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CIVIL DEFENSE WARNING REQUIREMENTS STUDY

by

Special Projects Staff

Operations Development Department

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This report has been reviewed in the Office of Civil Defense and approved for publication. This approval does not signify that the contents necessarily reflect the views and policies of the Office of Civil Defense or of the various State and local civil defense organizations.

SDC

PREFACE

In February of 1962, the System Development Corporation was awarded contract OCD-OS-62-119 by the Office of Civil Defense to perform a program requirements analysis of the DOD-OCD warning system. The principal objective of this contract was to determine system requirements for an effective warning system to meet present and future needs.

This document and the classified material contained in a separate volume: "Classified Supplement to Civil Defense Warning Requirements Study (U)," TM(L)-900/002/00, constitute the final report by the System Development Corporation on this project. In addition to the basic report contained in these two volumes, a Summary Report of Civil Defense Warning Requirements Study, TM(L)-900/000/01, has been issued.

ACKNOWLEDGMENT

The efforts of many persons working either full or part time contributed to the material presented in this report. Significant contributions were provided by the following individuals of the Special Projects Staff, Operations Development Department: R. C. Brictson, A. P. Cutter, T. P. Haney, C. P. Newton, L. W. Sepmeyer, and D. C. Swavely.

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Many OCD personnel contributed materially to the project by providing guidance, information, and constructive criticism throughout the course of our research efforts. Special appreciation is due W. E. Strope, J. W. Kerr, H. M. Brown, H. E. Roderick, and many of the Warning Center and Regional Warning Officers.

W. R. Warren

Special Projects Staff

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CHAPTER ONE

INTRODUCTION

I. SCOPE OF THE STUDY

In February 1962, under a research contract (OCD-OS-62-119) to the Office of Civil Defense, the System Development Corporation began a program requirements analysis of the Department of Defense - Office of Civil Defense warning system. The objective of this research effort was to determine warning system effectiveness in meeting the present and future needs for warning. Program objectives, as stated in the contract, and the SDC approach to the study are as follows:

A. PROGRAM OBJECTIVES

1. A detailed study of the requirements for warning in the late 60's and early 70's, including an evaluation of the need for outdoor and indoor warning devices and other warning systems which are capable of transmitting identifiable signals to the general population.

2. An analysis and evaluation of the effectiveness of the warning system in meeting the needs for warning of attack and for determining what role the system plays in providing warning of radiological, chemical, and biological hazards.

3. An identification of the cost-effectiveness of feasible warning systems and programs for the present and future, considering strategic needs in the late 60's and early 70's, and the likely performance requirements of the warning system.

4. An identification of training requirements, formulation of an overall training plan, and evaluation of the use of simulation techniques and tactical exercises as training devices.

5. The development of testing procedures which are capable of measuring operational readiness both independently and in conjunction with the training plan.

B. APPROACH TO THE STUDY

There are various approaches to the study of a national warning program. One of these is a fundamental study determining a national philosophy about the need and usefulness of civil defense warning. Questions concerning whether or not there is a need for such a program, what must its goals be, and what will be its effects upon overall national policy must be answered in that type of study. This broad view of the warning program must also consider the relationship between the establishment of an effective warning program and the presently planned shelter program. As capabilities to shelter the population increase, the more stringent time requirements presently imposed upon the system are lessened. Responsibility for warning is another important consideration. What agency is most capable of performing the warning function? Is warning a basic civil defense function, or a separate function more adequately performed by another agency?

A second approach to performing a warning study is that of specifically defining the overall scope of the warning program, more from a view of what it entails than how it should be administered or how it relates to other programs. What elements are required in the warning itself? Is nuclear attack warning sufficient, or is there a basic responsibility to provide warning of the effects of such an attack and of various natural disasters? Is a single warning system capable of performing all these functions? What are the basic requirements for warning and what are the opera l characteristics and performance requirements of the system?

A third approach is that of defining the system itself. This includes the definition of necessary decision points, an appropriate organization, all communication networks, and specifications for hardware design and implementation.

All of these approaches, or levels of investigation, are necessary in the development of an effective warning program. However, they are not all contained within the scope of this study as outlined in the objectives of the contract. The SDC focus, due to contractual guidelines, time, and manpower constraints, has been predominantly at the second level with as much overlap into the other areas as was possible to accomplish.

The Warning Requirements Study is therefore primarily concerned with:

a. Establishing the need for warning.
b. Developing basic requirements for a warning system.
c. Evaluating feasible warning systems.
d. Establishing an implementation program.

Subsequent to this study and dependent upon concurrence with the needs and requirements established, projects should be initiated to evaluate further the specific types of warning systems considered in this project and recommended as being most feasible. These investigations should cover both the operational and technical feasibilities of such systems. Studies of operational feasibility should include the determination of required warning coverages and how they may be attained. This should be accomplished in more detail than this study provides. The technical elements of the warning system (i.e., warning devices, communication networks, etc.) can then be evaluated to ensure an effective operational capability.

Research which concurrently examines operational and potential systems is subject to unique constraints. Although the existing system does provide a partial basis for focus and improvement, recommendations for any future system should not be linked arbitrarily to what exists solely for the sake of providing a continuing operational capability which may be inadequate. In some sense this implies results more compatible with the extant system and can preclude genuine research designed for exhaustive study leading to new conclusions or substantiation of existing opinion. Such recommendations are based on both new and/or differently collated facts derived from the research. SDC has attempted to maintain a research perspective despite limitation imposed by the scope of study and the fact that warning is simultaneously a complex research problem as well as a controversial public issue.

II. NEED FOR WARNING

It has been said that warning of a nuclear attack will be of little value for those who are in the ground zero area and the immediately adjacent areas. Other than on moral grounds, it is difficult to argue with this concept. It is equally difficult, however, to describe with any degree of accuracy and dependability what will be the strategies of the attacker, the scope of the attack, and the specific ground zero points (for which warning will be of no value). It is obvious, then, that to those millions outside of the immediate ground zero area, and to those well away from the target area itself, provision of warning is justifiable. Not being able to define specifically to whom warning should be provided dictates the requirement that warning should be provided to all who might derive some benefit from receiving it.

In addition to the moral obligation to the people, there is the practical consideration of enhancing the survivability of our nation. Studies indicate that an adequate set of protective measures, combined with sufficient warning to permit the populace to take advantage of them, can save the lives of large segments of the population. These lives represent the skills and experience that mean the difference between economic and social viability and total destruction of our nation and way of life. This aspect of the need for warning becomes increasingly important as the shelter program continues to provide additional protective means to be taken in the event of an attack.

Any elaborate analysis of population as a resource should include the structure of urban, rural and transient elements and the analysis of human skills by priority. However, such an analysis appears basically inimical to the warning program and could lead to the same type of invidious comparisons engendered by the question asked as to whether it is moral and/or legal to protect your fallout shelter with a gun. Further, and more importantly, warning information assists planners and populace in definition of the situation which, in turn, facilitates protection of people, protection and recovery of property, and resource management.

Providing warning, then, of a forthcoming direct nuclear attack is justifiable. Of equal importance is the necessity of providing effective warning and information about the after effects of an attack. The requirement to provide the populace warning of these effects is no less stringent than the requirement for providing attack warning itself, since attack effects may impair or kill many more millions than the attack itself. The position of the Federal government on the need for warning appears to be clear. That position has been stated in the Federal Civil Defense Act of 1950,[1] the Reorganization Plan of 1958,[2] and the National Plan for Civil and Defense Mobilization.[3] More recently, the obligations and responsibility of the Federal government for provision of warning were reaffirmed through Presidential Executive Order 10952. This EO, in assigning former OCDM tasks to the Department of Defense, states that the DOD functions shall include all functions contained in the Federal Civil Defense Act of 1950. These functions included the development of:

1. A fallout shelter program.
2. A chemical, biological, and radiological warfare defense program.
3. All steps necessary to warn or alert Federal military and civilian authorities, state officials and the civilian population.[4]

III. DEFINITIONS AND ASSUMPTIONS

As a preface to this study, it was necessary to formulate and state certain definitions and assumptions upon which work could be based and warning requirements developed. As the study progressed, it became imperative that terms be clarified. A list of terms used in the study is given in Appendix E. However, a few whose exact meaning is crucial to the understanding of this report are defined here:

Alert - An attention getting signal or alarm used to arouse the intended recipient to a state of action. As opposed to warning, alert or the process of alerting provides only an initial awareness of a threatening situation, and does not in itself define what the situation is, where it is, or when it will happen.

Warning - The advance notification of a nuclear threat, the effects of an attack, or impending natural disasters. Notification includes the provision of information about the nature of the threat, its extent or scope, and its imminence. Warning is completed when the recipient has received and

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1. Federal Civil Defense Act of 1950, 81st Congress 2nd Session, 12 January 1951, p. 1248.
2. Reorganization Plan of 1958, Prepared by the President and submitted to the Congress, 24 April 1958.
3. Office of Civil and Defense Mobilization. National Plan for Civil Defense and Defense Mobilization, October 1958.
4. U.S. Government, Hearings Before a Subcommittee of the Committee on Government Operations, House of Representatives, Eighty Seventh Congress, First Session. Civil Defense 1961, Washington 1961, Appendix 3A, Executive Order 10952, p. 379.

interpreted data presented to him and decided to act.

Local Warning Center - A facility capable of 24 hour operation found normally at the city or county level. The local warning center must be capable of performing all functions required to provide warning to the inhabitants within its jurisdiction.

Intermediate Centers - An organizational level in the warning system between the national and local levels. Intermediate centers will normally be at state or regional levels, and will have functions which will require interactions with both Federal, state, and even local civil defense organizations.

The assumptions upon which this study was predicated were based on information contained in various portions of the National Plan or were formulated as a result of recent changes in the civil defense program. The assumptions are divided into three categories: those which are concerned with the nature and scope of the hazard; those pertaining to the process of warning; and those related to a program of protective measures.

A. NATURE AND SCOPE OF THE HAZARD

The DOD-OCD warning program must provide warning to the people of the United States of impending nuclear attack, hazards which result from such an attack, and as applicable, impending natural disasters and their after effects.

The threats and hazards defined above if allowed to pursue their courses unhindered or unprotected against, will result in injury and death to many people or damage and destruction to property. The overt aggressive acts of foreign powers toward this country are of the greatest concern to the DOD-OCD warning system, as nuclear detonations and their effects could harm millions of people. Biological and chemical hazards as the result of a hostile attack can also decimate large segments of the population. The attack strategy employed by the enemy may have significantly different effects on different portions of the populace. Likewise, natural disasters such as earthquakes and hurricanes can have catastrophic effects. Therefore, civil defense must plan for a variety of contingencies to achieve the maximum amount of protection attainable.

B. THE WARNING PROCESS

The warning process must provide for the dissemination of alert and warning to the civil defense organization and to the general public.

The primary source of tactical warning is, and will continue to be, the North American Aerospace Defense Command (NORAD). In addition to NORAD, messages providing strategic warnings may be received from the President or his delegates, DOD or other intelligence agencies, and from civil defense headquarters. Detection and evaluation of attack effects such as radiological fallout and contamination, and biological and chemical hazards must be performed by the civil defense organization and allied agencies (data sources) at local levels.

To disseminate warning of natural disaster the warning system must be sensitive to a great many sources of information. Means of developing sensitivity to all such sources is beyond the scope of this study.

C. PROTECTIVE MEASURES PROGRAM

The final effectiveness of the total national warning program will be dependent upon the development and availability of a suitable program of protective measures.

