, herbicides or fungicides; livestock breeding services; and the delivery of ice, fuel, or ready-mix cement--to name a few of the functions.

Except for Categories (4), (5), and (8), frequencies are available for assignment in each of the three bands noted in Part a above (plus some lower frequencies, some in the 72-76 MHz band, and some microwave frequencies). The Motion Picture Radio Service has no assignments in the UHF band (450-470 MHz); the Relay Press Radio Service has no assignments in the low band (20-50 MHz); and the Industrial Radio Location Radio Service has no assignments in any of the bands of interest.

Availability to CD operations is covered by Paragraph 91.161 of FCC Rules and Regulations (too lengthy to be quoted here), which states (in essence) that a National Defense Emergency Authorization (NDEA) will be issued, on a system basis, by the Commission to those licensees who are engaged in industrial activities for which an approved National Industry Advisory Committee Emergency Plan has been adopted, provided that the licensee has submitted to the Commission a certification of willingness to participate in and conform to the emergency communication plans applicable to his stations. Once issued, the NDEA is effective for each station in the system concurrently with the regular license for that station, but subject to termination by the Commission at any time for various forms of noncompliance. Under certain conditions, stations in the Petroleum Radio Services may operate under somewhat more lenient restrictions than other services in the Industrial Radio Services. This involves not only an NDEA but also participation in the Petroleum and Gas Industry Communications Emergency Plan (PAGICEP).

An interesting and potentially valuable group of systems are licensed under Business Radio Services for paging systems. They are of two types:

- Induction paging systems that use low-frequency transmitters (normally below about 100 kHz) feeding special "loop" antennas (built into buildings during construction or installed in existing buildings). These systems

radiate a field only in the vicinity of the antenna and do not require FCC licensing.

- Radio paging systems that use conventional base stations and antennas and can cover distances of approximately 20 miles. Frequencies are available in the Lo, Hi, and UHF land mobile bands; these systems require FCC licensing.

The "pocket pagers" are small radio receivers that are easily transported in a shirt pocket and remain silent (squelched) until that specific pager is actuated by a coded tone. The simplest version merely sounds a tone signal that requires the listener to accomplish some prearranged action such as telephoning his office, or a central dispatch number for a message. Others--voice pagers--sound a tone followed by a voice message from the operator or system dispatcher. Both AM and FM systems are available; the lower noise level of FM makes it more generally desirable. Other available features include a high degree of resistance to "falsing" (the accidental actuation of a pager by an undesired signal or noise), "hands free" operation (no action required by the person being paged in order to hear the message and reset the pager for the next call), pager substitution equipment that permits rapid assignment of one person's call to another, and a battery life that with nominal use on specialized equipment will last 24 hours a day for a year. One fairly recent development alerts the person being paged by a flashing light or by a vibrator for tactile recognition of the call. (The first major use of the tactile equipment was at the P.G.A. championship matches in Florida where the tone "beep" was prohibited on the course as being a potential distraction to the golfers.) The tactile call is also used by the deaf and those in such a high-noise environment that the beep tone could go unnoticed.

A mandatory feature of paging systems is the ability to call selectively only one of the pagers in its system. One major manufacturer advertises

- A single-tone encoder system capable of individually calling up to 40 paging receivers
- A two-tone encoder system that can selectively call up to 1000 paging receivers individually, or in groups
- A dial access capability that permits a pager call to originate from any dial or touch tone telephone to at least 1000 paging receivers (more if required) either individually or in groups.

Most paging systems today are privately owned by their users; however, the trend appears to be toward public paging services to which small companies as well as individuals can subscribe. Paging systems are used by city governments (for key officials), private business concerns, hospitals, clinics, hotels, schools, and similar groups.

Since there is no apparent restriction on the content of the paging message, there should be no constraints involved in using these systems. Obvious CD applications are:

- Extension of the warning system to all paging systems through paging relay
- Means of contacting key government officials throughout an emergency
- Extension of emergency information from Health and Welfare communication systems to hospitals, clinics, and doctors

- Extension of any communication system that is accessible to a paging control center
- Spare paging receivers of existing systems could be placed with key officials (if they are not already in a paging system), to ensure notification of emergency conditions, regardless of their location within the coverage of the system
- Planning for a distribution of paging receivers (and their owners) to shelters to provide a one-way flow of information during the in-shelter phase. This procedure assumes an operable base station for the system that is accessible to the SCHQ/EOC.

Systems in the Industrial Radio Services, therefore, may participate in CD activities if they express a willingness to participate and get Commission approval by a National Defense Emergency Authorization. The particular Service, however, must be engaged in activities for which an approved National Industry Advisory Committee Emergency Plan has been adopted.

d. Land Transportation Radio Services

Four services make up this group:

- Motor Carrier
- Railroad
- Taxicab
- Automobile Emergency Radio Service.

The term Motor Carrier is defined by FCC Regulations, Paragraph 93.7, as follows:

> Motor Carrier. Any streetcar, bus, truck, or other land motor vehicle operated over public streets or highways or a common or contract carrier and used for the transportation of passengers or property (freight) for compensation, provided, however, that motor vehicles used as taxicabs, livery vehicles, or school buses, and motor vehicles used for sightseeing or special charter purposes, shall not be included within the meaning of this term as used in the Motor Carrier Radio Service.

The term Automobile Emergency Radio Service, as used here, means a radio communication service for dispatching of emergency road service vehicles to provide assistance to disabled automotive vehicles. Associations of owners of private automobiles as well as commercial enterprises are eligible to hold authorizations to operate radio stations in the AERS.

Motor Carrier Radio Services and Taxicab Radio Services have available frequencies in the Lo, Hi, and UHF bands, plus a few assignments in the 72 to 76 MHz band and at microwave frequencies. The Taxicab Radio Service and Automobile Emergency Radio Services have available frequencies in the Lo, Hi, and UHF bands and at microwave frequencies.

The CD availability for this group of services lies between that of the Public Safety Radio Services and the Industrial Radio Services. The Taxicab Radio Services operate with a specific CD authorization (Paragraph 93.405 of FCC Rules and Regulations) which permits the transmission of messages relating to the dispatch of taxicabs that are temporarily diverted from their normal public transportation activities to the performance of Civil Defense transportation functions. Also permitted are messages relating to the activities of the Civil Defense agency in those cases where other communication facilities, including RACES, are inoperative or inadequate, either in fact, or during a simulated Civil Defense emergency. (The Commission and the Engineer in charge of the Radio District in which the station is located must be notified of each such use.) The remaining three services in the Land Transportation Radio Services require a National Defense Emergency Authorization as for the

Industrial Radio Services, with somewhat fewer restrictions for those systems participating in the Land Transportation Industries Communications Emergency Plan (LATICEP).

e. Applicability

These three branches of land mobile--Public Safety, Industrial, and Land Transportation Radio Services (Domestic Public will be covered later)--can be made available for use in CD activities--subject to certain restrictions. Their applicability, however, still remains to be established. At first one must determine what each radio system provides as a potential asset to a community or city. Each system (there may be several hundred systems in a moderate-sized city) is a complete entity. Implicit in any operating system is the existence of all the necessary radio equipment to allow two-way communication between one or more base stations and a number of mobile stations that can vary from a few to more than a hundred. Possession of equipment implies the availability of a maintenance and repair facility of some type, either self-contained within the organization or providing its services under contract. An operating radio system also implies the presence of trained radio operators, experienced not only in the mechanics of operating the equipment in a reasonably efficient manner but also in working with the other individuals in the system in handling the traffic, as well as the logistics connected with every mobile operation. Arranging for mealtime relief, night shifts, emergency repairs, and routing instructions, and minimizing the impact of equipment limitations are logistics problems that are handled routinely by the radio system personnel. Each system in an area may have some aspects of logistics that are unique to the service or product involved; however, in every case, the problems and workable solutions are known.

It is possible that there may be as many as 100 land mobile radio systems in a particular area. These systems may be supporting a wide variety of products and services used by and hence important to the community. The total capability embodied in these systems, considering each system as a complete entity rather than as an assortment of individual stations, has not been overlooked by the Federal Communications Commission. Sections of the Rules and Regulations pertaining to emergency operation under an NDEA (paragraphs 91.161 and 93.163) state that the authorization will be issued "on a system basis."

The Federal Civil Defense Guide makes frequent reference to the importance of industry for contributing to the attainment of effective CD planning and organization. Part E-2.1 reminds the executive head of government (local) and his CD director that representatives from industry and commerce can serve as heads of emergency departments. The public officials are urged to work with businesses in the community to ensure the maximum availability of resources for emergency needs. Part A-3.1 of the Guide states that a basic purpose of a Civil Defense organization is to coordinate the existing agencies of government and to provide those unique skills and capabilities not available in existing government organizations. Part F-3.1 gives, as the objective of industrial Civil Defense,

> . . . to ensure that industrial and commercial enterprises make appropriate preparations for protecting life and property in a CD emergency. The managers of these enterprises are encouraged to prepare for civil defense by taking the actions necessary to assure their own survival and that of their work forces, to minimize damage to their facilities and operating capability, and to provide active support of the community CD program in areas where their facilities are located.

The executive head of government and his CD director are advised that, to achieve these objectives, they should:

1. Obtain cooperation of local managers of industrial, commercial, and institutional facilities in the survey, licensing, marking, and stocking of public fall-out shelters in their facilities.

2. Provide whatever technical assistance is needed to update or improve shelter capabilities of existing structures.

Apparently both FCC and OCD are interested in using commercial enterprises as a supplement to local government CD activities, not only for the resources involved, but also as supplementary shelters--if or when they have an adequate protection factor.

The fallout shelter system is the heart of the CD program. The climax of a CD crisis, hopefully, occurs when the entire populace is within well-stocked, adequate shelters. The in-shelter phase is the critical period; to be effective, this phase must have been preceded by extensive planning not only for the in-shelter phase but also for the pre- and post-shelter periods of a CD emergency. The pre-shelter period is often considered in two time frames, the increased-readiness phase and the movement-to-shelter phase. Similarly, the post-shelter period comprises the emergence phase and the recovery phase. During these four phases, the utility of commercial enterprises may be greatest although, depending on the circumstances--which no one can predict--they may also prove useful during the in-shelter phase. If fallout is negligible, for example, mobiles may be able to park near the shelters and operate their radios from shelter-supplied power. Remote operation from within the shelter is another possibility.

Now the requirements for and the restrictions imposed by an NDEA certification can be viewed in a new light. The radio systems can be far more valuable during CD emergency operations if they remain intact, i.e., with the normal operating personnel, both at the base stations and in the mobiles--precisely as required. The restrictions act

to force the most effective method of including land mobile radio services in CD activities. Two major problems that beset every local Civil Defense in the pre- and post-shelter phases are communication and logistics. (Casualties, fire, and fallout overshadow all else in the in-shelter phase, although communication is still vital.) Incorporation of several of the land mobile radio systems, intact, in the CD plan can ease the communication and logistics problems simultaneously.

Two other FCC regulations regarding stations operating in the Industrial Radio Services and Land Transportation Radio Services are pertinent. Paragraphs 91.151 and 93.151 are nearly identical. They state, in part,

> (a) Stations licensed under this part may transmit the following types of communications:
>
> (1) Any communication related directly to the safety of life or the protection of property . . . .
>
> (b) A station licensed under this part may communicate with other stations without restrictions as to type, service, or license when the communications to be transmitted are of the type described in paragraph (a)(1) of this section . . . .

The intent of the Regulatory Commission is clear. During normal conditions every licensee is legally bound to restrict his communication within the limits defined by his license; however, the restrictions are eased under circumstances relating to the safety of life or protection of property. This is an emergency condition by definition and acceptance, and it is hard to conceive of an emergency condition that does not involve either safety of life or the protection of property.

The availability of land mobile radio services to CD activities has been established. The effectiveness of their application depends on whether a service is used intact or in a fragmented fashion.

If the radio services are incorporated as systems, greater efficiency will result--which could eventually be reflected as a lower cost to the city. There is, however, an even greater advantage to be gained. This course of action could assist in combating the tendency toward apathy that many citizens assume when asked to participate in any CD or emergency planning. One reason for the apathy is that few people like to give up the professional status they enjoy in normal life to play a, perhaps, relatively unimportant (to them) role in the usually much broader effort represented by a well-organized CD plan. If a service is allowed to retain its identity, however, the participants retain their professionalism while performing the same task they do under normal conditions.

6. Citizens Radio Service*

a. General Description

The Citizens Radio Service provides for private, short distance radio service for

- Business or personal activities
- Radio signalling
- Control of remote objects or devices by radio.