The goal of the protective measures program is the provision of both specified and suitable levels of protection, including improvised, fallout, and blast shelters and tactical and strategic evacuation or dispersal. It is assumed that a national program of fallout shelters suitable and proximate for the majority of the population in urban industrial and target areas will be developed and implemented.

IV. DATA ACQUISITION

In the early stages of the contract period, it was necessary to collect and assess a quantity of data pertaining to the operation and administration of the Attack Warning System.

Throughout the contract period, facility visits and discussions with Federal agencies, civil defense organizations, and other organizations working on related OCD contracts have provided a wealth of information on the field of warning. In order to obtain information required, project staff members have visited:

The National Warning Center
All OCD Attack Warning Centers
The Washington Area Control Point
All OCD Regional Offices
The National Survival Attack Warning Center in Ottawa
Approximately 15 state and local civil defense organizations

In addition to the above visits, conferences and discussions at a more limited nature were held with a wide variety of other organizations both in Canada and the U.S.

V. ORGANIZATION OF REPORT

This report is divided into thirteen chapters. Chapter Two contains a summary of significant findings and recommendations for further research. In Chapter Three, the scope of the project is defined through the establishment of the warning process model. Chapter Four looks at the first and last phases of the model and develops warning time categories within which the system must operate. Chapters Five and Six concern themselves with development of the basic requirements and the performance and operational requirements for a warning system.

In Chapter Seven, evaluations of proposed warning systems are made. A summary and comparative evaluation of warning systems is contained in Chapter Eight. Chapter Nine is an analysis of the present system, and Chapter Ten is an implementation plan indicating both long range programs and immediate modifications that should be undertaken.

Chapters Eleven and Twelve deal with system training and testing considerations and procedures. Finally, Chapter Thirteen describes areas for further research and development. Six appendices are also included. They give background information supplementing the basic document.

TM(L) 900/002/00, a classified volume issued under separate cover, provides the threat and environmental information which was used throughout the study. TM(L)-900/000/01, also issued under separate cover, presents an outline of the scope and methodology of the study, a summary of the significant conclusions and plans for system implementation, and a discussion of further research efforts required.

CHAPTER TWO

CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

I. CONCLUSIONS

Significant conclusions emerging from the research efforts applied in this Warning Requirements Study are as follows:

A. ALERT AND WARNING

It is necessary to distinguish between alert and warning at the outset. Alert is an attention getting signal that is used to call the intended recipient to a state of action. Warning, on the other hand, means the advance notification and the provision of meaningful data about the nature, extent, and imminence of: a nuclear threat, the chemical, biological, and radiological effects of an attack and, as appropriate, the advance notification of certain natural disasters.

B. WARNING SYSTEM MISSION

The mission of the warning system is to enable the population to achieve specified levels of protection upon detection of a threat or threats within a defined range.

C. THE WARNING PROCESS

The process of warning consists of ordered and interrelated phases which are set into action by the perception of a defined threat or hazard. The phases are: the evaluation of the detected threat; the making of the decision to warn; the dissemination of the alert and the warning information; and the receipt, interpretation, and decision to act on the part of the recipient. The decision by the recipient to take action concludes the warning process.

D. WARNING TIME CATEGORIES

General ranges of warning time may be established by an analysis of threats and hazards. These ranges relate to the anticipated time between detection of the threat and the moment of occurrence of the threatened event. They provide increments of time from which warning system parameters may be derived and within which ranges of protective actions may be taken. The categories derived from the analysis and utilized in this study are as follows:

Critically Short Warning Time	0-15 minutes
Short Warning Time	15-45 minutes
Moderate Warning Time	45 minutes - 3 hours
Long Warning Time	3-5 hours
Extended Warning Time	5 hours and greater

E. PROTECTIVE MEASURES

Protective measures feasible for use within the warning time categories are shelter and evacuation. Duck and cover measures (including improvisation), fallout and blast are types of shelter which may be obtained. Evacuation measures can be considered as either tactical (dispersal) or strategic.

F. BASIC WARNING REQUIREMENTS

Basic warning requirements have been divided into two sets: those which are applicable to nuclear attack warning and those which are imposed by radiological, chemical, and biological hazards and natural disasters. The basic requirements for warning of nuclear attack are as follows:

- The public must be conditioned through training and education to respond to alerting and warning in such a way that available levels of protection can be achieved.
- The warning must contain all information necessary to permit carrying out prescribed activities.
- The alerting and warning messages must be clearly recognizable, distinctive and unambiguous.
- Confidence in the validity of the warning must exist.
- The warning system must operate reliably and its capability to perform should not be subject to degradation due to malfunction, sabotage, or false triggering.
- The warning system must be designed to provide warning to the vast majority of the population.
- Destruction of one geographic segment of the warning network should not impair the capability of the warning to reach surviving segments.
- The warning system must be a full period system, in a state of constant readiness.

. Within the capabilities of detection facilities, public warning must be disseminated in sufficient time to permit the designed levels of protection to be achieved. (Assuring that the time available allows people to attain protective measures and not be enroute when subsequent or shorter warnings are received is a special problem requiring further investigation.)

For warning of attack effects and natural disasters, the basic requirements are the following:

. Detection, monitoring, and assessing capabilities must be provided at the local level and assessing capabilities provided at successively higher organizational levels.

. A two way communications capability between civil defense organizational elements at local, intermediate, and national levels must be provided with extensions to government elements responsible for public protection and welfare.

. The capability must exist to alert and disseminate information and instructions to the general public.

G. PERFORMANCE CHARACTERISTICS

Based on the above requirements for warning, the performance characteristics were determined to be as follows:

1. The attack warning to the general public shall be capable of being disseminated in two forms: an alerting signal plus a voice warning message, and a voice warning message only.

2. The warning system must provide the capability to:

a. Simultaneously transmit warning both to the general population and civil defense organizational elements from a National Warning Center without interruption or intervention at any lower organizational level.

b. Transmit warning to relevant civil defense organizational elements only.

c. Initiate warning at the local level for dissemination to that segment of the population that is within the jurisdiction of the local warning center.

d. Disseminate a warning message either generally or selectively to the population from the major political levels above the local level (i.e., state and Federal).

e. Maintain the capability to disseminate a voice message to the general public, even when sheltered, in any area subjected to damage short of total destruction.

3. Any public alerting signal must be capable of commanding the attention of the public and indicating that an extremely hazardous condition exists or is imminent. The alerting signal must be immediately followed by a warning message which will contain all necessary information.

4. The alerting signal must not have been or be compromised by resemblance to other signaling devices in common use or by testing in a manner which will result in doubt whether the alert heralds a test or a hazardous condition.

5. All devices employed for alerting the general population and civil defense organizational elements shall be capable of activation by a common alert activation signal.

6. The warning system shall provide basic attack data in coded form from a National Warning Center which will result in automatic selection of several locally determined prerecorded messages and dissemination of these messages within the area of local jurisdiction. Basic attack data must also be provided in printed form from the National Warning Center to all civil defense organizational elements.

7. Inherent to the warning system must be the capability to disseminate a voice message from the principal governmental levels (i.e., city/county, state, and Federal) to the general population within their respective areas of jurisdiction.

8. The warning system shall provide complete and immediate coverage in those areas having relatively high population densities and/or presumed to be "target" areas (including people indoors, outdoors, and in transit) and coverage to the greatest degree possible within the limits of practicability to the sparsely populated areas of the country.

9. The transmission of warning should be via a highly survivable network so that destruction of any single link would not cause isolation of any part of the system.

10. The warning system shall be capable of detecting the failure or malfunction of any element of the network and restoring the path or substituting an alternate facility in order to ensure and maintain continuous and reliable operation of the system.

11. The warning system must be virtually immune to false triggering due to accident, sabotage, or malfunction; rigid design standards for the system must be imposed.

12. The warning system must be continuously in a state of readiness.

H. OPERATIONAL REQUIREMENTS

The operational requirements of the warning system indicate that:

1. Three organizational levels are required in the warning system, namely, national, intermediate, and local.

2. Two specific decision making levels are required within the system organization. One of these is at the national level, where the National Warning Center is the focal point for the dissemination of the nuclear attack warning. The second is at the local warning center, wherein attack effects and natural disaster warning will be disseminated to the general public. The intermediate level normally has no critical decision making functions as pertains to the issuance of warning messages.

3. Three interconnected and related communication networks are required in the warning system. One of these is a survivable distributed network interconnecting the national center with intermediate centers. The second network interconnects intermediate levels with local warning centers. The third network connects local warning centers with the public warning distribution services.

I. COMPARATIVE EVALUATION OF PROPOSED WARNING SYSTEMS

The results of a comparative evaluation of proposed warning systems are presented in matrix form in Figure 1.

Seven basic conclusions may be derived from the evaluation derived from the study and summarized in Figure 1. These conclusions are:

1. All systems analyzed could be made capable of reaching the indoor and outdoor populace. However, the radio system is the most feasible for reaching the 10 to 25% transient population.

2. Current power line systems (e.g., NEAR) are incapable of transmitting a voice message, requiring validation of the warning by other means, and incapable of being tested without compromise.

3. The radio and telephone systems have the greatest possibility of fast, unified alert and warning.

4. The radio, telephone and power line systems are decreasingly survivable in that order. Power line systems are less survivable because they are dependent on 60 cycle power both at the signal generator and at the receiver.

5. The radio system is the only system not requiring change or expansion to meet population changes or growth.

6. The legal and implementation problems of a power line system and the system using existing telephone lines and instruments are greater than those of the private wire telephone system and the radio system.

7. The ten year costs of utilizing individual or private wire systems are prohibitively expensive. A power line system, radio system, and system using existing telephone lines and instruments are progressively less costly in that order.

J. ANALYSIS OF THE PRESENT ATTACK WARNING SYSTEM

Based upon the requirements set forth in this document, the analysis of the present system indicates that:

1. The Attack Warning System lacks a cohesive, coordinated organization. There is a lack of appropriate and adequate procedures at all levels of the system. The system is not well trained nor adequately supported to provide more than a minimum degree of capability and effectiveness.

2. The three subsystems in the Attack Warning System are controlled and administered by the political subdivision within which each falls. Consequently, they tend to isolate themselves, allowing only a minimum of interaction and coordination.

3. At state and local levels, misconceptions often exist as to potential threats and hazards, and local circumstances often dictate the means and methods for the warning dissemination more than do operational requirements.