The service is composed of fixed, land (base station), and mobile stations and is estimated to have over 850,000 licensees in early 1971. "Fixed service" is that service authorized between specified fixed points, "land station" pertains to a station in the mobile service not intended for operation while in motion (and in the Citizens Radio Service pertains to base stations), and a mobile station is one intended to be used

*Widely known as CB (Citizens Band).

while in motion or during halts at unspecified points. "Mobile" Citizens Radio Service also includes hand-carried and pack-carried units.

Four classes of stations presently exist in this Service:

- Class A Station--Licensed for operation on an assigned frequency in the 460 to 470-MHz band and with an input power of 60 watts or less. May be operated as mobile, base, or fixed station.

- Class B Station--Licensed for operation on an assigned frequency in the 460 to 470-MHz band and with an input power of 5 watts or less. May be operated only as a mobile station, although they may be operated at fixed locations under certain conditions. Existing Class B stations are only authorized to operate until 1 November 1971, and no new applications have been accepted for filing since 18 March 1968. Hence, these stations will not receive further consideration for purposes of this report.

- Class C Station--Licensed for operation on any authorized frequency in the 26.96 to 27.23-MHz band, or on 27.255 MHz for the radio control of remote objects or devices, or for the remote actuation of devices solely for the purposes of attracting attention; or on an authorized frequency in the 72 to 76-MHz band only for model aircraft. Since these stations do not readily lend themselves to communication without extensive modification, they, also, are not discussed further.

- Class D Station--Licensed for operation on any authorized frequency in the 26.96 to 27.23-MHz band, or on

27.255 MHz (see Appendix A), with an input power of 5 watts or less for AM radio telephony only. Of the 23 authorized channels, Channel 9 (27.065 MHz) can only be used for emergency communication entailing the immediate safety of life, the immediate protection of property, or to render assistance to a motorist. Even though the regulations permit the use of Channel 9 for marine emergencies, the Coast Guard does not provide a watch on this, or on any other Citizens Radio Service channel. A large majority of all licensed stations in the Citizens Radio Service are Class D, and these stations represent a potentially valuable source of emergency Civil Defense communication capability.

Although not a part of the Citizens Radio Service, many thousands of small, hand portable, unlicensed radio telephony transceivers are in use through the provisions of Part 15 of the FCC Rules and Regulations. This Part authorizes the operation of low-power communication devices within the band 26.97 to 27.27 MHz with a power input to the final stage not to exceed 100 milliwatts. Since the band is almost completely contained in the 27-MHz Citizens Radio Service, these devices are considered here. The power limitation restricts these devices to a maximum distance of about one-half mile. When the transmission path must pass through trees, buildings, or other obstacles, the range is much less.

The equipment authorized for Citizens Radio Service use must either be type-accepted* or type-approved† by the Commission. The type required generally depends on the class of station and the method of frequency control.

*Type-accepted--FCC type acceptance of equipment is based on data submitted by the manufacturer.

†Type-approval--FCC type approval of equipment is based on tests conducted by the FCC.

b. Applicability to CD Emergency Communication (Constraints)

Any licensed Citizens Radio Service station may transmit messages relating to Civil Defense activities for tests, drills, or actual emergencies, provided only that the operation of the station is voluntary and that the communication is conducted under the direction of a Civil Defense authority. Therefore, the only regulatory requirements for emergency use of this service are easily met by simply using them for Civil Defense emergency communication.

The principal technical limitations of this service are the power limitation and the generally widespread saturated condition of the 27-MHz band. Furthermore, additional interference from distant stations created by skywave propagation adds to the problem. The skywave signals are affected by the 11-year sunspot cycle (now on a downward trend--poorer conditions for long-distance communication), seasonal variations, and diurnal variations. For the next few years, at least, skywave interference on this band will be limited to the daytime hours only and will not be a problem during the hours of darkness. As an example, current predictions indicate that, for the month June 1972, skywave signals may be received at the following distances with the general probability indicated, using nominal power and a dipole antenna.

Distance	Probability
750-1500 miles	Best between 0700 and 1700 local time, peaking in midday for as low as 10 percent of the days at 750 miles, to as high as 75 percent of the days at 150 miles.
Over 1500 miles	Generally limited to late morning and early afternoon, not exceeding 50 percent of the days. Foreign stations are occasionally heard here.

It is probably this phenomenon that caused the existing prohibition against communication with any unit of the same or another station over a distance of more than 150 miles. Class A stations do not have to contend with skywave contamination, since the ionosphere does not support this mode of propagation at 450-470 MHz.

The interference problem has become so great that a limitation on the duration of transmissions has been established. In addition to the requirement to restrict all transmissions to the minimum practical time, communication between or among Class D stations cannot exceed five consecutive minutes. At the end of the five minutes (or sooner if the communication stops earlier), the stations must remain silent for five minutes (although they are permitted a short transmission to advise a calling station that they are in a silent period and must wait to respond). This time limitation is waived during emergencies.

c. Modifications Required for Use

There are no significant technical modifications required for use. Antennas, power supplies, and operating positions must be made available at the base station location and other outlying net stations in fixed locations. The mobiles can be used in their vehicles.

Probably the most important problem involved in the efficient use of the Citizens Radio Service arises from the voluntary nature of the effort and in ensuring that the volunteers will provide their assistance when and where required. The underlying motivating factor is community spirit and patriotism. In addition, however, an effective emergency communication organization must be a well-trained, cohesive team with experience, which requires not only training periods and tests, but occasional challenging projects to maintain interest. Apart from an interest in radio (or a need for personal communication), few operators

in the Citizens Radio Service possess any technical knowledge of electronics and communication nor do they use any particularly efficient operational procedures. The CD Communication Officer must, therefore, develop the desired net structures and frequency assignments, assign the member stations, establish standardized operating procedures, and train the nets.

With respect to frequency usage in a local planning jurisdiction, it would be most desirable to accomplish the following actions in order to reduce local interference:

- Prior to, and during the early stages of an emergency, obtain an agreement with the local Class D members of the Citizens Radio Service and the unlicensed operators to remain off the air, making the channels available for Civil Defense. Since there will undoubtedly be personal emergencies occurring to the licensees, only those channels required for Civil Defense emergency communication should be cleared.
- Prior to emergencies, use local newspaper articles, radio and TV coverage, and short meetings to explain the program and to request cooperation.
- Continue to keep Channel 9 clear as an emergency channel available to all; monitor Channel 9 continuously in the EOC for reports of new problems or additional emergency areas.
- Inform local licensees who are not members of Civil Defense nets of the details of the arrangements in each community to ensure understanding and cooperation.

- Assign a primary and an alternate frequency to each net, which will (if Channel 9 is reserved as a common emergency frequency) provide a maximum of eleven nets in the 28-MHz band.

- Carefully correlate the capabilities of the net member stations with the frequency assignment plan to ensure that their equipment is capable of transmitting and receiving on those frequencies assigned to the net. Class D stations exist in many configurations ranging from a single crystal-controlled frequency for both transmit and receive to those capable of operation on all 23 channels, with many options of intermediate capabilities.

- Class A stations have several limitations imposed on their use as fixed stations within 100 miles of the center of an urbanized area of 200,000 or more population, and on their use as a fixed station used to control a base station from a location less than 100 miles from these urban areas. Nevertheless, should Class A stations be available, they should be given special consideration. First, they will normally be assigned one (or two) of 16 paired frequencies between 462 and 468 MHz and thus do not have to contend with skywave interference nor that interference created locally by the Class D stations. Although they may have an authorized power of up to 60 watts, their capability is limited to the existing configuration of fixed, base, and mobile stations already licensed (i.e., other stations are not capable of joining the net

without having been designed to cover this frequency band and without new crystals and realignment to the frequency).

In summary, Citizens Radio Service of all classes is composed of millions of radios distributed in practically every community and available for CD emergency use, provided only that their operation is voluntary and that they are under the direction of Civil Defense authorities. The majority of the licensed sets (Class D) are limited to 5 w power and there are unknown thousands of small, 100 mW, hand-held, unlicensed transceivers capable of short-range communication. In addition there are 60-w Class A UHF stations available in some localities. The major considerations in effectively using the Citizens Radio Service sets for emergencies include planning for their proper use, conducting training and tests of their capability, developing and maintaining the interest of their owners in the program through an innovative incentive program, and control of extremely heavy interference in many communities.

7. Amateur Radio Service

a. General Description

A fundamental, stated purpose of the amateur radio service is to provide to the public "a voluntary, noncommercial communication service, particularly with respect to providing emergency communication. Other purposes include advancement of the radio art, improving communication and technical skills, expanding the reservoir of trained operators, technicians, and electronics experts, and enhancing international good will."

Radio amateurs, referred to as "Hams," are required to pass operational and technical examinations prior to licensing. The degree of difficulty and technical level of the examinations vary among

the nations of the world. In the United States, only citizens or nationals of the United States are eligible to apply for the various classes of amateur licenses. About 275,000 amateurs are licensed today.

Amateurs are authorized to use various types of emissions on any frequency in specified bands ranging from 1800 kHz to 21,000 MHz, with all frequencies above 40,000 MHz available (see Appendix B). With certain restrictions in several bands and for some classes of license, an amateur may operate with a maximum power input to the final amplifier of 1 kW; provided the required specifications are met, the amateur stations may be operated from a remote location, from a temporary location other than that licensed, and as a mobile station from a vehicle, an aircraft, or a vessel.

b. Applicability and Availability for CD Emergency Communication

General--Point Six of the Amateur's Code as promulgated by the American Radio Relay League (ARRL) states: "The amateur is Patriotic . . . His knowledge and his station are always ready for the service of his country and his community." This credo has been proven over the years in innumerable instances since the time the first widely known emergency communications were conducted in 1913 (to provide communication to a large isolated area in the midwest left by a severe windstorm) to the present time.

The Radio Amateur's Handbook roughly divides "public service" into two classes--expeditions and emergencies. In the area of public service, amateurs have cooperated with expeditions to provide communication between the expedition and home contacts in the United States and Canada in over 200 voyages and expeditions, including the several explorations of the Antarctic.

The second area of public service includes emergency communication. Since the cited 1913 incident, amateur radio has been the principal (in many cases, the only) means of communication to the outside world in hundreds of floods, earthquakes, storms, tornados, hurricanes, forest fires, blizzards, and other disasters that have disrupted normal communication.

Several well-defined organizations within the general amateur radio group can provide emergency Civil Defense communication. Their description, applicability, and availability for emergency use (including constraints) are described in the following paragraphs.

Amateur Radio Public Service Corps (ARPSC)--The ARPSC includes the combined facilities of the Amateur Radio Emergency Corps (AREC) and the National Traffic System (NTS), and recognizes the Radio Amateur Civil Emergency Service (RACES) and other independently organized amateur groups as integral parts of the amateur service's public service effort. ARPSC is sponsored by the ARRL and has been for many years.

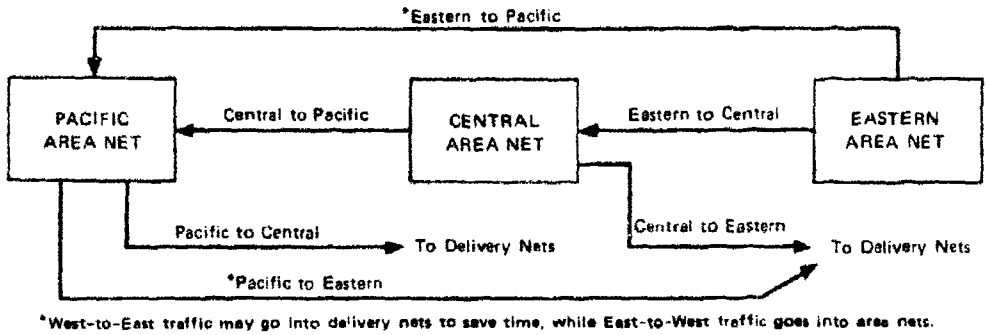
National Traffic System (NTS)--The handling of message traffic via amateur radio has been an important ham activity since the earliest days of radio. Initially, random relay of messages by any amateur was used, followed by the establishment of trunk lines to the extent that, by the mid-1930s (after interruption by World War I), ARRL was supervising and operating approximately 14 trunk lines crossing the nation. After suspension during World War II, the trunk circuits were reestablished and developed into the NTS by 1949.

Today NTS is an integrated national traffic facility designed to provide a rapid movement of traffic and to train amateurs in the efficient handling of traffic and operationally effective participation

in directed nets.* Four different levels of nets (see Figure 13) operate in a time-phased sequence (using any suitable mode of transmission) to ensure efficient traffic flow:

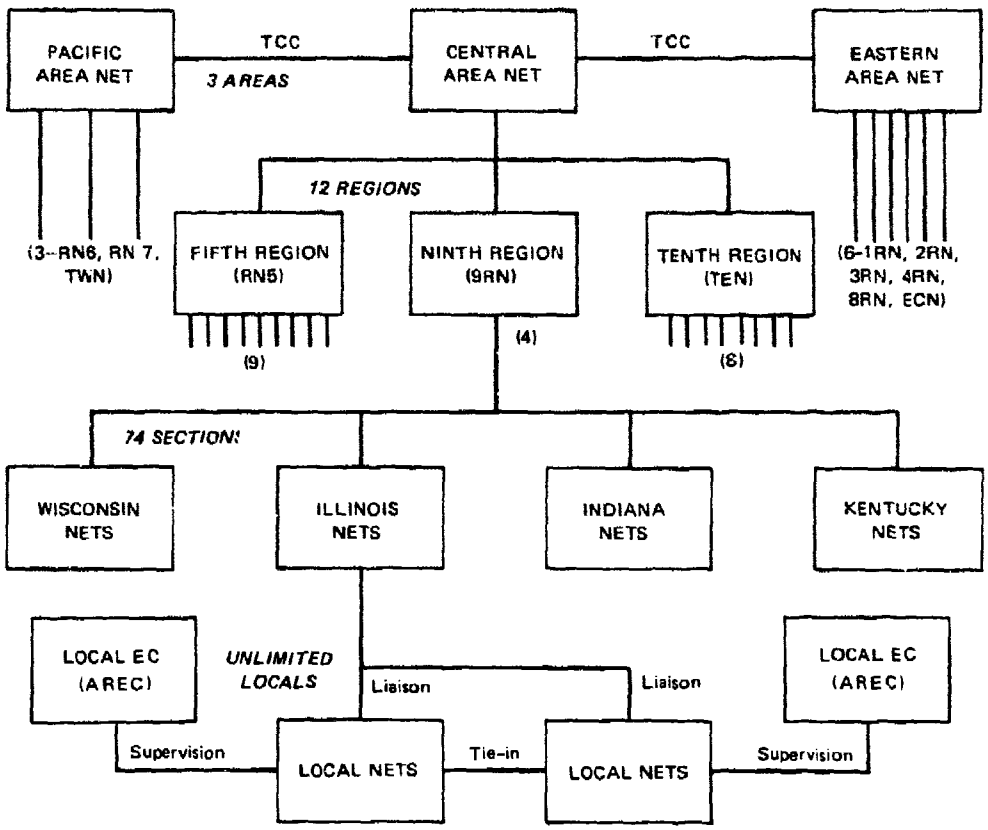
- Transcontinental Corps (TCC), while not a true net, is a group of designated stations responsible for interarea traffic between the three NTS Areas (Eastern, Central, and Pacific). A TCC director in each area assigns stations to report into the Area Nets to clear traffic with the areas and to keep "out-of-net" schedules with each other to pass traffic from one area to another [Figure 13(a)].
- Area Nets (Eastern, Central, and Pacific), are each composed of two or more ARRL Sections. The Pacific Area Net includes the Mountain as well as the Pacific States [Figure 13(b)].
- Regional Nets (12) each covering several states, and generally, a call area. They cover the United States, Canada, and U.S. possessions [Figure 13(b)].
- Section Nets, each of which normally covers an ARRL section, are administered by the ARRL SCM (Section Communications Manager) [Figure 13(b)].
- Local Nets are those that cover smaller areas such as cities, counties, or communities. They usually operate on VHF (very high frequency) voice and normally handle local delivery of traffic on an

*A net whose activities are closely controlled by the Net Control Station (NCS).



*West-to-East traffic may go into delivery nets to save time, while East-to-West traffic goes into area nets.

(a) TRANSCONTINENTAL CORPS



(b) AREA, REGION, SECTION, LOCAL NETS

FIGURE 13 NATIONAL TRAFFIC SYSTEM

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emergency basis, since normal local delivery can more easily be accomplished by telephone. However, some NTS local nets operate daily to move the traffic as close as possible to its destination prior to delivery [Figure 13(b)].

Of the approximately 600 nets listed in the ARRL Net Directory, about 165 are NTS nets, and 215 additional nets have as their main purpose emergency communication. Thus, over half of the 600 registered nets are available for emergency communication.

During an emergency, NTS has a communication plan that can speed up the normal 24-hour cycle of operations to a two-hour cycle, following the normal sequence of operations. In summary, NTS normally operates (on a daily basis) a nationwide message traffic trunking and distribution system capable of handling Civil Defense emergency communication over wide areas. However, in the event of a war-caused emergency (if the precedent established during World Wars I and II is followed), NTS would be prohibited from on-the-air operation, since only RACES (Radio Amateur Civil Emergency Service) will remain operational during a general war. The Military Affiliate Radio System (MARS) will also remain operational, but MARS is not an amateur service, although possession of an amateur license is a prerequisite to being a member of MARS).

Amateur Radio Emergency Corps (AREC)--The Amateur Radio Emergency Corps (AREC) is a group of amateurs dedicated to providing emergency communication under sponsorship of the ARRL. Its parent organization, the ARRL Emergency Corps (AEC) was formed in 1935 and provided outstanding emergency communication until December of 1941, when most amateur radios were shut down for the duration of the war. The AEC remained active, however, but only for necessary communication for Civilian Defense purposes. Within a month of Pearl Harbor, over 2,000 amateur

stations had been reauthorized for civilian defense, but due to reaction against rigid controls and a propensity to carry on informal conversations over the air, the Federal Communications Commission (FCC) ceased issuing authorizations and cancelled all existing ones, completely silencing amateur radio per se for the duration of the war in January 1942.

Amateur activity was supplanted from then until the end of the war by a War Emergency Radio Service (WERS) administered by the Office of Civil Defense, supported by the ARRL. Licenses were issued to communities, not individuals, and most of the equipment was donated by amateurs, or modified or built by them. WERS was used for communications for Air Raid Protection and used the 2-1/2 meter band (112-116 MHz) and some higher frequencies. WERS expanded into three different kinds of WERS by 1943--one for Civil Defense, one for State Guard use, and one for Civil Air Patrol use.

Shortly after the end of the war in 1945, the FCC initiated the return to regular use of the amateur bands by amateurs with a portion of the 2-1/2 meter band to be shared with WERS. WERS was then terminated in November of 1945. On 15 November, the 10, 5, and 2 meter bands were defined for amateur use and the ARRL Emergency Corps (AEC) was reestablished.

The AEC continued to grow and provide distinguished service during emergencies through the 1950s. During this period, the position of Section Emergency Coordinator (SEC) was created for each ARRL Section and the first annual Simulated Emergency Test (SET) that was designed to provide a nationwide test of AEC emergency communication operations was conducted in October of 1946. The SET continues in a greatly expanded form today. Outstanding emergency communication support continued and, in 1951, AEC became the Amateur Radio Emergency Corps (AREC) and in 1963 became the Emergency Division of the ARPSC.

Today, the AREC consists of licensed amateurs who have voluntarily registered their qualifications and equipment for public service emergency communications when disaster strikes. (See Appendix C for the AREC Registration Form.) Every licensed amateur is eligible for membership, but only amateurs are eligible: Citizens Band operators and licensees in the other radio services are not eligible for participation.

There are three levels of AREC organization--national, sectional, and local. The national level effort is under the direct supervision of the ARRL Communications Manager, who maintains central coordination with the federal government and other national officials concerned with amateur emergency communication potential, and ensures that the ARRL's policies regarding emergency communication are observed. He also advises AREC officials regarding their problem areas.

At the ARRL Section Level (currently numbering 74) the Section Emergency Coordinator (SEC) is appointed by the Section Communications Manager (SCM) who is elected by the ARRL members in his section. The SEC and SCM normally work together to establish a Section emergency communication plan and to appoint Emergency Coordinators (EC) for the jurisdictions and municipalities in the Section, although the SEC has the authority to do this alone.

At the local level, where most emergencies occur, AREC makes direct contact with its members and with local officials. The EC can have jurisdiction over AREC activities in areas ranging from a small community to a group of counties. The EC quite frequently appoints Assistant EC's to supervise the activities of different groups of AREC operators in his area--e.g., a VHF group, an SSB group, the Red Cross group, the mobile group. The local AREC organization for operation (mostly nets) is then designed to meet the local requirements, and normally culminates

in a control center designed to accept and pass traffic outside the EC area--the NTS gate station to the appropriate net(s).

Together with the NTS, AREC represents a system, in being, ready to assist in an emergency. AREC shares the same major constraint that NTS has--in a wartime emergency, AREC would be prohibited from on-the-air operation unless some special prior arrangement has been effected with the FCC.

Radio Amateur Civil Emergency Service--As early as 1947, various groups and agencies became increasingly interested in Civil Defense. The "Hopley Civil Defense planning group," the National Security Resources Board, and (ultimately) the Federal Civil Defense Administration,* together with the FCC and representatives of ARRL, studied the problem in depth and concluded that there existed two requirements for emergency communication--Civil Defense communication and peacetime emergency communication. It was concluded that the requirements were not the same, the frequencies required were not the same, and there was no problem of security or availability in the use of our frequency bands during peacetime emergencies. They further held that preparation for one kind of emergency is not necessarily adequate for the second type of emergency. These conclusions were the foundation on which the creation (in 1951) of a new amateur service aimed at Civil Defense emergency communications--RACES--was based.

RACES is an emergency radio communication service designed exclusively for Civil Defense purposes and under Civil Defense control. Although the term "Radio Amateur" is in its title, provision is made for the use of radio nonamateurs in the service--specifically, certain classes

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*Now the Office of Civil Defense, Department of the Army.

of commercial operators are authorized. The rules governing RACES are in Subpart F, Part 97, of the FCC Rules and Regulations.

RACES nets are sponsored at Civil Defense levels--Federal, Region, state, county, and local community. They are established by obtaining approval of a comprehensive Civil Defense Communications Plan from the State and Federal Civil Defense authorities. The plan requires the provision of a Civil Defense Radio Officer, who must hold either a first or second class commercial radio operators license or an amateur operators license other than Technician or Novice Class. He must also have been determined to be loyal to the United States.

While other than amateur operators may be used in RACES, station authorizations may be issued only to a person who holds an amateur radio operator license other than a Technician or Novice Class and an appropriate amateur radio station license. The RACES station authorization runs concurrently with the term of the amateur radio station license.

When RACES nets are activated, only authorized communication is permitted. When the nets are secured, nonamateur operators are, of course, prohibited further operation.

The period 1950 to 1955 saw great emphasis on RACES by all concerned, and many proposed that ARRL abandon its AREC and rely entirely on RACES during both peace and war. By the late 1950s, however, participation in RACES and AREC activity had increased. By the early 1960s, the Federal government even ceased its annual nationwide Civil Defense test, leaving the AREC's annual Simulated Emergency Test (SET) as the only nationwide test of amateur radio emergency communication.

RACES is the only amateur radio service to be considered in this report that is authorized to provide Civil Defense emergency communication during a state of national emergency and wartime conditions.

Military Affiliate Radio System (MARS)--MARS is composed of Army, Navy, and Air Force sponsored communications systems designed to

- Create interest and further training in military radio communication
- Promote study and experimentation
- Coordinate practices and procedures of amateur radio operations with those of military radio communication
- Provide additional radio circuits and radio communication personnel in the event of a local or national emergency
- Provide a system in-being designed to serve military commands as an auxiliary communication system.

The principles and aims of MARS were first established by the Army Amateur Radio System (AARS) at Ft. Monmouth, N.J. in 1925; the organization continued to function until the beginning of World War II. In 1948, the Secretaries of the Army and Air Force established the Military Amateur Radio Service, whose membership was still restricted to military amateurs and units.

In November 1950, a major policy change permitted civilian amateur radio operators to join the system. As a result, the name of the organization was changed in September of 1952 to the present Military Affiliate Radio System, to portray more accurately the combination of military and civilian members. Also in 1952, the Navy joined the organization, and in 1953, the age limit for membership was lowered from 21 to 16 years, principally to permit civilian radio amateurs to participate in the MARS training program prior to formal military service.

Each of the three MARS organizations--MARS (Army), MARS (Navy), and MARS (Air Force)--have similar network structures, differing mostly in names and geographical coverage caused principally by the differing military organizations that sponsor them. In addition to nets overseas where U.S. forces are stationed (normally contingent on host country approval), the services each have national nets, regional nets (Army Areas, Naval Regions, and numbered Air Forces), State or intermediate nets of some type, and local nets.

A specific statement of interest and intent pertaining to Civil Defense emergency communication is contained in the MARS Communications Manual. It includes the statement (within current availability of personnel and equipment) that MARS may:

- Provide communication services between the Military Services in support of Civil Defense and the Civil Defense agencies
- Make available communication services for Civil Defense forces on a temporary or emergency basis when such services are not otherwise available.
- Make available radio terminal facilities at designated military installations for Civil Defense tie-in as required.
- Make these services available on military frequencies assigned to established MARS networks.