WITHOUT COMPROMISE	POOR	VERY GOOD	GOOD	GOOD
GROWTH POTENTIAL	GENERATOR SYSTEM REQUIRES CHANGE WITH GROWTH OF POWER SYSTEM AND POPULATION	PLANT MUST EXPAND WITH POPULATION	PLANT MUST EXPAND WITH POPULATION	TRANSMITTER SYSTEM PRACTICALLY INDEPENDENT OF POPULATION GROWTH
IMPLEMENTATION PROBLEMS				
LEGAL	MANY	SOME	NONE DISCERNIBLE	NONE DISCERNIBLE
RATE CHARGES	UNRESOLVED	UNRESOLVED	NONE	NONE
RECEIVER DISTRIBUTION & INSTALLATION	UNRESOLVED	NONE	UNRESOLVED	UNRESOLVED
PUBLIC ACCEPTANCE OF RECEIVER	UNKNOWN	EXCELLENT	UNKNOWN	UNKNOWN
COST: INITIAL & RECURRENT				
NUMBER OF RECEIVERS, BEGINNING AND END OF PERIOD	60-70 MILLION	50-60 MILLION[1]	60-70 MILLION	60-70 MILLION
SIGNAL GENERATORS	$4/METER $240 MILLION	$20/SUBSCRIBER 1.0 BILLION	INCLUDED IN[2] SUBSCRIPTION COST	$2 MILLION
SIGNAL DISTRIBUTION FACILITIES	EXISTING POWER LINE	EXISTING TELEPHONE LINES	LEASE FROM COMMON CARRIER	FREE SPACE
SYSTEM ENGINEERING	$3.0 MILLION/YR	INSIGNIFICANT	INCLUDED IN SUBSCRIPTION COST	INSIGNIFICANT
SYSTEM MAINTENANCE	$2.4 MILLION/YR	$10 MILLION/YR	INCLUDED IN SUBSCRIPTION COST	INSIGNIFICANT
RECEIVER COST (MANUFACTURE & DISTRIBUTION)	$15 EACH $900 MILLION	NO ADDITIONAL CHARGE	INCLUDED IN SUBSCRIPTION COST	$20 EACH 1.2 BILLION
RECEIVER INSTALLATION	$210 MILLION	NONE REQUIRED	INCLUDED IN[3] SUBSCRIPTION COST	$210 MILLION
RECEIVER MAINTENANCE	$4.75 MILLION/YR	NO ADDITIONAL CHARGE	INCLUDED IN SUBSCRIPTION COST	$1.7 MILLION/YR
ADMINISTRATION	UNRESOLVED	UNRESOLVED	INCLUDED IN SUBSCRIPTION COST	INSIGNIFICANT
OTHER COSTS	NONE	NONE	NONE	$2.0 MILLION/YR (NIGHT OPERATORS)
10 YEAR COST[4]	$1.98 BILLION[5]	$1.31 BILLION	$23.4 BILLION[6]	$1.68 Billion

1. BASED ON ESTIMATED NUMBER OF TELEPHONE SUBSCRIBERS
2. $30 MILLION
3. $210 MILLION
4. SEE APPENDIX D FOR DERIVATION OF 10 YEAR COST
5. IN ADDITION TO THE LISTED CHARGES, THE NEAR· SYSTEM MUST ALSO SUPPORT AN ADDITIONAL VOICE NETWORK TO TRANSMIT THE WARNING MESSAGE FROM LOCAL WARNING CENTERS TO ONE OR MORE LOCAL RADIO STATIONS
6. COST BASED ON $36/YR SUBSCRIBER CHARGE

* TESTING AND TRAINING ISSUES ARE CONSIDERED GENERICALLY RATHER THAN FOR SPECIFIC SYSTEMS.

2

REQUIREMENTS AND COSTS *	TYPES OF WARNING SYSTEMS: POWER LINE SYSTEM, e.g. , NEAR	TELEPHONE SYSTEM USING EXISTING LINES AND INSTRUMENTS	PRIVATE WIRE TELEPHONE SYSTEM USING SPECIAL PURPOSE RECEIVER BY SUBSCRIPTION e.g. , TELEGLOBE	RADIO SYSTEM
POPULATION COVERAGE				
INDOOR	VERY GOOD	GOOD	VERY GOOD	VERY GOOD
OUTDOOR (WITH APPROPRIATE AUXILIARIES)	GOOD	GOOD	GOOD	GOOD
TRANSIENT (IN VEHICLES)	NONE	NONE	NONE	GOOD
RELIABILITY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
SURVIVABILITY	FAIR	GOOD	GOOD	GOOD
SABOTAGE	NOT CONSIDERED A UNIQUE PROBLEM			
FALSE ALARM PROBABILITY	LOW	LOW	LOW	LOW
QUALITY OF WARNING				
UNIQUENESS OF SIGNAL	GOOD	FAIR	VERY GOOD	EXCELLENT
ABILITY TO DISSEMINATE VOICE MESSAGE	NONE	GOOD	VERY GOOD	EXCELLENT
VALIDITY OF WARNING	REQUIRES VALIDATION	SELF VALIDATING	SELF VALIDATING	SELF VALIDATING
ABILITY TO TEST WITHOUT COMPROMISE	POOR	VERY GOOD	GOOD	GOOD
GROWTH POTENTIAL	GENERATOR SYSTEM REQUIRES CHANGE WITH GROWTH OF POWER SYSTEM AND POPULATION	PLANT MUST EXPAND WITH POPULATION	PLANT MUST EXPAND WITH POPULATION	TRANSMITTER SYSTEM PRACTICALLY INDEPENDENT OF POPULATION GROWTH
IMPLEMENTATION PROBLEMS				
LEGAL	MANY	SOME	NONE DISCERNIBLE	NONE DISCERNIBLE
RATE CHARGES	UNRESOLVED	UNRESOLVED	NONE	NONE
RECEIVER DISTRIBUTION & INSTALLATION	UNRESOLVED	NONE	UNRESOLVED	UNRESOLVED
PUBLIC ACCEPTANCE OF RECEIVER	UNKNOWN	EXCELLENT	UNKNOWN	UNKNOWN
COST: INITIAL & RECURRENT				
NUMBER OF RECEIVERS, BEGINNING AND END OF PERIOD	60-70 MILLION	50-60 MILLION[1]	60-70 MILLION	60-70 MILLION
SIGNAL GENERATORS	$4/METER $240 MILLION	$20/SUBSCRIBER 1.0 BILLION	INCLUDED IN[2] SUBSCRIPTION COST	$2 MILLION
SIGNAL DISTRIBUTION FACILITIES	EXISTING POWER LINE	EXISTING TELEPHONE LINES	LEASE FROM COMMON CARRIER	FREE SPACE
SYSTEM ENGINEERING	$3.0 MILLION/YR	INSIGNIFICANT	INCLUDED IN SUBSCRIPTION COST	INSIGNIFICANT

Figure 1. Comparative Evaluation of Warning Systems

4. The elements of the existing Attack Warning System are vulnerable to sabotage and attack damage and do not comprise a distributed network.

5. Local alerting and signalling systems are subject to false alarms and do not supply either the necessary quantity of information or validation of their specific intent.

6. Activation of local alerting devices is often dependent entirely upon the approval of a local authority.

7. The Federal portion of the Attack Warning System (NAWAS) fulfills some of the basic requirements for a warning system. It has an organization, basic procedures, is a full period system, and utilizes voice messages in its operation. Unfortunately, these voice warning messages stop at the warning point and are not disseminated to the general public.

K. GENERAL IMPLEMENTATION

Practical system development is evolutionary in nature. An implementation plan should provide a means for progressing from the existing system to the desired system without impairing a minimum operational capability in the process. Two considerations upon which an implementation plan must be based are the annual budget level available for this purpose and the results of present and future research studies.

1. Long Range Program

The warning program must be established firmly in fact. It must be long-term and well-defined. It must be coupled to the shelter program because the two are complementary. The existence of one does little good without the other. The absence of one, however, does not negate the need for the other.

2. Public Conditioning

Education, training, and a comprehensive conditioning of the public to the necessity and benefits of an effective warning program is of paramount importance.

3. Phase 1 - Immediate Modifications and Improvements

Modifications of a more immediate nature to the present Attack Warning System would serve to strengthen and improve the existing capabilities of the system. In some instances these modifications are necessary to provide the system a minimum essential capability to provide warning.

In others, they extend existing capabilities and improve overall system effectiveness. A summary of these modifications, which are detailed in Chapter Ten, follows:

- Establish a cohesive and unitary organizational structure which may be regularly modified in a coordinated fashion to meet new developments.

- Implement appropriate organizational manning to ensure both immediate and long range operational capability.

- Review and revise warning system operational procedures in light of the current threat and specify all duties and responsibilities of the warning system personnel.

- Establish alert conditions appropriate for all levels of civil defense to provide graduated levels of readiness in case of emergencies.

- Maintain civilian control of the attack warning system, until further research is concluded, in order to provide an organization whose primary role is warning, and whose mission is not likely to be secondary to the alerting and control of military forces.

- Consolidate warning system operational functions at OCD regions and attack warning centers to promote greater efficiency and effectiveness.

- Utilize commercial radio broadcast facilities as warning points on the NAWAS net, integrate useful CONELRAD procedures, and allow voice warning to be disseminated directly to the public.

- Establish uniform meaning for signals and provide both an alerting signal and a warning message to the general public.

- Establish non-alert testing capability that will not compromise or degrade the meaning of the signal for the public.

- Modify the interconnections of the warning circuit to provide the capability of immediate operation and system control to the National Warning Center.

- Expand back-up radio communication capability in case NAWAS links are destroyed or disrupted.

- Augment the NAWAS extensions program to provide voice warnings below the warning points to local warning points.
- Provide necessary equipments, authorities and procedures for local warning points to activate alerting devices immediately and without local approval upon receipt of warning from higher levels.
- Provide warning system teletype capability to obviate delays caused by hand recording of information.

4. Phase 2 - Interim System Modifications

Interim modifications to the warning system take on the aspect of the final system configuration. In some cases, they are extensions of work accomplished in Phase 1. In other cases, they involve greater capital outlay and must be undertaken only after some additional research has been completed. A listing of proposed modifications follows:

a. Establish and integrate additional local warning centers to provide adequate warning coverage and data collection capability.

b. Program and locate the desired number of intermediate centers necessary to provide support to lower echelons.

c. Relocate state warning centers away from prime target areas, where necessary.

d. Expand or modify existing circuits between warning centers to provide adequate survivability.

e. Extend the hard copy teletype warning message capability to local warning centers.

f. Provide tie lines between local warning centers and selected radio stations and arrange for 24 hour standby capability where necessary.

g. Provide emergency power and fallout protection for all radio stations required for the dissemination of voice warning messages and other communications.

h. Equip sirens having separate air compressors with modulated air stream loudspeakers to provide outdoor warning messages.

i. Establish public address warning dissemination capability in urban and industrial areas.

5. Phase 3 - Achieving Full System Capability

Prior to the initiation of Phase 3, the results of additional research will be known, development of a suitable warning receiver will have been completed, and necessary funding accomplished. The interim capability and the integration of final improvements must be planned and coordinated to achieve optimum system effectiveness at all times. In view of the size of the task (e.g., 70 million receivers required), it is unlikely that full system capability will be attained before 1970. Long range activities calculated to lead to an adequate system should be undertaken to determine and implement the required improvements.

a. Install an automatic warning system developed through studies aimed at specifying plans and specifications for this system.

b. Integrate the warning and attack effects activities into a single homogeneous working organization.

c. Plan and provide necessary communication links with appropriate military installations, and develop the procedures necessary for close cooperation with these agencies.

d. Implement the most feasible indoor warning system as determined by further study and research.

L. SYSTEM TRAINING

Training requirements derived from this study lead to two general conclusions:

1. Development of a System Training Program with simulation exercises is essential to establishing, maintaining, and testing operational readiness of the warning system. These should be capable of involving civil defense officials generally, NAWAS personnel specifically, and sections of the populace when appropriate.

2. Training and testing programs should be designed for appropriate system and subsystem elements to facilitate integration of new equipment procedures or personnel without sacrificing operational readiness.

M. TESTING PROGRAM

1. The warning system must ensure its operational readiness capability. To accomplish this requires that elaborate subsystem testing be a routine and periodic activity.

2. Component testing may be determined by:

a. The failure rate of each component of the subsystem under standby conditions.

b. The required probability of operation.

c. The statistical probability distribution function that describes the reliability behavior of the component.