MARS frequencies are assigned to the military and are not in the amateur bands. Furthermore, military requirements for MARS during emergencies will govern the extent of the services provided to Civil Defense agencies. The statement of intent is further defined in the operational plans for the Services where authorized messages for MARS

transmission during real or simulated periods of emergency include "civil emergency traffic."

As a further example of availability for Civil Defense emergency communication, a Sixth U.S. Army Signal Operating Instruction concerning the Sixth U.S. Army MARS Emergency Net of August 1970, states in part that the Sixth U.S. Army MARS

> . . . is established to provide auxiliary and emergency radio communications as an adjunct to, or extension of normal military communications services. These include, but are not limited to:
>
> a. Emergency communications support in military defense of the Sixth U.S. Army area.
>
> b. Emergency communications support to Civil Defense activities.
>
> c. Emergency communications support of military and civil relief operations in natural or man-made disasters as directed by the Army Commander.
>
> d. Auxiliary communications between Sixth U.S. Army area installations when normal communications are disrupted for extensive periods of time.

MARS members are eligible to take technical correspondence courses from the service communication schools without charge. Occasionally, this privilege is suspended due to lack of facilities, but generally it is available. Further, one of the strongest incentives to amateurs to participate in MARS activities is the MARS program for distribution of surplus military electronic parts, components, and sets to MARS members. This is normally accomplished on a merit basis--that is, amateurs with the largest number of hours of MARS participation receive first choice of equipment.

Instant Service Nets--There are groups of amateurs who, without sponsorship and on a voluntary basis, monitor one frequency for

the purpose of providing immediate service to the public and to other amateurs by assisting in emergencies, facilitating contacts, and arranging to handle traffic. The operation is practically continuous and is always continued as long as there are operators and a need for the service. This activity began with the organization of the West Coast Amateur Radio Service, Inc., in early 1963, followed by the Mid-West Amateur Radio Service in 1968, and the East Coast Amateur Radio Service in 1969. These groups refer to themselves as WCARS or WESTCARS, MWARS or MIDCARS (sic), and ECARS or EASTCARS. There is no direct organization relationship between the three groups.

WCARS and ECARS operate on 7255 kHz, and MWARS on 7258 kHz. These service frequencies have a net control station and relays, ready at all times to pass traffic and perform services. WCARS has approximately 600 members from Canada to Mexico with hundreds more who make use of the service every day. MWARS has 250 members and ECARS has over 700 members. A rough approximation, therefore, indicates that there are approximately 1600 members of these three nets with additional hundreds using the service. By using ground wave propagation in addition to "short skip" and "long skip" skywave propagation and augmented by relays, the three nets provide widespread coverage of the contiguous United States with capabilities extending to Hawaii and Alaska and other points outside the continental United States. All three nets have adopted priority calling procedures and operating practices that permit fast break-in and efficient traffic handling. Traffic is normally passed at least 4 kHz off the service frequency. Mobile amateur stations play an important role.

The Western Public Service System operates in the evening hours on 3952 kHz, for the same purpose and with the same procedure as WCARS. MWARS members are now meeting informally on 3915 kHz, and ECARS

is discussing the establishment of a nighttime operation on the East Coast. MWARS is also trying to start a CW section on 7100 kHz (CWARS), while WCARS is starting the same action on 7155 kHz. On at least one recent occasion, ECARS provided instant weather reports over a wide area to Connecticut Civil Defense when requested to trace a cold front during a flood alert.

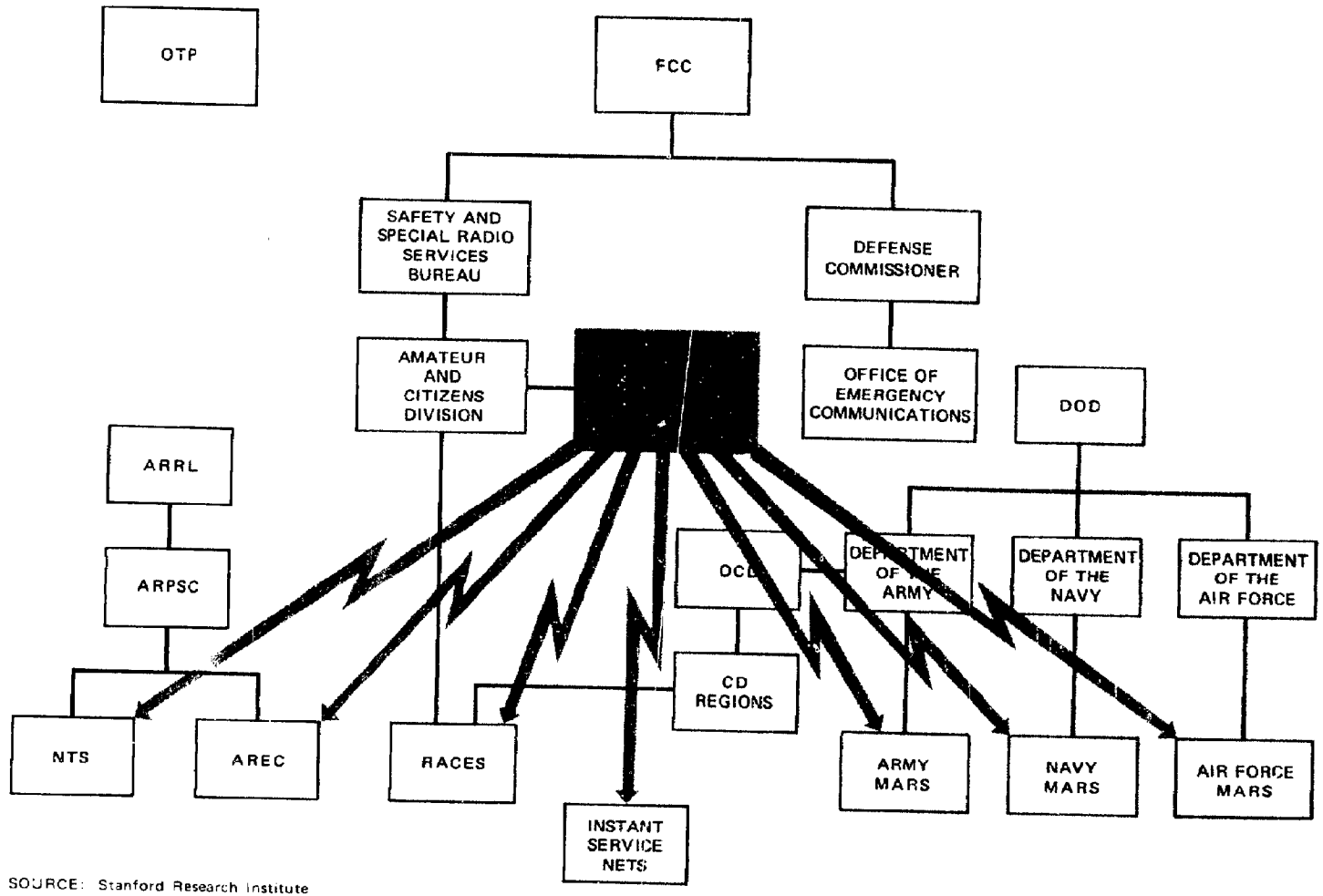
c. Modifications Required for Effective Civil Defense Emergency Communication Use

The foregoing has described the many segments, elements, groups, and organizations within the amateur ranks that can potentially provide Civil Defense emergency communication. It is now appropriate to place each of these groups in perspective and to suggest actions that should be taken to enhance the effectiveness of all of the groups for providing Civil Defense emergency communication.

The relationship of the licensed amateur to the several organized groups is depicted in Figure 14. After having acquired and demonstrated the necessary technical skills and operational expertise, the FCC licenses the amateur. Then, he has a choice of at least seven major fields that can provide emergency communications:

- National Traffic System
- Amateur Radio Emergency Corps
- Radio Amateur Civil Emergency Service
- Instant Service Nets
- Army Military Affiliate Radio System
- Navy Military Affiliate Radio System
- Air Force Military Affiliate Radio System

Note the sponsoring or supervising elements of these groups, and the apparent lack of national level supervision of RACES. It is also



SOURCE: Stanford Research Institute

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FIGURE 14 RELATIONSHIP OF AMATEURS TO EMERGENCY COMMUNICATIONS ORGANIZATIONS

interesting to note that the Office of Emergency Communications of the FCC has an Emergency Communications System Division that develops and recommends plans and procedures for several services in an emergency. The services include:

> § 0.183(e)(2) "Safety and Special Radio Services. Authorization, operation, and use of specified safety and special radio services, facilities and personnel in the national interest in an emergency." The Amateur Radio Service is one of the Special Radio Services. The Office of Emergency Communications' responsibilities also include the responsibility for the assignment of radio frequencies to commission licensees during national emergency conditions and the control of radio stations in an emergency except those belonging to, or operated by, any department or agency of the U.S. government.*

The seven major fields of amateur operations applicable to emergencies translate into at least 30 different activities within these fields (Figure 15). The average amateur has at least these 30 different activities available to him, and, if different services, functions or nets are considered, he has several times this number of choices available.

In general and, although there are several variations, it can be said that an amateur interested in public service and emergency work has three courses of action open to him:

- He can join any net or group voluntarily organized by amateurs not under sponsorship of the ARRL, e.g., the Instant Service Nets, EYE Bank Nets, Boy Scouts
- He can join an ARRL sponsored net or group, e.g., ARPSC, NTS, AREC
- He can join one of the government authorized nets, e.g., RACES and MARS.

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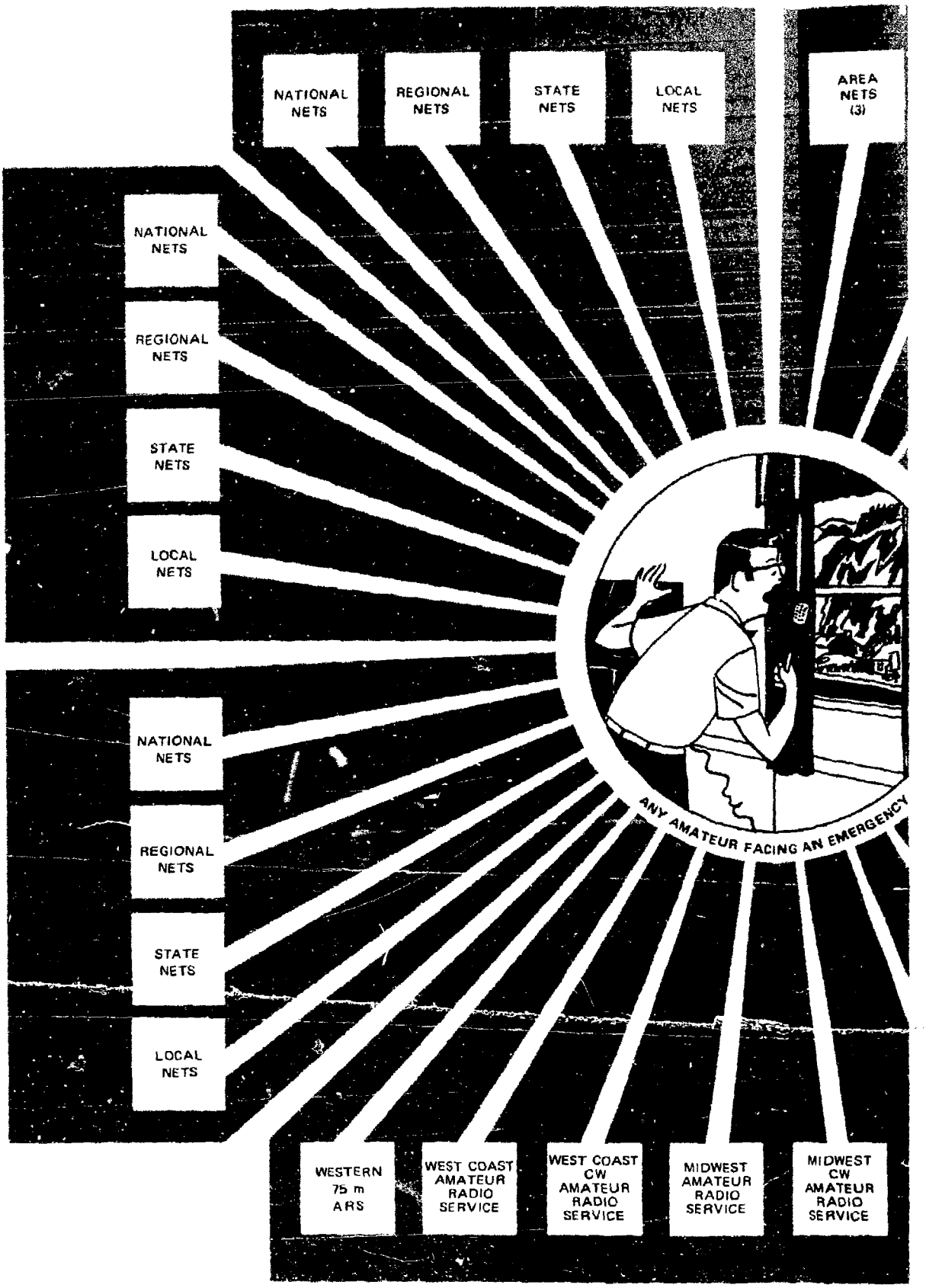
*FCC Rules and Regulations, Vol. I, Part 0.

d. Summary

There is a well defined difference between peacetime emergencies and a state of national emergency declared by the President. Civil Defense has the responsibility for saving lives and the protection of property during a national emergency, and its communication systems are developed and justified on this basis. Some local governments use their full Civil Defense capability for peacetime disasters, in addition, but some do not.

All amateur radio operations except RACES and MARS are scheduled to cease in the event of a national emergency, such as war. The RACES mission is to provide emergency Civil Defense communication, and MARS has this mission as a secondary priority ranking only below official military traffic. The remainder of the tens of thousands of amateurs find themselves (and their emergency nets and groups) unable to assist.

At least two major reasons have been advanced to justify prohibiting these amateurs from operating during national emergencies--security considerations and the availability of amateur bands for wartime operations. No loyalty investigation, with respect to security, is conducted prior to issuing MARS authorization; nor is there any background investigation made prior to issuance of RACES. However, the RACES Radio Officer and the operators of the RACES stations must have been determined to be loyal to the United States and to be generally reliable in accordance with the procedures provided in the approved Civil Defense communication plan of the area concerned. In some cases, this is nothing more definitive than the signing of a loyalty oath by the applicant or a routine check with the local police. Thus, it would appear that any licensed amateur could be found just as trustworthy as a MARS or RACES member with very little effort.



SOURCE: Stanford Research Institute

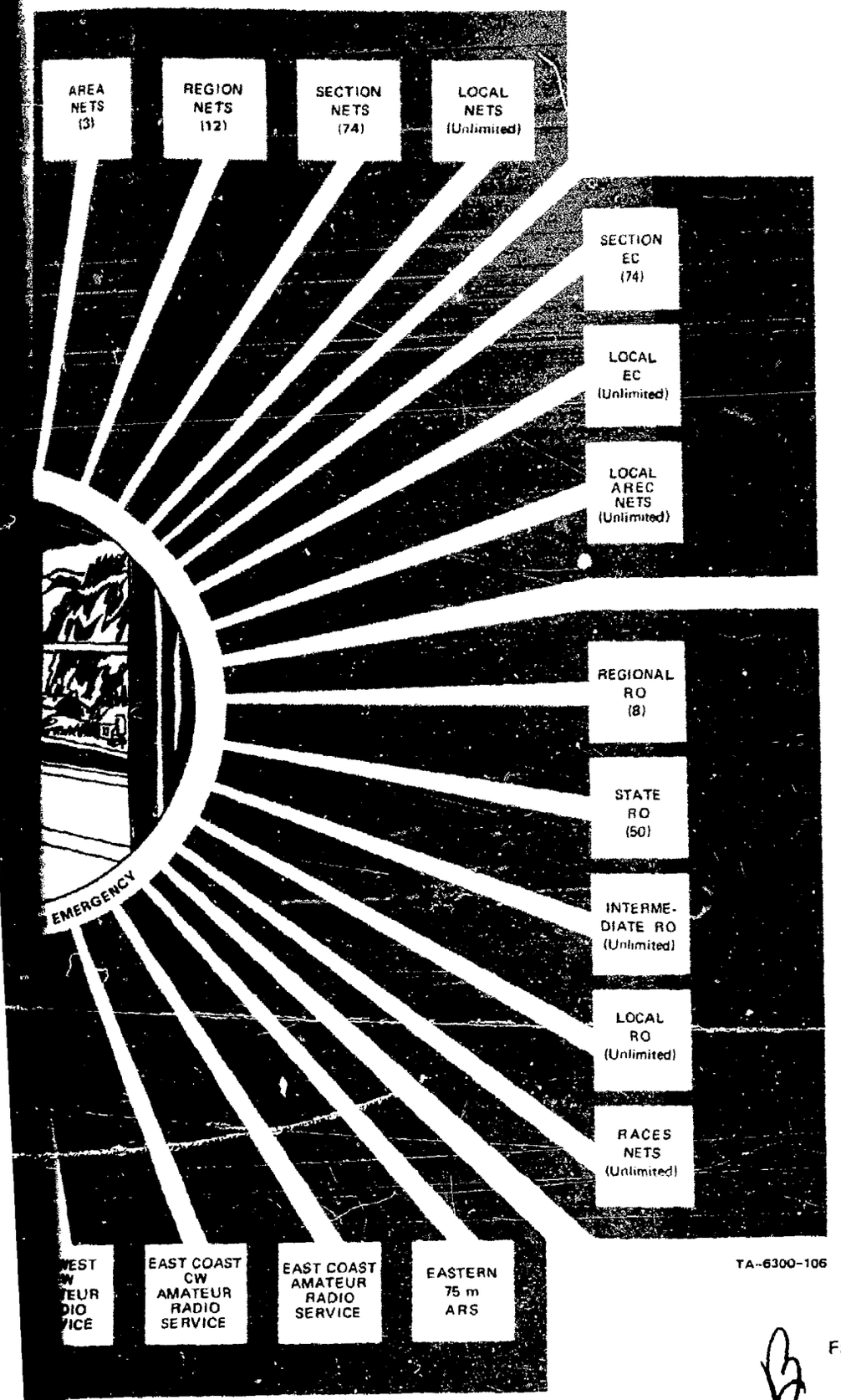


FIGURE 15 NETWORKS AVAILABLE TO ANY AMATEUR

With respect to the use of amateur bands during wartime: While there are undoubtedly nonamateur requirements for some of these frequencies, sufficient frequencies could probably be designated for selective use of the amateur bands by NTS, AREC, and the instant-service nets. This procedure could eliminate general amateur operation and still retain the flexibility, versatility and communication capability of the amateurs trained in public service and emergency communication.

Amateur radio operators, whose backgrounds include training and facilities, very extensive numbers, and wide geographical dispersion, can provide effective emergency communication services for Civil Defense purposes when properly organized, supervised, and trained.

One course of action that could achieve the desired objective of more effective use of amateurs to provide Civil Defense emergency communication is briefly described below.

Establish a national level working group, chaired by the Office of Civil Defense, with representatives from:

- Office of Telecommunications Policy
- Federal Communications Commission
- Interdepartmental Radio Advisory Committee
- Department of Defense
- Department of Army--MARS Director
- Department of Navy--MARS Director
- Department of Air Force--MARS Director
- American Radio Relay League.

The working group should be given the mission of designing a basic emergency plan for the effective use of amateurs during peacetime emergencies as well as during a state of national emergency (war). The plan would address and recommend solutions to such problem areas as:

- Emergency use of the Amateur Radio Service frequency bands
- What elements, groups, or individuals are to be prohibited from operating during wartime--which ones are to be permitted operations during wartime
- Standardized message formats, precedences, and operational procedures
- An agreed definition of public service activities and the amateur's right to provide communication services for these activities
- National level supervision, policies, and training for RACES
- The interface required between NTS, AREC, RACES, MARS (Army), MARS (Navy), MARS (AF), the "Instant Service Nets" (ECARS, MWARS, WCARS), and the amateur who belongs to none of these groups in order to achieve an integrated operational amateur capability
- Operational use and improvement of the system required to maintain necessary efficiency and interest
- Amateur participation and interest in emergency communication and the incentives required to maintain an acceptable level of effort
- The authority for FCC licensed nonamateur operators to participate in the plan
- Public-spirited amateurs frequently belong to two or more emergency groups with no firm arrangement for participation by any <u>one</u> service in a real emergency.

The working group should avail itself of the data, experience, and findings of the Amateur Sub-Committee of the National Industrial Advisory Committee (NIAC) that is currently reported to be studying this same area under the sponsorship of the FCC's Office of Emergency Communication.

When an acceptable emergency plan for amateurs has been developed, the suggested membership for the working group has the authority, each in its own area, to promulgate the plan.

The amateur radio service offers the most flexible capability for Civil Defense emergency communication because of the following factors:

- Broad spectrum coverage
- Ability to use any frequency within these bands
- 1000 watts input authorized
- Different modes of operation available
- Capable of fixed, portable, and mobile operation
- RACES designed for Civil Defense
- MARS has dual mission, including Civil Defense
- Trained operators who have had to pass electronic theory and operational FCC tests before being licensed.

8. Disaster Communication Service

This service is defined in the FCC Rules and Regulations* as:

A service of fixed, land, and mobile stations licensed, or authorized, to provide essential communications incident to or in connection with disasters or other incidents which involve loss

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*Part 99, Subpart A, Paragraph 99.3.

of communications facilities normally available or which require the temporary establishment of communications facilities beyond those normally available.

The disaster may be local, regional, or national in scope. Both government and nongovernment stations may be included in one or several disaster communication networks. The key phrase in the above definition is "licensed, or authorized." As defined in the Regulations, licenses are required for commercial stations while authorizations pertain to government stations. Both operate under the same liberal rules once a disaster net is activated. Intercommunication between services is freely permitted if all are involved in resolving a disaster. A disaster communication network, once established, is a valuable asset; but the limitations imposed by the licensing requirements make establishment of such a network a very unattractive proposition to a potential licensee.

The most serious limitation is the choice of operating frequency. Transmitting equipment and antennas for the 1750 to 1800-kHz band are unduly bulky and expensive, especially for special-purpose intermittent use equipment. The fact that the frequencies are shared by the Industrial Radiolocation Services calls for careful liaison between the two services. Frequencies in this band have widely different propagation characteristics during daylight hours compared to darkness. Even with the 500-watt power limitation, if a disaster net were required to operate throughout a 24-hour period, some mutual interference problems would be highly probable.

The operating frequency limits the flexibility of a disaster net in another way. Although disaster net stations are authorized to communicate with just about everyone during emergencies, the chances are high that they will find very few other services equipped to communicate on the disaster frequencies. The end result is that a disaster network can frequently be a separate net rather than an integral and interconnected part of an overall disaster communication plan.

The necessity for a special license for a disaster station is questionable. A recommended improvement is an endorsement on an existing license in some other service on their regular assigned frequency(ies). The endorsement could bestow the same operating privileges during emergencies as permitted in the present licensing plan. Most importantly, however, the endorsement would do away with the necessity for operations in this band, and could permit operation on the regularly assigned frequency for that particular service. The 1750 to 1800-kHz limitation and special call signs would then apply only to existing networks--to be phased out as soon as practicable.

A disaster communications endorsement on the license of, say a Forest Products Radio Station should be recognized as the local version of a National Defense Emergency Authorization, with emphasis shifted from the national to the state and local areas. Strong, well-organized, state and local disaster communication networks would strengthen the national emergency capability.

9. Domestic Public Radio Services (Common Carrier)

This category of radio services comprises four general classifications:

- Domestic public land mobile radio service
- Rural radio service
- Point-to-point microwave radio service
- Local television transmission service.

The first service is the familiar mobile public telephone with the associated base, repeater, and relay stations. The second service, as the name implies, supplies radio facilities between rural subscribers and a central office station when landline facilities are not practicable. The third and fourth services are self-explanatory.

a. Domestic Public Land Mobile Radio Services

Mobile radiotelephone service is available to a wide range of customers under a strict priority system. The order of precedence places public safety and health agencies in the prime category, which includes federal, state, county, and municipal government agencies as well as private organizations such as physicians, hospitals, ambulance services, volunteer fire departments, Red Cross, licensed protective patrols, armored cars, and similar agencies. Other categories include, in order, contract carriers, public utilities, the physically handicapped, industrial users, and the traveling public such as train passengers. Other potential users rank following all of the above categories.

Mobile stations in this service are authorized to communicate with and through base stations only. The base stations are normally authorized to communicate with associated land mobile stations in the same service or with transient land mobile stations normally associated with another common carrier base station.

Frequency allocations for this service include 20 paired frequencies in the 35- and 43-MHz bands on a domestic zone basis, about 50 frequencies in the 72 to 76-MHz band (primarily for control and repeater stations), somewhat fewer frequencies in the 152 MHz and 454 MHz bands, and a few microwave frequencies on a shared basis with point-to-point services.