3. Appropriate testing of an alert signal coupled with proper information and education can instill awareness of the system and enhance its effectiveness.

II. RECOMMENDATIONS FOR FURTHER RESEARCH

Constraints of manpower and time, coupled with the required focus imposed by contract objectives, have limited the warning requirements study to the establishment of basic requirements, establishment of performance characteristics, and a general survey of feasible warning systems. These constraints have, however, served to point up areas in which SDC feels additional research is required.

These areas include both technical studies required prior to warning system selection and studies of a more general nature dealing with operational and organizational functions. The areas of concern for further research are outlined below and described in Chapter Thirteen. Additional areas of investigation are included in the discussion of implementation, Chapter Ten.

1. Determine specific feasibility and cost of a radio based civil defense warning system. Accomplish radio coverage studies and develop and field test a civil defense warning receiver.

2. Perform studies to indicate the comparative costs of telephone systems for warning.

3. Formulate plans and specifications for specific circuits and equipments required to implement an automatic warning system.

4. Determine through research, the potential use of components of the military services for maintenance and/or operation of the warning system.

5. Determine the operational interfaces between OCD and military command and control structures; analyze and determine the factors that influence the making of the national decision to warn.

6. Establish a schedule of applicable alerting conditions and standardize these for all levels of civil defense.

7. Analyze various operational facilities at Federal, state and local levels to determine the need for information processing in the operation of the system.

8. Determine appropriate formats and contents of warning messages in light of information needs and requirements of civil defense officials and the general public.

CHAPTER THREE

THE WARNING PROCESS

I. GENERAL

A. INTRODUCTION

Before entering into detailed discussions of system design and system requirements for a Civil Defense Warning System, it is desirable to state just what is meant by the warning process. This will help to avoid misunderstandings in the following discussions and to clarify issues which arise.

Annex 13, Warning, of the National Plan sets forth definitions, assumptions, general responsibilities, and functions for the warning system. The principal functions stated there for a warning program are (1) obtaining information for warning, (2) provision of warning systems, (3) dissemination of warning, (4) public understanding of warning signals, and (5) action on warning.[1]

Although these are considered as separate functions in the National Plan they also indicate that warning is a dynamic process consisting of a sequence with interrelated phases. As the total process seeks to achieve a defined goal, so too must the elements within the process also interact to provide logical progression and continuity of action.

The range of hazards which the warning program must meet varies from the threat of a direct nuclear attack to the threat of a natural disaster such as a hurricane or a flood. The responsibilities of the warning program do not end with the warning of the impending attack (whether nuclear or conventional) or disastrous occurrence, but must continue during the attack and post attack period. Information must be collected concerning attack or disaster damage, radiological hazards such as fallout

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1. Office of Civil and Defense Mobilization. National Plan for Civil Defense and Defense Mobilization, Annex 13, Warning, September 1959, p. 3.
Also see: H. B. Williams, Communication in Community Disasters, Unpublished Dissertation, Univ. of North Carolina, Chapel Hill, 1956; and more recently R. W. Mack and G. W. Baker, The Occasion Instant: The Structure of Social Responses to Unanticipated Air Raid Warnings, Publication 945, National Academy of Sciences - National Research Council, Washington, D. C., 1961.

and 'hot spots,' and chemical and biological dangers. Following collation, interpretation, evaluation, and decision, the public is then warned of the dangers and hazardous conditions.

Basically, warning messages should alert and direct the populace to take those protective measures which will counter or reduce the effects of the defined hazards. Protective measures to counter a direct attack include taking shelter (which includes simple duck and cover measures, fallout shelters, and blast shelters) and evacuations of both a strategic and a tactical nature. Protective measures to counter post attack or post disaster effects must be prefaced by directions to avoid hazardous areas, and include actions necessary to counter the effects of radiological, chemical, and biological warfare. Information on or directions to sources of possible assistance must also be provided.

B. THE NATURE AND MISSION OF THE WARNING PROCESS

Knowing the kind and nature of the hazards and the protective measures needed to cope with them, we may state: The mission of the process of warning is to enable specified levels of protection to be achieved upon detection of a threat or threats within a defined range.

The process of warning may be considered in three overlapping phases: Perception, Dissemination, and Reaction. The attainment of the desired output (specified protective measures) requires that the phases of the warning process react to the threat input in a logical and orderly sequence. The elements within each phase must be considered in light of their relative importance to the ultimate objectives of the warning program. For example, the availability and close proximity of a shelter to the recipient of the warning is of no use if he misinterprets the meaning of the siren, thinking it to be a false alarm instead of an alert. The determination of complete operational and performance requirements is dependent upon an understanding of all phases of this process. Figure 2 shows the dynamic process of warning from perception of the threat to completion of the protective reaction.

II. THE PERCEPTION PHASE

A. HAZARD DETECTION

The perception phase in the warning process is concerned initially with hazard detection. The actual detection of hazards may or may not be accomplished by the agents who will be doing the warning.[1] For a direct

1. Three NORAD regulations of interest concerning responsibilities and warning functions are: NORAD 55-3, Defense Readiness Conditions, States of Alert, Alert Requirements and Air Defense Warnings; NORAD 55-12, Air Defense Warning System for North American Continent; NORAD 55-23, Memorandum of Understanding concerning the Civilian Attack Warning System between OCD(M) and NORAD.

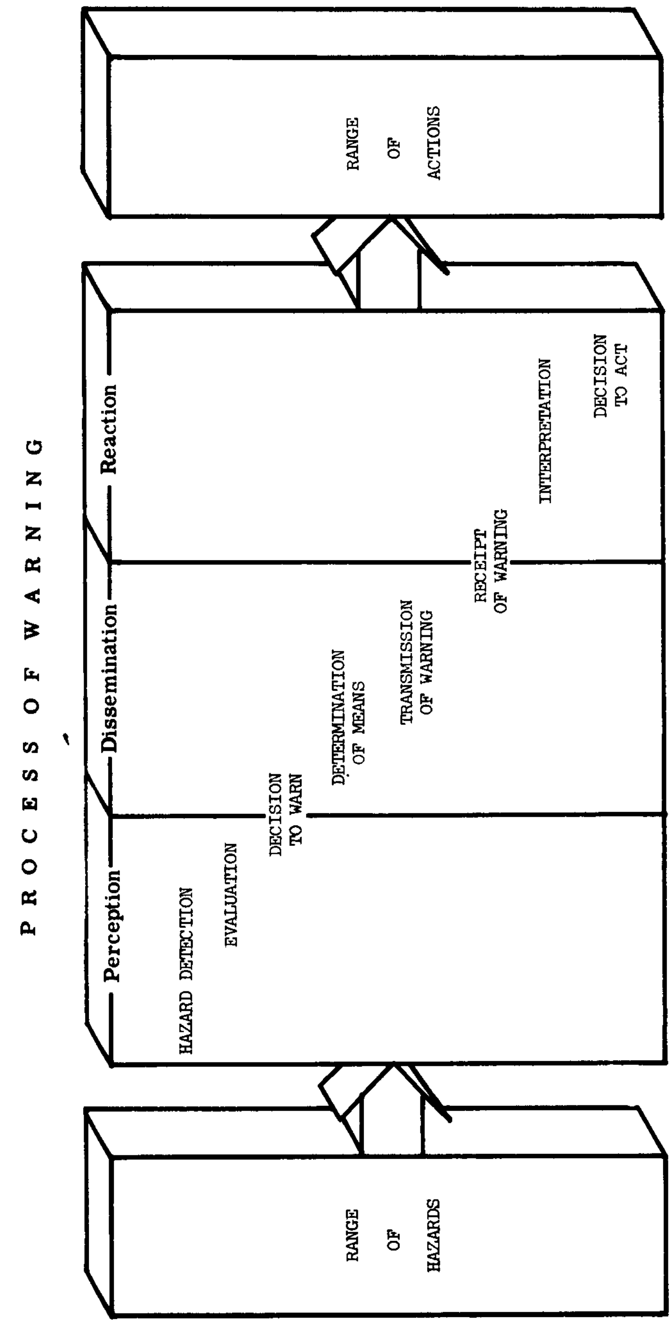
PROCESS OF WARNING
Perception
Dissemination
Reaction
RANGE OF HAZARDS
HAZARD DETECTION
EVALUATION
DECISION TO WARN
DETERMINATION OF MEANS
TRANSMISSION OF WARNING
RECEIPT OF WARNING
INTERPRETATION
DECISION TO ACT
RANGE OF ACTIONS

Figure 2.

attack and a tactical warning situation, detection will normally be accomplished by elements of the North American Aerospace Defense Command (NORAD).[1] The NORAD declaration of a certain state of preparedness or readiness is the basis upon which a warning to the civilian population is given. Under a strategic warning condition, other elements of the government may decide that a warning should be given on the basis of intelligence reports or in the case of a deteriorating international situation. However, even under these conditions, warning decisions may come through NORAD channels.

Detection of hazards of a natural disaster may be expected to come from the U.S. (or local) Weather Bureau in case of cyclone or flood, from the Forestry Service in case of fire, from the U.S. Public Health Service in case of pestilence, or from any one of several other agencies engaged in public service activities.[2] Perception of hazards arising from attack effects, post attack, and post disaster conditions will be accomplished by local agencies manned by government, military or civilian defense personnel and will be processed through the warning network for evaluation or local action.

B. EVALUATION OF HAZARDS

Before the decision to warn the population is made, those responsible for making this decision must be aware of the scope and nature of the hazard and of its imminence. Knowledge gained from previous experience and from previous studies indicates that the decision maker must possess a knowledge of the protective measures that will be required to cope with the particular hazard and must further be capable of determining the overall effect of his decision once it is made.[3] The evaluations of a hazard should be accomplished, time permitting, by those agents or combination of agents

1. For a brief discussion of the role of the military in certain foreign CD programs, see Civil Defense in the West, an unpublished manuscript completed by the Plans and Programs Directorate, OCD-DOD.

2. M. E. Treadwell, Hurricane Carla, G.P.O., Washington, D. C., 1961. Also, publications of the National Academy of Sciences Disaster Research Group, especially: R. A. Clifford, The Rio Grande Flood, Publication 458, National Academy of Sciences, National Research Council, Washington, D.C., 1956; and E. R. Danzig, et al., The Effects of a Threatening Rumor on a Disaster-Stricken Community, Publication 517, National Academy of Sciences, National Research Council, Washington, D.C., 1958.

3. C. E. Fritz, "Disaster," in R. K. Merton and R. A. Nisbet, Contemporary Social Problems, Harcourt, Brace and World, Inc., New York and Burlingame, 1961, pp. 651-694. Also, H. B. Williams, Human Behavior and Thermonuclear Disaster, an unpublished manuscript obtained from OCD-DOD, August 1961 (especially Chapter 4, "The Warning Phase," pp. 27-47).

who are best capable of the total assessment required. Depending upon the hazard, some agents qualified to evaluate detected hazards are:

1. Executive branch of the Federal government
2. Department of Defense (including NORAD and OCD)
3. Public Health Service, and local health departments
4. State governments, and/or their civil defense organizations
5. Local governments and civil defense organizations
6. Local law enforcement agencies

C. THE DECISION TO WARN

The decision to warn is the culmination of the perception phase of the warning process. The decision must be based upon reliable and certain information, but it is important that decisions about warning not be delayed pending arrival of additional information.[1] Here the decision process may be facilitated by the use of regulations and standard operating procedures which specify the warnings to be given when predetermined sets of conditions are met.

Regulations and standard procedures may also help in overcoming reluctance to make critical decisions that could lead to costly delay in warning dissemination. Reluctance to decide may be encouraged by possible punitive actions which might be taken in cases of false alarms. However, officials who function within the letter and meaning of regulations and SOPs have some degree of immunity to repercussions which may follow the decision. Moreover, if procedures are based on reasonable assumptions and well-defined responsibilities, ambivalence or uncertainty on the part of officials is minimized.

III. THE DISSEMINATION PHASE

A. DETERMINATION OF MEANS

Again, at this point, the nature, imminence, and scope of the threat must be evaluated to enable selection of the type of warning which will elicit the appropriate responses. Once the decision to warn is made, a further evaluation and decision must be made to determine the best means of dissemination in order to warn the intended recipients of the particular threat. Speed of decision is again of primary importance, with selection of the dissemination means following the decision to warn.

B. TRANSMISSION OF THE WARNING

Available means must be used to transmit the warning as quickly and as directly as possible. Complications are introduced by the necessity of warning a group as small as a local civil defense organization or as broad as the total population of the nation. Complications are also introduced by the need to reach people in out of the way places and those in transit.

1. Williams, Communication in Community Disaster, op. cit. (especially pp. 110-140).

C. RECEIPT OF THE WARNING

Ensuring that a warning has been received and understood is a most difficult requirement for the warning process. It is not enough just to know that the means of dissemination have operated successfully. Some means of feedback to determine that the warning message has been actually noted by the public and is being acted upon should be included. To ensure receipt of the warning, the warning system should include some means of attracting the attention of the recipients despite their location or activity. It must also provide channels for transmitting adequate information to the recipient, and a message format designed to assure him of its authenticity. In short, the interface between the recipient and the warning system is vital to the fulfilment of the process.

IV. THE REACTION PHASE

A. RECEIPT OF THE WARNING

The reaction phase of the warning process begins with the receipt of the warning. However, the appropriate response to the different kinds of hazards may vary from location to location, depending upon the protective measures available and the seriousness of the threat to the particular locale. The warning system must transmit the appropriate type and quantity of information to each group or locale.

Through the use of specific operational plans and procedures, predetermined and instilled through training and assessed as to operational readiness by testing programs, the varying system may present the local civil defense organization with a coded signal to automatically trigger all actions required on a local level. The populace, however, cannot be expected to respond as automatically as the warning system. The local civil defense organization must continue to act after the initial warning has been given to reaffirm or authenticate the message, to direct the population, to gather information for further warning decisions, and to report on the effectiveness of the warning.

B. INTERPRETATION

The warning process must provide recipients with sufficient information to permit adequate definition of the situation, an understanding of the desired responses, and decisions regarding their appropriate behavior. The message must be audible, intelligible, of sufficient coverage, and provide the recipient with the necessary information to determine possible consequences of his action. Provided with this data, the recipient may evaluate it in light of his personal situation, taking action required to seek the specified level of protection.

If the initial message does not convey sufficient information, the warning process must be prepared to provide additional or amplifying data.

C. THE DECISION TO ACT

Providing the recipient with all the information necessary to a correct decision does not necessarily mean that he will respond as desired. Hopefully, through training and education performed prior to the emergency situation, the public will be taught to follow civil defense instructions and obtain suitable protective measures. If not, a great deal of confusion may result, and a considerable share of the populace may be lost due to attack and post attack (or disaster) effects. Since such a loss may deal an irreparable blow to national viability following attack or disaster, proper training and education is extremely desirable. It should be noted that during attack conditions preceded by a warning period of short duration, very little in the way of enforcement of civil defense directives is possible. Voluntary decisions to respond in the desired manner must be depended upon. Measures to ensure these decisions must be made prior to entry into the emergency situation and the appropriateness of specific responses in particular time phases must be emphasized.

V. SUMMARY

Although this study is specifically concerned with determining the operational requirements and performance characteristics for a warning system it must be realized that a warning system does not operate in and for itself. It is essential in performing the overall program mission that the warning system take into account its interrelationships with all the data collection, decision making, and interacting agencies associated with warning. Various definitions of the phases of the warning process contain certain convergence. Indeed, there is reason to consider that authorities are virtually unanimous in their conclusions.[1]

1. See: Williams, Communications in Community Disaster, op. cit., pp. 108-179, especially pp. 109a; Williams, Human Behavior and Thermonuclear Disaster, op. cit., pp. 30-33; and Mack and Baker, The Occasion Instant, op. cit., p. 4. Discussions with various authorities also revealed compatible versions. These included personnel from OCD Research Directorate, OCD Plans and Programs, and the NAS Disaster Research Group.

CHAPTER FOUR

HAZARDS AND PROTECTIVE MEASURES

I. INTRODUCTION

Analysis of the inputs to the warning system and the expected outputs must be related to time in order to derive realistic use of available protective measures or planning appropriations. Inputs are represented by a range of threats which constitute hazards to people and property. The belief that we can effectively cope with this array of hazards in the time available is reason enough for mere existence of a warning system. Conclusions as to which available measures will be most effective during what time categories represent the major focus of this chapter. Essentially this analysis is an exercise in probability, attempting to discuss elements of a mixed threat in relation to the type of protective measures feasible over a span of time categories.

To make this problem manageable here, larger significant issues such as counter-force versus countervalue attacks, cost effectiveness of active and passive defense, and the impact of civil defense on a national policy deterrence have been set aside.

For purposes of discussion the threat is separated into strategic and technical aspects, with hazards related to both impact and post impact periods. Military weapons, accidents, and the forces of nature are considered as agents of destruction.

Certain data consulted for this analysis are classified. To allow presentation of unclassified material in this report, "mirror-image" reviews have been made of both attacker and detection system capabilities. Material dealing with the explicit magnitude and severity of the nuclear threat from the present through 1972 was extracted from intelligence estimates and is presented in the classified supplement.

II. WARNING TIME CATEGORIES

A. GENERAL

The civilian warning system must deal with a wide range of threats and protective measures, each having its own set of alternative courses of action and expectations. In order to give this wide spectrum the practical consideration necessary, some means of grouping these phenomena into a few meaningful categories is desirable. The classification system might be a natural one by threat categories:

1. Nuclear primary effects
2. Radiological contamination
3. Biological and chemical agents
4. Natural disasters

But, a very wide range of available reaction time and possible courses of action exists within each category and the classification does not create a sufficiently meaningful grouping of both hazard and response. The situation is even less satisfactory with natural groupings of possible protective measures (shelters, evacuation, etc.).

However, both the threat of hazard and the protective measures that can be taken are closely associated with the amount of time available to warn and to react. Therefore, in discussing both hazards and protective measures, the principal assessment or criterion of the severity of the threat and the appropriateness of the protective response will be the significant time intervals for various threat/detection/response combinations.

B. WARNING TIME CATEGORIES

1. <u>Critically Short Warning Time (0-15 Minutes)</u>

The warning time available in this category presents a measure of extreme hazard. There is barely time to give a warning and practically no time to take any but the most rudimentary protective measures.

Examples of threats in this category are sub-launched missiles in coastal waters, satellite objects suddenly attempting re-entry, undetected ICBMs, and IRBMs launched at targets close to launch sites. Protective measures would be simple duck and cover actions or at the most, getting to a very near shelter; therefore, population casualties are likely to be extensive.

2. <u>Short Warning Time (15-45 Minutes)</u>

This amount of warning may be considered typical in the intercontinental ballistic missile era. There is time to warn the bulk of the population and for them to take elementary protective measures.

Examples of threats might be ICBMs on polar trajectories, and manual bombers with air to surface missiles (ASMs) undetected at extended radar warning lines. Adequate time to alert and warn is available, and possible protective measures include going to the nearest shelter.

Persons in transit may have some difficulty doing this. Population casualities should be moderate due to increased warning time and protective measures.

3. Moderate Warning Time (45 Minutes - 3 Hours)

This amount of warning time may be considered possible during the period of the air-breathing threat. The time is adequate to alert and warn the population and for them to take shelter and other protective actions.

The threat in this category is predominantly from manned bombers using low altitude approach runs and from ICBMs approaching the North American continent from the south. Time is available to warn the public and to provide them with more than rudimentary warning and guidance. Protective measures in large population centers are still limited to shelter seeking, but some other preparatory actions may be taken. In isolated areas near prime targets some evacuation may be possible. Under these conditions, the bulk of the population may be expected to reach the best shelter available in their general neighborhood.

4. Long Warning Time (3-5 Hours)

This amount of warning may be considered typical during the period of the air-breathing threat. Warning time is adequate and some evacuation is feasible except in very large cities.

The threat is predominantly from manned long range bombers employing normal attack tactics. Detailed warning information may be given and the best available shelter sought. Evacuation of relatively isolated areas is possible.

5. Extended Warning Time (5 Hours to Several Days)

This condition may be expected to arise as a result of the operation of the system. Time is adequate to warn all and to evacuate large segments of the population if this is desirable.

Such warning might arise from photographic techniques or electromagnetic ferreting which indicate increased enemy activity in preparation for an attack, or from serious deterioration of the international situation. Time may be available for some planning and arrangements and issuing detailed instructions to the public. Evacuation of some segments of the population (women, children and non-critical personnel) is a possibility during this time period.

III. ANALYSIS OF HAZARDS

A. STRATEGIC THREAT

The strategic threat is associated with enemy preparations for attack. Various military intelligence systems make use of photographic, electromagnetic ferreting and many other first hand data gathering techniques to detect and evaluate increased enemy activities. Even a surprise attack would entail a considerable build-up of personnel, aircraft, missiles enroute to launchers, and increased electronic countermeasures, etc. on the part of the enemy. Strategic build-up, if properly evaluated, could give warning many hours or even days in advance of an attack. This amount of warning falls within the extended warning time (5 hours - several days) category.

Even under disarmament, however, we can never assume all weapons have been eliminated. Consequently, hidden weapons or mobile delivery systems must always be considered by intelligence gatherers and anticipated for OCD planners.

B. TACTICAL NUCLEAR THREAT

The primary threat with which a warning system must cope is imposed by the combination of missiles with multi-megaton nuclear warheads, although in the time period considered (1962-1972), the air-breathing bomber still remains a useful offensive weapon. The weapon systems which could be used to attack the U.S. are:

1) Submarine Launched Ballistic and Cruise Missiles (SLBMs) and (SLCMs)

2) Satellite Bombardment Missiles (SBMs)

3) Intermediate Range Ballistic Missiles (IRBMs)

4) Intercontinental Ballistic Missiles (ICBMs)

5) Free Fall Bombs

6) Air Launched Ballistic and Cruise Missiles (ALBMs and ALCMs)

Present U.S. detection systems include the SAGE Air Defense System with its Early Warning extensions, Ballistic Missile Early Warning System (BMEWS), and Navy Anti-Submarine Warfare Systems.

Future detection systems may include extensions and additions to BMEWS, a satellite based missile surveillance system, and ionospheric radar detection systems such as Magnetic Drum Receiving Equipment (MADRE) and the Navy's Missile Warning System (TEPEE)[1], for detection of both air-breathing and missile vehicles.