Since this service gives priority to public safety and health agencies, and since the frequency allocations are similar to those for other public safety services, the domestic public radio services should be included in all CD communication plans.

b. Rural Radio Services

Rural radio stations are used to render communication services to remote points where the provision of wire telephone facilities is not practicable, or for restoration of communication service disrupted by storms, floods, earthquakes, or other emergencies. Frequencies used by this service are available primarily to the Domestic Public Land Mobile Radio Service, hence may be used only if no harmful interference is caused to the prime user service. The State of Hawaii has many additional channels available in the 76 to 108-MHz band.

Rural subscriber stations normally are authorized to communicate with and through the central office station with which they are associated. If this is impracticable, they may be authorized to communicate with a specified base station in the Domestic Public Land Mobile Radio Service.

Under some circumstances, the Rural Radio Services may be a valuable adjunct to a CD communication plan. The Rural Radio Service is authorized to provide emergency communication and may be considered an extension of the Domestic Public Land Mobile Radio Service to give coverage to outlying points.

c. Point-to-Point Microwave Radio Service

The point-to-point installations serve the public interest, convenience, and necessity by providing communication facilities such as telegraph, telephone, and program transmission for radio, television broadcasting, or theater television. A complete facility often comprises open wire and cable as well as radio. The radio portions of a facility have microwave frequencies available ranging from 2.1 through 40 GHz in eleven bands, most of which set different maximum channel bandwidths. Control stations in this service may be assigned frequencies in other bands on a shared basis with other services.

VI TYPICAL APPLICATIONS OF GOVERNMENT AND NONGOVERNMENT FACILITIES AND SYSTEMS TO SATISFY CD EMERGENCY COMMUNICATION REQUIREMENTS

Various assumptions can be made as to the amount of damage that may be sustained by the facilities that normally carry the communication traffic of governmental agencies during CD emergencies. Assumptions can also vary as to the extent of added traffic load that can be expected and the consequent probability that saturation of communication resources may be produced by a nuclear emergency.

This section makes no attempt to postulate the specific circumstances that will call for transferring traffic from a primary means to an alternate or backup. The discussion will suggest only some candidate systems to substitute for or augment a primary system in the event that the primary's facilities are no longer available or adequate. Examples appropriate for each service in the emergency organization of the operating zone, are given and some comments on state functions are provided. The complete set of useful alternates is contained, in summary graphic form, in Section VII.

A. Typical Applications

1. Direction and Control

a. Communication and Warning

A significant requirement, generated when a nuclear detonation in the vicinity of an operating zone is observed or reported without advance warning, is the need to contact officials and other essential local government personnel who are away from their normal locations or

are in mobile situations. Some of these individuals may not be accessible via the common carrier telephone system or the normal government radio nets. In these circumstances, proper utilization of the paging systems operating in the Business Radio Service would at least permit an alert call, which could then be followed by telephone or other contact. The goal would be to direct the officials to a desired location or to initiate prespecified actions.

b. Radiological Defense (RADEF)

Adequate monitoring of and reporting on fallout radiation distribution and intensity requires an extensive system to transfer the information and instructions between collection points, the EOC, and other entities. The need for continuity in performing this function and the extensive, widespread character of the monitoring sites suggest that the Amateur and Citizens Radio Services might be appropriate resources to augment the existing resources over which RADEF information is being reported. RACES members, in particular those members having mobile stations, could be called upon to provide the necessary facilities.

c. Operational Information

This function calls for the transmittal of information to elements and organizations outside the operating zone. The recipients (e.g., higher levels of government) require data on the local situations and requirements for coordination and optimum allocation of limited supporting resources. RACES, augmented by county and state government communication facilities, is the logical radio service for satisfying this requirement in the event that common carrier systems can no longer carry the traffic load.

d. Public Information

The EBS outlet can be relieved by a CATV system, particularly when CATV is extensively connected into the shelter system. Broadcasts need not include the video portion, although if video can be received, it is likely that the appearance of public officials on the television screens viewed by a frightened, uncertain population could conceivably enhance public morale and thereby facilitate recovery.*

2. Police Service

The Police Radio Service of the Public Safety Radio Services will probably operate at or close to saturation during CD emergencies. Augmentation of these important facilities should be planned for in an attempt to relieve their congestion or to replace facilities rendered inoperative. For out-of-zone police communication, it may be possible to transfer some traffic to facilities of the Fire Service, augmented by the Local Government Service. The use of taxicabs and their radio sets may be useful to back up the mobiles, not only for the communication facilities that they can provide, but for the actual vehicles that might be used to augment the police patrol capability.

3. Fire Service

The general requirement for a fire watch under CD emergency conditions can be expected to generate numerous specific communication requirements that require deployment of a gamut of facilities. One especially important aspect of this function is that the Fire Service must maintain an overview of the distribution of fires and firefighting

*See Section VIII-C-1 for an expansion of this concept and its significance.

resources and of the changes that are taking place in both of these in time. Exploitation of the Civil Air Patrol and its communication facilities could greatly facilitate the fire watch function. Provision for interconnection of the fire watch system and the supporting CAP surveillance aircraft would also be necessary.

4. Medical Service

Radio communication facilities to satisfy the requirements of the Medical Service are to be found in the Special Emergency Radio Services of the Public Safety Radio Services. Although these include the facilities used by the hospitals and ambulance operators, which would satisfy some requirements on a normal basis, other useful facilities--specifically those of the Disaster Relief organizations--are also in this category of service. In that Disaster Relief organizations are commonly closely associated with the Medical Service activities, both geographically and functionally, the exploitation of the Disaster Relief facilities to augment the principal radio facilities under conditions of CD emergencies would appear to be appropriate.

In addition, to support shelter-based medical aid teams, CATV and/or RACES stations located at the shelters could be used to relieve and back up the common carrier system.

5. Shelter Service

The common carrier facilities that normally are expected to serve the Shelter Service and its functional requirements should be reinforced by other means of communication. In addition to the radios used to provide communication to mobile elements, the Disaster Relief Service facilities, the Citizens' Radio Service, and CATV systems could all provide resources of considerable value for supporting the complex

shelter system at various points in the operating zone. The existence and availability of all of the facilities listed should be established and capitalized on, particularly in view of the extensiveness of the shelter system and the importance of the human resources that are located in the shelters.

6. Resource Service

The diverse and complex functions that must be performed by this service produce a large set of individual and specific communication requirements, not many of which are normally satisfied by using common carrier facilities. As a consequence, the Resource Service must explore the full range of facilities available in the operating zone so that all of those that are useful can be brought to bear, if only in part, to satisfy the total communication requirements.

Many of the problems can be solved if the radio stations servicing each element of the Resource Service can be interconnected. Of even more significance, however, would be the employment by prearrangement of many of the varied users operating in the Industrial and Land Transportation Services. It is conceivable that many of the normal commercial transportation and industrial activities would have to be curtailed during CD emergencies. To the extent that curtailment takes place, even during short periods of time, the Resource Service should make use of the equipment and personnel made available. The Resource Service's prime function is to ensure that the available facilities of any kind are put to use to a common public and national goal. Among the Land Transportation Radio Services, the taxicab and motor carrier services appear most useful, by reason of their inherent flexibility and the transportation capability that they provide. Selections of the specific resources that might be provided by licensees in the Industrial Radio Service must be accomplished at the local level because of the tremendous range of possibilities that

could exist in various parts of the country, each of which is essentially unique in each operating zone.

7. State Level Functions

The primary functions of a state during any CD emergency, whether purely local or widespread, are those of coordinating and facilitating information exchange between the lower levels of government that must actually perform the necessary recovery actions. If an emergency is localized to one community or area, it is appropriate for the next higher echelon to coordinate the assistance of surrounding communities, since the affected government will likely be fully occupied at the scene of the emergency. A single request for assistance from a disaster or emergency area should suffice to stimulate county, region, and state action, if needed, to provide all necessary and available assistance. Communication facilities necessary for coordination of assistance should be supplied by higher-echelon systems, rather than by relying on the communication networks in the emergency area.

A large percentage of the communication resources of a state may be diverted temporarily for CD purposes. A detailed CD communication plan is essential if coordinated operations among state, mutual aid regions, and operational areas (counties) are to be effective during an emergency period. The state communication plan should be prepared under the direction of a well-qualified individual to ensure technical interface and compatibility of the various communication systems owned or leased by the state. Close coordination is required between communication representatives of the state, state regions, operational areas, and commercial telephone companies.

Every communication system within a state is a potential emergency communication link. This includes not only the long-line, statewide systems such as the Disaster Communications Service and RACES, but

also the localized, often interconnected, base-mobile systems such as the highway patrol, the division of highways, and the Departments of Forestry, Water Resources, Fish and Game, and Justice. In the State of California, for example, the Department of Forestry alone has more than 3200 radio units in service. This includes approximately 50 portable base or mobile relays, 1900 mobile stations, 400 base stations, 125 mobile relays, and several hundred handie-talkies. Deployment of even one-tenth of these units around a disaster area would certainly alleviate the interface problems from a scene of disaster. Since several other departments also have more than 2000 radio units in service, there should be no problem in supplying sufficient units. Even in states with fewer communication resources, their most efficient employment under conditions of emergency can and must be developed.

Sending state communication facilities into an area simply as units to supplement local communications almost negates the advantages that might be gained. The disaster area does not need more logistics and frequency management problems. Radio units, if they are to provide the maximum support consistent with their capabilities, must report in as complete systems. This requirement holds whether a system remains on the outskirts of the area to serve as an outlet or moves into the disaster area to take over a specific task, such as furnishing the communication for the radiological defense teams. One or two units can perhaps act to provide liaison with the local CD directorate, but the rest of the system--base stations and mobiles--would be most effective if it were to retain its cohesiveness as an experienced operational system with full responsibility for its own logistic support.

For some systems in some services, there are some areas of indecision regarding full authority to communicate as necessary when asked to participate in emergency action. Such constraints should be removed. A possible solution might be to establish, for every service that might

be useful in an emergency but for which doubts exist regarding its permissible communication, an endorsement from the FCC that the element is a disaster communication station. This is not a suggestion that a separate license be issued, but rather an endorsement to an existing license extending the station's rights.

State military forces may be able to provide additional aid. Despite the restrictions implicit in operating in the State Guard Radio Service (paragraph V.B.1.h), ground and air military forces of the individual states, whether they are called National Guard, State Guard, or State Militia, commonly possess communication resources in both material and trained operations and maintenance personnel. In some instance these resources may be extensive. It is conceivable that, in the event of an emergency, elements of such forces, even if federalized, could be assigned the mission of providing support to CD organizations in their areas. Alternately, even if such forces become federalized and are assigned combat or support missions elsewhere, they might be replaced by militia or home guard forces which assume the CD support role. Each such possibility should be investigated thoroughly to establish the possible utilization of their resources at State level or locally.

B. Major Problem Areas

Complete exploitation during CD emergencies of all of the available and applicable communication services and their facilities is not possible. There are a number of constraints on their use, of which only some can be overcome or compensated for. Among these constraints are the problems of obtaining sufficient financing to procure, install, and maintain the equipment; technical problems associated with the installation and operation of the equipment; the need to train operators and maintenance personnel; and the real and continuing problem of developing and maintaining public interest and cooperation in the entire civil defense effort and its ramifications. Although discussion of these problem areas is not considered

within the scope of this research effort, the problems resulting from regulatory constraints and technical constraints are both pertinent to the study. They are discussed below.

1. Regulatory Constraints

FCC Rules and Regulations impose varying levels of restrictions on the categories of communication services. Since these constraints have already been described in considerable detail in a number of other publications, only their impact will be summarized here together with some suggestions as to their relaxation.

In some categories of radio service, the FCC provides for specific permissible CD communication. In other categories, however, applicability to CD operations is made dependent upon the relationship of the activity or activities that form the basis of the particular licensee's eligibility to operate, to the nature of the CD communication to be transmitted. In a few categories, CD communication is permitted. Table 2 indicates the general policy of the FCC in establishing and interpreting the rules for authorizing CD communications, although some specific changes have occurred since it was originally proposed.[8] It is evident from the table that authority is adequate in many cases, since CD functions are often inherent in the normal operations of the organizations with which we are concerned. In those cases, however, in which radio services are essential in wartime, or in industries (e.g., manufacturing and transportation) for which radio is an indispensible tool to their efficient operation, significant constraints exist on their use for CD purposes. In the former instance, for example, the service being unessential may be liable to elimination, curtailment, or diversion. In the latter case, CD communication is likely to be limited to that traffic essential to permit the particular industry to continue operating in the emergency environment.