The SAGE air defense system was intended to defend against an air-breathing threat. SAGE relies on the Mid-Canada Line and DEW Line to provide early warning from the north. Coastal extensions of SAGE include the Airborne Long Range Inputs (AIRI) system off the Atlantic and Gulf Coasts, Airborne Early Warning and Control (AEW&C) system off the Pacific Coast, as well as radar picket ships off both coasts. The SAGE system was intended primarily to detect bomber type weapon carriers and to provide warning times of several hours between detection of the carrier over northern approaches and bomb release over Continental United States (CONUS) targets. If penetrations were made by over water routes, time between detection and crossing of the U.S. coastline would depend both on the altitude of penetration and the status of the seaward extensions to the air defense system. The BMEWS system is intended to detect and track Soviet long range missiles traveling from their launching sites to CONUS targets. The flight time of these missiles to maximum range targets is somewhat greater than one half hour. Owing to the distance between BMEWS radars and Soviet launching sites, initial detection cannot be made until the missiles reach very high altitude; hence warning time will be less than missile flight time by 5 to 10 minutes.

The Soviets have, in addition to the conventional direct route ICBM flight, the capability of attacking the U.S. via South Pole routes. In addition to ballistic missiles, an enemy could place nuclear warheads into earth orbit for recall on command. Such vehicles would have to be tracked continuously to detect a re-entry maneuver. Re-entry time depends on orbit altitude. For low orbits it would be similar to that of Project Mercury capsules, approximately 15 to 20 minutes from retro-firing to impact. IRBMs, which could be used against some Northwest U.S. and Hawaiian targets as could submarine launched ballistic missiles, would not come within the range of BMEWS. If a multi-hop, ionospheric radar system or a satellite surveillance system were implemented, it could provide detection to impact times only a few minutes less than the missile flight times.

Discussion of specific types of tactical threat follows.

1. Submarine Launched Ballistic Missiles (SLBM)

The launchings of missile weapons from either nuclear or convention-

1. TEPEE is the acronym for Thaler's Project named for originator Dr. William J. Thaler of the Naval Research Laboratory.

ally powered submarines could occur underwater or on the surface. Polaris type missiles with a range from 350-1000 n.m. presently exist and an ultimate range increase to approximately 2500 n.m. is anticipated for the early 1970's.

It is possible that the presence of the enemy submarines may be detected by elements of the Atlantic and Pacific Barrier Forces, or seaward extension elements of the air defense system, thus providing information to NORAD Headquarters prior to any missile launchings.

Assuming a missile speed of approximately 7,000 m.p.h. the flight time of an SLBM should vary from 5 to 20 minutes, with the detection till impact time varying from 0 to 15 minutes. The threat of an enemy attack employing SLBMs is greatest in coastal areas where the submarine can lie sufficiently far out at sea to avoid detection. As the range of SLBMs increases, greater portions of the continent will be subjected to this threat with only 0 to 15 minutes warning time. This amount of warning falls within the critically short warning time category.

2. Satellite Bombardment Weapons

Satellite weapons, placed in orbit over a period of time, could be recalled when an attack was to take place. The threat of the decoy or recall of orbiting satellite weapons is nationwide and would not vary significantly with the locale. Detection of the satellites and calculations of their orbits would be accomplished by the current and proposed space surveillance systems. Continual calculations of all orbits of the satellite population could indicate deviations from established orbits suggesting re-entries and impact areas. The height and shape of the satellite's orbit would determine the time required to effect re-entry. However, the available warning time may be expected to fall within the critically short or short categories and thereby constitute a very serious hazard in the civil defense warning system.

3. Intermediate Range Ballistic Missiles (IRBM)

Currently, the enemy possesses IRBMs with ranges of 1200-2500 miles. The threat of the IRBM is greatest to the states of Alaska and Hawaii, to the extreme northwest portions of the United States, and to military establishments in Canada, Greenland, Aleutian Islands and the Arctic.

While the range of this missile is not expected to increase, the relocation of launch sites could shift the threat to other areas. The Cuban crisis has given us some inkling of how an IRBM threat can rapidly change character. If weapons of this nature are presumed hidden in Cuba the threat also applies to Florida, Gulf States and the southwestern United States.

Detection of the IRBM could be made by BMEWS or space surveillance systems. Assuming a missile speed of approximately 9,000 m.p.h., time from launch until impact of an IRBM could vary from 5 to 20 minutes, with a detection-time-till-impact varying from 3 to 18 minutes. The warning time available to the areas threatened by an IRBM falls roughly within the critically short warning time category.

4. Intercontinental Ballistic Missiles (ICBM)

ICBMs similar to the U.S. Atlas and Titan with ranges from 6,000 - 8,500 miles could be used against targets in the U.S. Statements by U.S.S.R. leaders indicate that the U.S.S.R. possesses a capability of firing ICBMs of much greater range than any U.S. counterpart. These would be required in order to cover the 18,000 miles separating Central Russia and the U.S. via this polar route.

Detection of an ICBM threat could be made by BMEWS for North Pole flights, and space surveillance systems for any flight. The 18,000 mile ICBM would be useful primarily if space surveillance systems were not completely operational. Otherwise, the lesser range over other routes would permit greater warhead capability and more rapid arrival on target.

Assuming a missile speed of approximately 14,000 m.p.h., the time from launch until impact of an ICBM could vary from 15-75 minutes. The time between detection and impact for North Pole trajectories would be 13-15 minutes; with South Pole trajectories the time ranges from zero, without space surveillance systems, to 55-75 minutes warning with operational space surveillance system coverage. That is, in general, the ICBM threat warning time available falls within the short warning time category.

5. Aircraft with Air Launched Ballistic Missiles (ALBM) and/or Air to Surface Missiles (ASM)

Heavy bombers with unrefueled ranges of over 6,000 miles and traveling at 600 m.p.h. speeds are capable of carrying ASM weapons with ranges of 450-1000 miles. Medium bombers capable of considerably greater speeds and unrefueled ranges of 4,000 miles can be equipped to carry ASMs with a range of 600 miles or ALBMs with a range of approximately 1000 miles.

Detection of the aircraft themselves could be achieved by the Pacific Barrier, SAGE network and its extensions, Atlantic Barrier, Greater-Iceland-United Kingdom Barrier, DEW Line, or Mid-Canada Line. ASMs traveling at subsonic speeds could also be detected by the same systems that pinpoint the launching aircraft. Under certain conditions ALBMs could be detected by BMEWS and space surveillance systems.

DEW Line penetrations would be 1,500 - 3,000 miles from the U.S. borders; MCL penetrations approximately 500 miles; 3,000 miles from the Mid-Pacific Barrier; 2,000 - 2,500 miles from the GIUK Barrier; 1,000 - 1,500 miles from the extensions of SAGE in both ocean directions; and less than 1,000 miles in the Gulf of Mexico and southern directions. ASMs and ALBMs could be launched whenever the aircraft came within range of the target. Since the distances used above were to the borders of the U.S., the time difference between the higher speed of the weapons (ASMs, ALBMs) and the distance needed to travel to targets interior to the country would offset each other for most targets.

The variety and number of aircraft available to approach the U.S. and launch air-to-surface missiles is great enough to endanger all areas of the country. The use of SLBMs, IRBMs, satellite weapons, and ICBMs to prepare the way for aircraft penetrations is a strategy available to the enemy. Other strategies could employ aircraft in probing weaknesses of the defensive systems to other means of attack. The threat of aircraft and their associated weapons systems allows longer times between detection and weapon impact. A range of 18 minutes - $2\frac{1}{2}$ hours could be likely for peripheral targets, increasing to 35 minutes - 5 hours for others. The warning time available for the ASM threat falls generally within the short or moderate warning time category.

6. Air-breathing Vehicles with Free-Fall Bombs

The discussion of delivery and detection systems in the previous section is applicable here. The discussion and the times available (35 minutes to 5 hours) would be applicable for targets on the periphery of the U.S.

Interior targets would have additional warning time depending on the speed of the aircraft. Most areas would be subject to attack in the 3-5 hour time period. Again, the possibility of weapons being clandestinely located in more proximate areas such as Cuba must be considered. The warning time available falls within the long warning time category.

C. ATTACK HAZARDS

1. Radiological

Following a nuclear explosion, the immediate effects of blast, shock, and radiation will have been experienced by those in the vicinity of the detonation. Radiological monitoring stations at this time must assume the task of data gathering and evaluating the effects of contamination in the immediate area of the detonation. The direction and speed of residual fallout is dependent upon the prevalent winds. Warning time available to downwind areas could vary from minutes to days. The detonation area requires warning of the level and extent of radiation, on an immediate basis, with communication available for days and weeks, or as long as the radiation hazard exists.

Residual nuclear radiation would be a threat whenever a ground or water burst had taken place. The threat would be immediate to survivors in the blast area and to others, depending upon fallout patterns generated by the wind movements.

Depending upon the distance from the point of impact, the direction of the wind, and the kind of burst, warning time for radiological and post attack effects varies from the critically short to the extensive categories.

2. Chemical and Biological

The introduction of either chemical or biological agents could be via the delivery systems heretofore mentioned or via clandestine means prior to, coincident with, or immediately following a nuclear attack. The detection of such a threat could be via a polluted water supply, a destruction of crops, an incapacitation of large groups of the population, etc. Warning to the population could be achieved in minutes where the cause and effects were easily ascertained; however, the effects might be known and the cause be unknown for hours or days.

Detection and evaluation of the threat are the principal problems here; warning time will fall generally within the extensive (greater than 5 hours) category. However, contact with particularly virulent biological or chemical agents is extremely serious and can cause a great deal of harm and panic. Warning information which will enable the recipient to protect himself against these hazards should be as complete and timely as possible.

D. NON-MILITARY DISASTERS

Floods, droughts, fires, earthquakes, hurricanes, storms, and catastrophes are examples of natural disasters that can affect large areas and many people. Detection of such disasters may be via the Hurricane Watch during hurricane season, seismographs for pinpointing epicenters and possible tidal waves or earthquakes, tornado watch and predictions, etc. Warning time could vary from little or none in the epicenter region of an earthquake to days in the case of hurricanes.

Thus, since warning time varies between critically short and extensive, the range of hazards represented by natural disasters affords as wide a range of warning problems to the system as does the hostile threat. The warning system can provide a valuable community service by timely warning of such hazards and by detecting and distributing pertinent warning information.

IV. ANALYSIS OF PROTECTIVE MEASURES

A. INTRODUCTION

1. General

Development of plans to use and develop protective measures for dealing with hazards is a critical issue. Preparing for an event which may never occur, yet one with such widespread repercussions, requires advance system planning and integration rather than mere emergency plans at the time of a crisis or during the disaster itself. From the history of civil defense one presumes it is not possible to insulate these activities from strong controversy. Moreover, those committed to a strong civil defense program may stake their career growth or political destiny on the issue. Direction and support by government executive and legislative leaders is required for the development of a civil defense capability which assures national viability by providing effective measures for the protection of life and property.

Although this discussion stresses protective measures designed to save lives, the survivors of an attack will be part of our vital national resource because they provide the necessary skill and experience to manipulate our productive potential and maintain our way of life. Various studies (SRI, OCD, RAND, Kahn) have estimated the necessary numbers of people and the percentage of surviving industrial potential essential to effect recovery. Warning provides time both for civil defense officials to assist the population in self-protection and for industrial management to reduce destruction to its physical plant.

Our present protective capability appears to be based on an obsolete array of threat and delivery systems and is predicated on World War II experience. However, the recent surge in public interest, requests for appropriations and authorization of research indicate an urgency and concern for developing a meaningful program. Such a program requires definitive statements of how civil defense is to be integrated into a framework of national policy and how it will evolve to provide protection for as much of the populace as possible. The program also requires the development of personal as well as community plans based on realistic considerations. Such considerations include physical equipment, technical procedures for its use and integration of personnel to provide planning, command and services. If the program is to be successful, it must be credible and evolve according to the nation's needs. This implies that any lapse in incremental development through budget slashes or research and development delays will impair operational readiness and to some degree undermine confidence in the program.

2. Protective Measures

The following framework of protective measures presents the various types of actions that can be taken within the warning time categories that are considered. These measures may be classed as follows:

a. Shelter programs

   1) Duck and cover, improvisation, and crash shelters

   2) Fallout shelters

   3) Blast shelters

b. Evacuation and dispersal

   1) Strategic

   2) Tactical

This analysis does not attempt to evaluate the effectiveness of these measures (i.e., how many lives they would save), but will suggest which measures are feasible in relation to available warning time. It must be borne in mind, however, that to maximize the efficiency of protective measures they must be coupled directly and effectively to civil defense plans, warning system characteristics, and training of the populace in reacting to warning messages.

3. Attack Effect Factors

It is also necessary to perform an analysis of the spatial zones and functional time periods which have evolved from studies of disasters. Certainly important differences are to be noted in using disaster data, but many advantages also can accrue. Use of zones such as total impact fringe, filter, and resource areas can be considered. Similarly the preparatory, warning, impact, post-impact, emergency, and recovery periods offer some utility. For example, Williams sees the preparatory period as one in which adequate survival plans are or are not made. The warning period is the time in which prepared protective measures must be implemented rapidly. The impact period is one which determines survival or destruction according to whether people:

> "1) ...had sufficient warning 2) ...acted on warning and also whether 3) ...adequate plans and preparations had been made in advance."[1]

Policy makers must consider a vast array of contingencies and probabilities before a CD program can be designed for specific areas. Although rationality on the part of an enemy cannot be assumed, explicit plans must be based on a likely enemy action. Dispersal or evacuation of an area may be necessary to counter nuclear blackmail threats, for example. Whatever the anticipated threat, the selection of protective measures and involvement of the population will be weighed carefully by leaders. This is so because even the involvement of a small portion of the total population may be both disruptive and dangerous.

B. PROTECTIVE MEASURES - TACTICAL THREAT

Having analyzed various hazards according to the amount of warning time allowed by each, it is necessary to evaluate the protective measures which can be taken within the available time. It must be remembered that the warning time is not all available for public reaction but also includes time required for the detection and evaluation of the threat, the dissemination of appropriate warning messages, and convincing the recipients that the warning is real and not a test or a false alarm.

1. Critically Short Warning Time (0-15 Minutes)

If any effective action is to be taken at all to warnings within

1. H. B. Williams, Human Behavior and Thermonuclear Disaster, August, 1961 (Unpublished Report).

this category, shelter must be immediately accessible because of the minimal flight time of such shorter range weapons as SLBMs, ALBMs, and satellite launched weapons. If no warning is received, or if no time is left after the receipt to take a more appropriate response, the only response providing a chance for survival may be to duck and gain cover from the immediate effect of the detonation and from flying debris.

If a greater amount of time is available, more effective shelter may be sought provided it is reachable in well under 15 minutes. With less than 2 minutes warning, it is unlikely that shelters will be very effective. There will be no time for delays in this warning category and even under the best of conditions resort to duck and cover will be the only available protection for many.

2. Short Warning Time (15-45 Minutes)

ICBMs launched in salvo are expected to spread across a 30-45 minute range. Warning time available between detection and impact is expected to be 15-45 minutes. A large number of people could be protected in shelters which are accessible within 20-40 minutes. However, shelters would have to be available to a majority of the population within 5 to 30 minutes in order to be most effective. Again, the lower the access time, the greater the degree of effectiveness. For most areas of the country it is assumed that those surviving the immediate effects of nuclear detonation would have at least 30 minutes before the arrival of fallout.[1]

3. Moderate Warning Time (45 Minutes - 3 Hours)

This time interval is ample for most high density population areas to put both shelter and evacuation plans into effect. For many areas on the fringe of target centers the maximum amount of time (3 hours) would be available before the arrival of fallout. An access time of approximately one hour would allow reasonable protection for the majority of the surviving population. Most areas would be able to use available shelters. Some areas would be able to evacuate their population to safer locations.

4. Long Warning Time (3 Hours - 5 Hours)

In addition to assuring access even to remotely located shelters, this amount of time would allow some tactical evacuation or dispersal of industry and resources. Normally, it would be

1. Speech by J. Romm before USCDC, Knoxville, Tenn., October 16, 1962.

associated with follow-on attack primarily by aircraft destined for secondary targets. Estimates of the extent and nature of the onslaught would be made on the basis of the initial attack phase and normal radar returns. For some areas this represents the amount of time available before the first arrival of fallout in which improvised emergency shelter can be arranged and stocked with supplies.

C. PROTECTIVE MEASURES - STRATEGIC THREAT

Extended Warning Time (5 Hours and Greater)

With such time available crash measures of construction, evacuation dispersal and logistics could be accomplished. Any efforts would have to be expeditious and consistent with integrated, pre-established plans. Warning of this nature would be based on a serious deterioration in the international situation and intelligence information of the build-up and employment of enemy strike forces.

D. PROTECTIVE MEASURES - OTHER HAZARDS

1. Attack and Post-Attack Effects

For maximum protection from the immediate effects of a nuclear detonation the population would have to be in blast and radiation resistant shelters. In lieu of this type of shelter, they would have to seek protection in the strongest building or fallout shelter available. Even evasive action to gain protection from flying debris, and thermal and nuclear radiation would reduce the immediate effects of the detonation. Fallout shelters with radiological monitoring devices would offer additional protection. Use of natural caves and mines and evacuation to areas outside the fallout patterns would be of considerable value for selected regions. Warning time for hazards of this nature is in the shorter time categories.

2. Chemical and Biological Agents

The threat of chemical and biological agents is so varied that each situation must be met with specifically designed protection. Poison gas threats can be met with protective gas masks, special clothing, and by sheltering where purification of the air supply is possible. If a water supply is polluted its use should be stopped and simultaneous decontamination measures begun. Hazards such as these are usually in the long or extended warning time categories.

3. Natural Disasters

The threat of flood, fire, hurricane, tornado, earthquake or other natural catastrophe is more meaningful to areas that have recently experienced a disaster. Evacuation of areas in the immediate path of a flood, fire or hurricane can be effective. Other individual protective measures can be taken depending on the situation.

No special requirements emerge from this area and all measures developed to cope with the military threat will pay dividends in the non-military area in terms of organization, emergency procedures, and means for communicating with the population. However, in all cases, mere equipment does not suffice. Equipment acquisition must be coupled with civil defense plans, training programs, operational procedures, and understanding by the citizenry. Hazards in these categories cover the gamut of warning time.

V. PLANS AND PROTECTIVE MEASURES

National policy statements stress the evolution of civil defense as a program of insurance contributing to a national posture of deterrence which currently emphasizes fallout shelters.[1] Composite damage assessment studies by the Department of Defense based on (1) fatalities in attack against population, industrial, and military targets, and (2) fatalities in attack primarily against military targets indicate that 60 million lives would be saved by shelters in the first case and 110 million additional lives would be saved in the second case. Speculation as to the necessary survival actions under probable fallout conditions further indicate that some two days to two weeks shelter occupancy would be required for all areas of the country.

Other assumptions promulgated by OCD Plans and Programs[2] indicate that a minimum of 15 minutes warning is being used as a planning base and that fallout danger for urban and suburban areas is based on the minimum of 30 minutes warning before the arrival of the hazard. For rural areas the expected minimum time is 60 minutes. Based on the warning time prior to impact, no evacuation traffic in vehicles is expected to be practical in high density urban areas, although there will be some moderate movement of up to 5 miles possible in vehicular suburban traffic. Pedestrians are expected to be able to move at a rate of 3/4 of a mile in 15 minutes in high density urban areas whereas they can cover approximately 1 mile in 15 minutes in suburban or low density population areas. Such assumptions lead

1. Remarks of Steuart L. Pittman before the Congressional Reserve Group in Washington, D.C., August 14, 1962, DOD-OCD Information Bulletin No. 50.
2. Speech by J. Romm, *op. cit.*

to the following conclusions:

1. Urban shelter locations must be within a 1 to 2 mile radial distance from potential occupants.

2. Suburban shelters may be located within approximately 3 miles of potential pedestrian occupants.

For evacuation or more distant shelter, suburban vehicular transport can move personnel approximately 15 miles prior to fallout, and rural transport can cover approximately 50 miles prior to fallout. Even though individual circumstances will vary, all situations will be dependent upon accurate, rapid, and complete warning information. By training and realistic assessment of hazards, citizens can be convinced that conformance with preconceived plans offers the greatest survival potential.

Under certain attack patterns active defense measures may make considerable difference in the number of lives saved, but these are not considered within this study. Passive measures consistent with the national civil defense plan must be designed by local communities in cooperation with Federal officials who can supply threat estimates and information such as that provided by the Nuclear Attack Hazards in the Continental U.S. (NAHICUS) studies based on such assumptions as those in the RISK II program. However, civil defense is predicated on Federal direction as well as the necessary local implementation. Theory and research support the belief that fallout shelters will resist obsolescence and will be an effective measure; however, until the local citizenry is convinced of this and is able to develop confidence in local leadership and civil defense plans, there is no assurance that established plans will be followed. Disaster research studies support such a conjecture. This implies that Federal officials, perhaps working through regional OCD-OEP offices, should be available for local consultation. Armed with intelligence information based on the threat to the immediate vicinity, they could advise on civil defense programs and be authorized to disseminate the information in a fashion that will not conflict with national security.

To inspire confidence local programs must be linked to facilities, procedures, and concrete plans recommended by officials. They must be meaningful for the individual citizen as well as for state and local echelons. Because of the short warning times likely, details such as control of access routes to shelter, communications enroute, through such persons as police officers and air raid wardens using public address facilities, and shelter entrances adequate to the ingress should be provided. Arrival at shelters is likely to peak at certain periods unless procedures are developed to assure an even flow of arrivals.

CHAPTER FIVE

WARNING SYSTEM REQUIREMENTS

I. INTRODUCTION

Having considered 1) the necessity for a warning system, 2) the types of hazards to be coped with, 3) the likely warning times associated with various categories of threat, and 4) protective measures that may be taken in response to these various categories of warning, the requirements of a warning system that will satisfy the needs of civil defense can be established.

These requirements must be based upon a comprehensive analysis of the nuclear attack hazard, the organizational and individual needs of those engaged in the operation of the warning system, the time constraints and limitations imposed by the threat and detection systems, and the demands for general system reliability required to achieve successful operation of the system at any time. Further, the requirements must reflect the necessity for the acquisition and dissemination of information and warnings based upon 1) the immediate effects and after effects of a nuclear attack, 2) the spread and effects of radiological, biological, and chemical hazards, and 3) the responsibility the system may assume for information acquisition and dissemination in warning of natural disasters. These latter requirements will be predominantly local or regional in scope, suggesting the need for local subsystems to operate independently of the national network.

These requirements are, in part, dependent upon warning and protective facilities which exist, and upon the level of public acceptance and support attainable in a peace-time environment. Thus, what constitutes an acceptable mechanization of the warning process depends not only upon the stringency of the basic requirements for warning, but upon the practical constraints of what can be achieved.

In presenting the following requirements (which are underlined for easy reference), no attempt to establish priority was made. All are important; all should be observed. However, the requirements have been divided into two sets: the necessities basic to nuclear attack warning; and the additional requirements imposed by radiological, chemical, and biological hazards and natural disasters. The first division, although of more dramatic initial consequence, is no more important than the second, and probably less demanding in the types, amount, and complexity of information to be processed.