Table 2

PERMISSIBLE CIVIL DEFENSE COMMUNICATION:
SAFETY AND SPECIAL RADIO SERVICES

Service Classification	Category*						
	I	II	III	IV	V	VI	VII
Marine Services							
Coastal Group						X	
Marine Radiolocation Land						X	
Ship Group						X	
Alaskan Group (Part 14)		X					
Aeronautical Services							
Aircraft Group		X					X
Aeronautical Advisory (128 MHz only)		X					
Aeronautical and Fixed Group						X	
Aviation Auxiliary Group						X	
Aviation Radionavigation Land						X	
Civil Air Patrol		X					
Public Safety Services							
Local Government	X			X			
Police		X					
Fire		X					
Highway Maintenance		X					
Forestry Conservation		X					
Special Emergency (Disaster relief organizations only)	X			X			
Special Emergency (In general)		X					
Industrial Services							
Power		X					
Petroleum		X					
Forest Products		X					
Motion Picture		X					
Relay Press		X					
Special Industrial		X					
Business		X					
Industrial Radiolocation		X					
Manufacturers		X					
Telephone Maintenance		X					
Land Transportation Services							
Motor Carrier		X					
Railroad		X					
Taxicab	X		X				
Automobile Emergency		X					
Citizens Service	X		X	X			
Amateur Services							
Amateur	X						
RACES				X	X		
Disaster Service	X			X			

*Description of Categories:

I Civil Defense Command and Control communication that does not relate to the licensee's normal activity.

II Civil Defense communication relating only to the activity that forms the basis of license eligibility.

III Communication system may be commandeered by Civil Defense authorities for Civil Defense command and control communication.

IV Radio service may be licensed for Civil Defense command and control functions only.

V Established solely for Civil Defense purposes.

VI No Civil Defense communication allowed.

VII Part of this group may be taken over by the Federal government in time of war emergency conditions. Those not taken over by the Federal government may participate in Civil Defense communication relating only to the activity that forms the license eligibility.

Source: Reference 8.

The value of such resources as the Citizens and Amateur Services is evident. The Amateur Service has been discontinued during wartime in the past. This discontinuation will take place for both the Amateur and the Citizens Services in comparable situations in the future under present regulations. Recognition and acceptance of the importance of these resources should be stressed, with representations made to appropriate agencies to ensure that the services will be utilized and not discarded if CD emergencies arise.

Comparably, it seems only realistic to predict that, under the conditions that are expected to prevail during a nuclear emergency, normal manufacturing and transportation functions might be forced to cease, at least temporarily. During such periods, it would be desirable, if not essential, to make maximum use of the local industrial and transportation communication facilities for the benefit of the entire community. This suggests that it might be appropriate to seek further relaxation of the constraints on the Industrial and Transportation Radio Services at least for those critical periods during which their normal operations are not feasible.

In addition to Federally-directed restrictions, there are undoubtedly local regulations in existence at various echelons of government throughout the United States that affect specific aspects of radio communication. Measures of this kind may have been instituted for a variety of reasons, such as to prevent the use of radio for improper activities, to promote safety of life and property, to forestall interference with other systems, or merely to provide additional revenue to the local administration. It would be only logical for the local CD communication director to ascertain what if any constraints have been imposed by his own and superior governmental organizations. Once this survey has been accomplished--and the rationale for the ordinances or other regulations established--he should take steps necessary to remove or ameliorate the

constraints in those cases where anticipated requirements generated by CD emergencies can be shown to override the reasons that caused the creation of the controls. It is also reasonable to believe that local ordinances would not be allowed to interfere with any legitimate use of radio proposed by local CD authorities.

2. Technical Constraints

a. Frequency

The problem of frequency incompatibility does not arise if communication traffic is transferred from the primary or normal means to an already existing system chosen for backup. If, however, individual stations are to be used in systems other than those operating in their normal service, some means of frequency adjustment must exist in the equipment. In sets that are capable of either continuous or incremental variable tuning, frequency adjustments are usually simple. Conversely, crystal-controlled transmitters and receivers are more difficult to retune, and the retuning may consume considerable periods of time. Even those radio sets that provide for the selection of one among a group of discrete channels by means of switching arrangements, the channels are preset and thus such equipments are limited in the flexibility that they can provide. Selection of equipment to be procured or the choice of radio service that is to provide backup must take this problem into account. Frequency compatibility requirements must be considered early in the planning stages.

b. Modulation

Radio systems generally require that both the transmitter and receiver employ the same type of modulation. Plans to shift traffic from one to another system must recognize this limitation. There are techniques available, however, that will permit the reception of signals

modulated in ways other than those for which the receivers were basically designed. Nevertheless, despite the existence of such emergency expedients, alternate facilities selected among those individual stations available should use the identical type of modulation that is used in the primary system. Under difficult conditions, plans that call for reliance on expedients are not the most effective.

c. Distances Between Stations

Intelligibility, coupled with speed of transmission, is a prime measure of effectiveness of a communication system. Intelligibility is dependent upon a number of factors, including antenna design and characteristics at both the transmitting and receiving ends, the transmitter power, the receiver sensitivity and selectivity, and the loss in signal strength along the propagation path. In the VHF and UHF bands, the use of repeaters to extend system coverage will improve effectiveness.

The technical aspects of these factors have been discussed at length in many publications on the subject of radio in general, and will not be repeated here. For the CD communication planner, however, who is interested in exploiting the resources to be found in his local area, attention should be directed toward identifying those systems operating over the same general path and distances that separate the agencies and organizations that will produce and receive the CD emergency communication traffic. Whatever selections are made, some attempts should be made to determine the effectiveness of the apparently suitable system during its normal day-to-day operation and estimate this effectiveness under the emergency situation.

The following section on providing guidance incorporates the preceding considerations into the technique suggested for selecting the appropriate facilities to satisfy the known and anticipated requirements.

VII GUIDANCE FOR STATE AND LOCAL GOVERNMENTS

A. Introduction

There is general agreement that existing communication resources in individual communities are normally adequate to provide primary communication support to a community during emergencies if proper planning and arrangements are made for their use. The additional support required is ordinarily nominal.

A series of field tests in 1969 in Georgia, Colorado, Texas, West Virginia, Vermont, and Kansas showed that it is possible for local Civil Defense Directors to prepare local emergency communication plans in a reasonable time with technical assistance that is locally available.[1c] The tests also showed that the amount of work on the plan actually requiring technical knowledge of communication techniques would require 40 hours or less in most communities. In order to establish an adequate local Civil Defense emergency communication system, a plan is needed. In order to develop such a plan, guidance and training should be provided to the local communities, provision for the planning effort should be made, and financial assistance may be needed. A planning program, then, consists of five elements--guidance, training, supervision, financing, and administration.

B. Current Guidance

This section addresses the area of improved guidance. The current seven-step guidance in FCDG Part E, Chapter 3 and Appendix 1 was analyzed and certain changes recommended in an SRI EOSD Task 65-7 Memorandum Report.[5] The major changes recommended include:

- Reducing the communication planning cycle to three steps, rather than the current seven steps
- Placing the determination of requirements based on the emergency operations plan first in the sequence
- Eliminating the exhaustive inventory of local communication assets by placing emphasis on only essential inventories of existing systems and their utilization in their normal role as much as possible, with modifications made to utilize these systems from the EOC.

Certain additional facilities are provided for Direction and Control and the responsibility for the installation, operation, and maintenance of the system and its elements is established. The result is a comprehensive set of instructions that will result in an effective emergency communication plan.

During the preparation of the plan in accordance with this guidance, requirements are established and local communication assets are selected to meet these requirements. In this respect, the field tests revealed that locally available technicians normally lacked a working knowledge of the actual requirements, the facilities that could be made available and the technical details of the several communication services.

C. Suggested Technique for Planning Guidance

This section describes a two-sided circular Civil Defense emergency communication guide containing many of these elements. The ALFA NEOP concept of emergency operations is used as the basis for emergency services, functions, and requirements. The guide is so constructed, however, that it is equally useful for natural disasters.

On the obverse side, 60 of the most common emergency communication requirements are identified and primary and alternate radio communication

means are selected for each requirement. To [illegible] ments are also grouped by function within the NEOP Services (Direction and Control, Police, Fire, Medical, Shelter, and Resource). Several operational and technical parameters were considered in selecting the assets to meet the requirement, including distance, mode of operation, power, frequency, modulation, normal fixed or mobile operation, primary function, and regulatory constraints. The main value lies in directing the users' attention to the normal primary radio means of communication and to suggest feasible alternate facilities for use or as a routing over which to pass messages if the primary radio means is inoperative.

On the reverse side, the nine principal radio services of primary interest to Civil Defense are listed, together with basic technical information of interest to the local radio officer. An Emergency Radio Checklist is also provided.

SRI believes that the widespread use of this communication guide will assist the local communication planner in achieving more effective use of available communication assets.

VIII CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

Extensive government and non-Government communication facilities and services exist that might be of significant value to CD agencies at all echelons in the event of emergency. The emergencies could arise from wartime conditions or by reason of natural disasters. In either event, prior planning to make optimum use of the available and applicable resources is necessary, since many difficulties and delay-producing complications are likely to exist before the communication resources can be used.

Current procedures and guidance are complex in some instances and scattered in others. It is widely recognized that the lower echelons of governmental hierarchy--particularly the local (operating zone) government agencies--will bear the brunt of initiating and carrying out recovery actions. The local CD directors and their communication officers have the least resources both in terms of manpower and in materials; these officials have the greatest need for assistance in the forms of information and advice.

Techniques and devices that can be used to assist the local government officials are especially valuable. Practical, simple means to provide information and guidance need to be developed, tested, and disseminated. One such device has evolved from this study. The device, although simple, appears to have a considerable potential for aiding the CD director and his staff in making optimum utilization of available communication resources.

B. Recommendations

The Civil Defense Communication Guide presented in Section VII of this report should be reproduced and distributed to a selected sample of CD agencies at state and lower echelons of government. Comments and suggestions should be solicited to confirm its value and usefulness at the various echelons. If the responses confirm that it has sufficient value for the suggested purposes, the device together with a brochure explains its use, should be disseminated throughout the CD organizations.

C. Areas in Which Further Investigation Appears Justifiable

When various alternative communication resources are considered for primary and backup communication roles in emergency situations, several examples of apparently underutilized communication resources become evident. The following paragraphs suggest how some of these resources might be exploited. At this time, the development of the concepts is not sufficient to permit their immediate implementation, and in some cases, to do so would be contrary to existing Civil Defense plans. Therefore, these ideas are not presented as concepts ready for Civil Defense Directors to incorporate into their planning programs, but rather as proposals for further investigation and development, preferably at the national level.

1. More Effective Use of Broadcast Facilities

The current regulations and operational procedures for using AM, FM, and TV broadcast facilities during an emergency situation dictate the immediate shutdown of many of these radio transmitters. In the large metropolitan areas of the country, in particular, only a small fraction of the total radio broadcast resources will be applied to emergency functions, while the major fraction of those resources will be prohibited

from operating. Yet these metropolitan areas are potentially more valuable targets for enemy nuclear attack and are more in need of emergency communication than are smaller cities and towns.

The radio and television broadcast facilities in the United States are now organized under the Emergency Broadcast System (EBS), a voluntary association of broadcasters controlled by the Federal Communications Commission. The EBS organization is comprised of four classes of station participants:

- Primary broadcast stations, which possess a National Defense Emergency Authorization (NDEA) and are responsible in an emergency for broadcasting EBS warning and emergency information and control messages directly to the public
- Alternate NDEA stations, which function in a standby (nonradiating) mode and take over EBS programming if the primary station in the area goes off the air
- Primary NDEA broadcast pickup and relay stations,* which function as receiving and radio relay links carrying programming material from Federal and state Civil Defense sources to the primary or alternate NDEA station for immediate or delayed rebroadcast to the public
- Alternate NDEA broadcast pickup and relay stations,* which function in a standby (nonradiating) mode to take over if the primary relay station in the area goes off the air.

On the activation of the EBS, all non-NDEA stations must terminate broadcasting immediately after delivering a prepared EBS warning message.

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*The pickup and relay stations are generally FM broadcast stations.

It should be possible to utilize the tremendous potential communication capabilities of the non-NDEA broadcast stations which can substantially survive EMP and be available for use in the reconstruction communication networks. The potential of these facilities derives from the fact that these radio transmitters are capable of delivering messages to any of the literally thousands of persons already equipped with broadcast receivers. Thus, this mode of communication is not limited by the numbers of outstations or radio-equipped mobile units pretuned to a net frequency, by the availability of trained radio operators, by the necessity for special antennas and sensitive receivers, or by severe propagation anomalies that sometimes limit the areas of useful mobile radio operation. Although broadcast stations are constrained to one-way transmissions of messages, it is obvious that many of the most difficult communication and control problems may be relieved significantly by the use of even a one-way communication link.

The most difficult problem of control involving large numbers of people exists during the period of time immediately preceding an attack, when the general public must be moved rapidly to shelter areas. The primary broadcast stations of the EBS will give warning and general direction messages to the public during this time, but they cannot devote a significant amount of their broadcast time to collecting and relaying special instructions to specific groups of people, neighborhoods, centers of traffic congestion, or routes to individual shelters. Broadcast stations could be organized to provide such information, and at the same time, to relieve the primary EBS station of much of the message traffic not essential for city- or county-wide dissemination.

The organization of the non-NDEA broadcast stations should be primarily on a geographical basis. Because of the general ownership of portable AM broadcast receivers, the AM broadcast stations should each be assigned to transmit instructions to the general public moving

to shelters in designated discrete neighborhoods, suburban areas, or urban districts. The public should be aware of the broadcast frequency to which they should tune their radios, signs should be posted (with shelter direction signs) indicating the frequency for that area, and the primary EBS broadcast should periodically call attention to those frequencies and areas for special shelter movement control messages. Telephone interconnections between central police headquarters or precinct headquarters and the broadcast studios should be provided for relay of vehicular and pedestrian control messages and shelter status information to the appropriate broadcast station. In this way, the traffic control officers can indirectly but rapidly direct people to expedite movement to shelters.

A special problem arises in the case of major industrial plants, universities, schools, or central city office complexes. The FM broadcast stations might be organized to aid in the direction of people in such cases. Since portable FM broadcast receivers are not as numerous as AM receivers, group leaders equipped with such receivers would be needed. An FM broadcast station could be assigned to each major plant, complex, or groups of complexes to give specific instructions to group leaders.

There may be additional important functions for broadcast stations after the public is in shelters. Consider, for example, some of the control problems of a BOS Condition 2, 4 or 5. These conditions may involve light to moderate fire and/or fallout in the area, so that units or teams of special workers will be operating outside the shelters for purposes of damage assessment, rescue, medical care, fire fighting, radiological survey, and repair of power, communication, and other essential services. Although some of these units will be equipped with mobile radio equipment, those which are not preorganized and preequipped

for non-Civil Defense functions would be forced to operate without the continuous control that radio communication would afford. Furthermore, even those units having radio-equipped vehicles may be unable to function sufficiently near those vehicles to ensure the immediate receipt of orders from their respective headquarters. Such would be the case especially when streets are blocked by debris from damaged buildings or abandoned vehicles.

Broadcast stations can supplement the available vehicular radio base stations for control of these working units and trains. Geographical assignments similar or identical to those used in the preattack operations could be applied. Alternatively, assignments of broadcast stations could be made by work unit functions, with designated stations handling such units as rescue teams, communication repair teams, street clearance teams, and medical treatment units, respectively.

Conspicuously missing from the preceding discussion is the use of television broadcasting stations. The fact that television receivers (or even television sound channel receivers) are not generally adaptable to portable or mobile use makes the TV broadcast facilities inappropriate for the kinds of services suggested above. Although it is conceivable that television cameras might be used with appropriate remote pickup and relay gear to enable key Civil Defense officials to view at first hand the damage to the city and to monitor progress in fire fighting, for example, such a concept may be an extravagance in the use of key technical personnel and equipment and would provide only marginal benefits. Perhaps the greatest service that television broadcasting could render in a national emergency is maintaining to the greatest degree possible the public awareness of national and internation affairs and actions, in addition to its perceived valuable role in CHAT.* Such a service would

*Crisis Home Alerting Technique.

be particularly valuable with respect to public morale and determination under the strained conditions of restricted existence in shelters.

2. Integrated Civil Defense Emergency Communication

When an emergency condition has been declared in an area, a central control authority is automatically established under the operational command of the local Civil Defense Director, who directs from his Emergency Operations Center (EOC) the efforts of police, fire, radiological defense and utilities services, medical services, shelters, and other services, as well as the movements and welfare of the general public. Although these various elements under the command of the CD director are generally prepared to operate in a coordinated effort in terms of liaison communication and dedicated personnel, a central command and control facility does not, as a rule, exist today with the means to integrate the assorted communication facilities, which were originally designed for the usual day-to-day operations of those services. For example, the radio base stations for dispatching police, fire, utilities, street and highway maintenance vehicles, and ambulances are usually scattered throughout the area and must be contacted by telephone lines that follow diverse routings to and from telephone exchanges. If measures are taken to use the radio facilities of taxis, buses, construction vehicles, business and industrial units, the citizens' band and amateurs for backup communication, the difficulties of coordinated operations will be further magnified, especially when telephone facilities have been damaged or destroyed.

Ideally, all control communication would be integrated and centrally controlled from the EOC. This ideal is not feasible for several reasons, including the fact that a single communication center would be vulnerable to complete breakdown of control if struck or severely damaged in the attack, and a single base station often will not provide

the coverage necessary for two-way links with vehicles throughout most large cities, regardless of their functions. Therefore, an optimum deployment of two or more alternate base stations, interconnected with the main and alternate EOC's by special direct underground telephone lines or by radio or radio relay facilities may be necessary. Conceptually, at least, the optimum base station locations for radio dispatching of vehicles throughout a large city or county area should not differ significantly for different specific vehicle functions, i.e., the radio base station locations optimized for police vehicle dispatching should also be near the optimum for such diverse functions as gas company vehicle, ambulance, television repair vehicle, or taxi dispatching as well. Thus, there may even be an economic incentive for the various local government agencies, utilities, and commercial organizations licensed to operate vehicular radio systems to set up collocated base stations, the control of which could be transferred to the Civil Defense Director in an emergency.

A more realistic approach to integrated radio communication, however, would involve equipping of a single set of local government base stations with appropriate receivers, transmitters, antennas, and antenna multicouplers to facilitate dispatching all local government vehicles (as a minimum) from those key stations. Thus, for example, if the police-radio base station complex appears to provide the best city- or county-wide coverage for vehicle dispatching, those base stations should also be equipped to dispatch fire units, street and highway units, city ambulances, and any other city or county radio-equipped vehicles in times of emergency. When such operation involves the use of different frequency channels, separate channel-monitoring receivers and multiple or frequency-switching transmitters should be provided at the base stations rather than in the vehicles. Wideband antennas with multicouplers to receivers and transmitters would minimize the complexity

and vulnerability to damage of the antenna installation required. All local government services may not require the use of these facilities for routine operations, but their availability in emergencies, when independently operated base stations scattered throughout the area are unable to function in a coordinated effort, would be of great value.

3. Better Exploitation of the Amateur Radio Service

The significant and unique capability of the Amateur Radio Service to provide communication during a Civil Defense emergency should be better exploited. Under current regulations, RACES will be the only organized group of amateurs that will be permitted to remain on the air; yet, RACES encompasses only a relatively small segment of the amateur fraternity and only portions of the available amateur bands of frequencies are available to RACES. To complicate the situation, there is no national level direction of RACES charged with coordination of RACES plans and operations; such coordination now exists only at state and regional levels. It has been reported that the locally prepared RACES plans are now being forwarded to the FCC for approval, since the FCC liaison officers at the regional level have been discontinued.

As discussed earlier, the Amateur Radio Public Service Corps composed of the National Traffic System and the Amateur Radio Emergency Corps, the Military Affiliate Radio Systems of the Army and Air Force, the East Coast, Midwest, and West Coast Amateur Radio Service ("Instant Service" nets), and the amateur who belongs to no organization for emergency traffic are all potential assets for use during a Civil Defense emergency.

A national basic emergency plan for the more effective use of amateurs should be designed to include, but not be limited to:

- National level management, supervision, policies and training for RACES

- Emergency use of the Amateur Radio Service frequency bands
- The interface or integration required between NTS, AREC, RACES, MARS (Army), MARS (Navy), MARS (AF), the "Instant Service Nets" (ECARS, MWARS, WCARS), and the amateur who belongs to none of these groups in order to achieve an integrated operational amateur capability
- Operational use and improvement of the system required to maintain necessary efficiency and interest
- Standardized message formats, precedences, and operational procedures.

4. Exploitation of Anticipated Cable Television Developments

A recently published comprehensive study of the impact of advances in communication technology on urban problems [11] anticipates that many areas of improvement in city life will result from these advances. Among the major areas of progress that are foreseen is expansion and more extensive use of the existing CATV systems and of their evolutionary development into Broadband Communication Networks.

The study visualizes the establishment of a number of basic urban communication networks. One such network would be based on the existing cable television systems, which can distribute information from central facilities to offices and homes. As well as having a large channel capacity, a limited callback capability would also exist for polling and making requests. Another basic network would employ the broadband facilities in a high capacity, two-way system that would interconnect the major public institutions and large commercial facilities of the city.

The impact of these anticipated changes on urban life is expected to be profound. The changes can also be expected to impact on

the manner in which emergency operations will be conducted. Therefore, it appears that the anticipated changes that are brought about by these communication developments in the near future must be carefully studied to ascertain their specific influences on Civil Defense functions and their mode of performance. As noted in the previous section on CATV in this report, it is conceivable that drastic revisions may be required in the manner in which Civil Defense communication will be performed, when these changes are implemented.

Appendix A

CITIZEN'S RADIO SERVICE CLASS D
AUTHORIZED CHANNELS

Appendix A

CITIZEN'S RADIO SERVICE CLASS D
AUTHORIZED CHANNELS

Channel	Frequency (MHz)
1	26.965
2	26.975
3	26.985
4	27.005
5	27.015
6	27.025
7	27.035
8	27.055
9 -------(Emergency Only)----	27.065
10	27.075
11	27.085
12	27.105
13	27.115
14	27.125
15	27.135
16	27.155
17	27.165
18	27.175
19	27.185
20	27.205
21	27.215
22	27.225
23	27.255

Appendix B

U.S. AND POSSESSIONS AMATEUR RADIO BANDS

Appendix B

U.S. AND POSSESSIONS AMATEUR RADIO BANDS*

1.8	-	2.0 MHz
3.5	-	4.0 MHz
7.0	-	7.3 MHz
14.0	-	14.35 MHz
21.0	-	21.45 MHz
28.0	-	29.7 MHz
50.0	-	54.0 MHz
144.0	-	148.0 MHz
200.0	-	225.0 MHz
420.0	-	450.0 MHz
1215.0	-	1,300.0 MHz
2300.0	-	2,450.0 MHz
3300.0	-	3,500.0 MHz
5650.0	-	5,925.0 MHz
10,000.0	-	10,500.0 MHz
21,000.0	-	22,000.0 MHz
All above 40,000 MHz		

*Authorized modulation, class of license restrictions, and other time and power constraints are omitted.

Appendix C

AMATEUR RADIO EMERGENCY CORPS REGISTRATION FORM

A M A T E U R R A D I O P U B L I C S E R V I C E C O R P S

AMATEUR RADIO EMERGENCY CORPS

REGISTRATION FORM

Registering in the Amateur Radio Emergency Corps, division of Amateur Radio Public Service Corps, involves no expense of any kind, nor any obligation to join any amateur radio organization to retain membership. (Please print or type)

Name_____ Call_____ Age_____

Home Address_____ City & State_____

County_____ Home Phone No._____ Code Speed_____

Business Address_____ City & State_____

County_____ Bus. Phone No._____ Days Off_____

What experience in handling emergency traffic?_____

Class Amateur license_____ ARRL Member?_____ RACES?_____

hat is your primary interest in amateur radio?_____

Check the bands on which you and your station are capable of operating efficiently.

Band	Fixed Station	Mobile	Portable	Band	Fixed Station	Mobile	Portable
160 M.	.....	.....	.....	20 M.	.....	.....	.....
80 c.w.	.....	.....	.....	10 M.	.....	.....	.....
75 Ph.	.....	.....	.....	6 M.	.....	.....	.....
40 c.w.	.....	.....	.....	2 M.	.....	.....	.....
40 Ph.	.....	.....	.....	Other	.....	.....	.....

Do you have emergency power continuously available at home station?_____

Use an attached sheet to describe equipment useful for emergency operation(if any).

☐ I intend to participate ACTIVELY and request FULL MEMBERSHIP.

☐ As my participation must be limited, I request LIMITED MEMBERSHIP.

It is understood and agreed that my membership grade (FULL or LIMITED) will be determined by the Emergency Coordinator supervising my area, based entirely on my activity in AREC plans and drills. I further understand that my continued interest and activity, together with annual endorsement of my membership card, are the sole requirements for retaining my membership in good standing.

Date_____ Signed_____

Forward this form to your EC, SEC, or SCM, in that order of preference. See SCM addresses page 6 each issue of QST. SEC and EC addresses are on file with hq. and the SCM. AREC registration is open only to licensed amateurs in the U.S. and Canada.

Form 7

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Appendix D

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Appendix D

BIBLIOGRAPHY ON AMATEUR RADIO

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