Amplifying evidence on certain requirements is presented in Chapter Eleven, "System Training and Human Factors Considerations," in which organizational and functional problems of the warning system are related to message format, prior research, training plans, and human response patterns.

II. NUCLEAR ATTACK WARNING

A. EDUCATING THE PUBLIC

The public must be conditioned through training and education to respond to alerting and warning in such a way that available levels of protection can be achieved.

The public's response must be speedy and appropriate if any warning system is to be successful. This is particularly true in the critically short (0 - 15 minutes), short (15 - 45 minutes), and moderate (45 minutes to 3 hours) time categories. The public must be able to recognize a warning for what it is, and proceed to shelters whose locations they know. Elements of the population in transit must be aware of the location of shelters or know how to discover this information. They must be made aware (i.e., warned) of the need for proceeding to shelter immediately.

In the longer warning time categories (3 hours and above) the requirement for immediate reaction is less stringent. However, alternate protective measures such as evacuation would necessitate specific and extensive instructions, and the need for trained response is still present.

Therefore, the civil defense program must have as an objective the training of the public regarding the value of and need for warning. The training must be such that the levels of protection designed and available will be utilized upon the receipt of warning. The capability of the public to recognize, understand, and react to warning must be a prime determinant in the selection of the types and contents of warning messages. Before the means for dissemination of warning may be considered, it is necessary to determine what types of warning will elicit the desired response.[1] For example, use of a signalling system to disseminate warning will not be successful if the level of training has not been adequate for the public to recognize, understand, or react appropriately to the message.

The need for prior training of the populace is pointed up by Williams as he differentiates between mere signals and warning. He defines warning as:

> "...the transmission of messages to individuals, groups or populations which provide them with information about (1) the existence of danger and (2) what can be done to prevent, avoid or minimize the danger....A state of alarm without a corresponding course of action to follow, at best leaves it up to the individual or

1. H. B. Williams, Human Behavior and Thermonuclear Disaster, (Unpublished Report), August 1961, p. 30.

> group to design its own course of action (without, too often, enough information to do so) or at worst leads to crippling confusion or indecision....The information about what to do, must be possessed by the population before the warning signal arises. The warning signal in this case becomes a message which says, now is the time to do it. If this kind of signal is to work it means that those who receive it must already have been successfully instructed in recognizing the signal and in the course of action to take when they do receive it... It must leave no room for ifs, ands or buts. If the signal can mean several different things, then the recipient requires still further information before he knows which one of these things he should do. In this way, the warning signal is an integral part of the whole emergency system; if the system does not contain clear plans which are to be followed, the usefulness and effectiveness of warning signals are seriously decreased."[1]

Regardless of activity or location, the public must become aware of the protection available to them. A training program must of necessity accompany the shelter program to inform the public concerning shelter direction signs, shelter locations, and shelter facilities. Concurrently, the population must be educated to recognize warning and to react appropriately to directions.

B. INFORMATION REQUIREMENTS

The warning must contain all information necessary to permit carrying out prescribed activities.

Under war-time conditions, a single unique signal could provide all the stimulus necessary to elicit the necessary protective reactions. The public would have been conditioned by the fact that a war exists (and perhaps by previous attacks and warning having occurred) to seek preassigned shelter space.

However, under peace-time conditions, a single unexplained signal is not enough. Even though proper instructions have been posted, published, and otherwise widely announced, the public will tend to doubt the authenticity of the signal or assume that it is "just another test." They may ignore or forget instructions previously given to them. An alerting signal, therefore, must be reinforced by a verbal message supplying a quantity of information about the situation and

1. *Ibid.*, pp. 31-32.

authenticating the alerting signal.

A characteristic of nearly every type of disaster is that people normally will not accept alerting signals and will tend to deny that threatening situations exist unless they have visible evidence to the contrary. Because of this, several factors should be considered in relationship to the warning message. Studies have shown that people will undoubtedly tend to seek a quantity of information about the threat; and secondly that their belief and acceptance of the signal is directly linked to the source of the warning. On the first point, the quantity of information required to elicit response may vary from one situation to the next. Various considerations will affect interpretation of warning. Fritz states that social and personal influences enter into people's interpretation and response to danger. These influences are past experience, present direct perception, perceptions of how others are responding; and their comparison of their own information and perceptions with people who are significant to them in their daily lives.[1]

The importance and need for the voice warning message is strikingly brought out, when viewed in light of the factors specified above. For example: to the family unit that has been forewarned of an imminent nuclear attack, the fact that they have no past experience with these situations; no present visible perception of the danger; and no perception of how others are responding will probably only serve to minimize or delay their recognition of the threat.[2]

The voice warning message must be provided from a recognized and reliable source. The message itself must be formatted to provide quickly and concisely information about the nature of the danger, its imminence either nationally or locally and the appropriate protective action or actions.

Further, a simple, one-response situation does not exist except under the most stringent conditions. Multiple threats are involved, and the protective measure appropriate will vary with the amount of time available. To allow the recipients of the warning to evaluate the situation properly certain information is essential. Particularly critical are 1) the nature of the hazard (flood or nuclear), 2) the time available--5 minutes or 5 hours, and 3) the recommended response (evacuation or going to a shelter). As time allows, amplifying data should be provided.

1. Charles E. Fritz, "Disaster," Chapter 14, in Contemporary Social Problems, edited by Robert K. Merton and Robert A. Nisbet, Harcourt, 1961, p. 667.
2. See Chapter Twelve for the section on Functional Problems and Message Format.

1. Evaluation of Alerting Signals

This report presumes that information about the nature of the threat is required to elicit any subjective feeling of threat or protective and avoidance actions. A simple, arbitrary signal appears appropriate where there is a foreseen danger from a single threat agent and simple protective actions are required during a brief warning period. However, a complex verbal message appears warranted for a prolonged or recurrent warning period regarding a danger with some unforeseen aspects requiring more complicated protective actions to cope with possible plural threat agents. It offers more inherent flexibility and appears resistant to system obsolescence although it must also be coupled to a program of training and public instruction.[1]

The alerting signal is important in that it heralds a warning message. It is an attention getting device, but may in itself have a singular meaning (e.g., turn on the radio). In fact, there is considerable justification for insisting that the alerting signal have only a singular meaning. In a study on knowledge and attitudes concerning civil defense in the Washington area, the Operations Research Office of Johns Hopkins University indicates the dearth of accurate knowledge about the meaning of signals:

> "When respondents were asked to describe the nature of the warning signals it was evident that a good deal of confusion and misinformation exists among the population. Only one-fourth of the sample could correctly identify at least one of the warning signals...; 16 percent did not even know that sirens provide the warning signal.... These figures are approximately the same as those in the 1954 national study...; i.e., in cities over 50,000 only 27 percent could identify at least one signal."[2]

More pervasive recognition of warning signals has been evidenced during periods of heightened international tensions. However, it is difficult to consider that this difference is great enough to warrant design of a system utilizing a signal without an attendant warning message.

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1. See Williams, Communications in Community Disasters, especially pp. 166a and 141a.
2. Johns Hopkins University, Operations Research Office, Knowledge and Attitudes Concerning Civil Defense among Residents of the Washington Metropolitan Area, August 1958, Bethesda, Maryland, February 1960, p. 31.

2. Determination of Message Content

Signalling or alerting devices perform an important function in that they alert the recipient to a potential threatening situation even though they, in themselves, do not indicate sufficiently the nature of the hazard, its imminence, or the appropriate response to be taken.

In specific examples the Oakland, California false "yellow alert" of May 1955, was heard by 75% of residents but was believed by only 3 of every 20 hearers. Moreover, "among those who heard the signal and thought for even a moment that it might not be a practice, 75% tried to get some further information to confirm the warning."[1] Another analysis of this alert[2] shows that 45% sought further information. However, the same authority[3] studied the false alerts in November, 1958, in Washington, D. C. and September, 1959, in Chicago where the proportion of those seeking additional information almost doubled to 75 and 77% respectively.

Until the public is provided basic attack data as to the nature of the threat, the quantity of time available, and the appropriate protective action, they are not capable of the necessary interpretation and evaluation which must preface the selection of a mode of action. A warning message must be provided to fulfill these basic information needs. Depending upon the mode and urgency of providing this message, an alerting signal may also be required.

To optimize the effectiveness of the alerting signal as it announces the warning message, the same media should be used for both. If an action is required by the recipient before he may receive the warning (e.g., to turn on the radio upon the receipt of the NEAR signal), he must know what the action is, he must have the capability (means at hand) of performing it, and he must react appropriately. If the individual knows the appropriate action through training and education, has the radio available and turns it on, he will be able to receive the warning. The recipient's action should be only to listen to the same media that were used to get his attention for a subsequent warning message.

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1. W. A. Scott, Public Reaction to a Surprise Civil Defense Alert in Oakland California, Survey Research Center, University of Michigan, no date.
2. Williams, Human Behavior and Thermonuclear Disaster, op. cit., p. 41.
3. Ibid.

In addition to the quantity of information required, there are two primary levels at which the warning message content will be determined. One is the national level at which generalized instructions will be issued in the event of imminent attack with little or no tactical warning; or in the event of strategic warning when generalized instructions will be issued. The second is the local level, at which specifications and responses may vary in accordance with available protective measures and facilities, and local environmental conditions. This second level will usually be a city or county. However, in sparsely populated regions the local level may be a group of adjacent counties which have cooperated in a civil defense program; and might even be an entire state where, because of its small size or other factors, protective measures would be essentially uniform.

The warning system must provide standardized criteria for the formulation and dissemination of the warning message at the local and national levels. The standardized criteria are the formats for providing a sufficient quantity of basic attack data to the public upon which appropriate actions may be based. The national level will normally have primary authority and initial prerogatives but the system should allow for preemption by the local level under specified contingencies.

C. WARNING MESSAGE CHARACTERISTICS[1]

The alerting and warning messages must be clearly recognizable, distinctive and unambiguous.

In the critically short, short, and moderate time categories, the criticality of the situation demands immediate public reaction to the messages. To be effective, therefore, the warning system must focus attention upon the fact that a warning message is forthcoming. The warning message, when it comes, must provide the minimum essential basic attack data as concisely, rapidly, and as clearly as possible.

Therefore, as a precursor to the warning message, the alerting signal may serve both as an attention getting device and as a meaningful warning in itself. Distinctive and unambiguous warning to the populace, however, requires that essential information be provided through voice messages. The question is not whether there should be one source of information or many, but that, if there are more than one, they should provide essentially the same information and be initiated by the same means. Receipt of the alerting signal and the warning message must be very close in time, so there is no delay in the receipt of the warning

1. See Chapter Eleven, the section on Prior Research in Warning and Disaster.

by the populace.

In the longer warning time categories some degree of ambiguity and slower dissemination can be tolerated; however, an alerting signal to gain attention is still mandatory.

Further, while some delay can be tolerated between the alerting signal and the receipt of the warning message, it is desirable that the warning message immediately follow the alerting signal.

In the extensive warning time category, for which only a warning message is absolutely necessary, an alert signal is still desirable. However, it is not considered an essential requirement.

D. CONFIDENCE IN THE WARNING

Confidence in the validity of the warning must exist.

For warning to be effective, and for it to elicit the appropriate response from the population promptly, the time required to substantiate the warning as valid must be minimum. The warning should provide, itself, sufficient confidence in its validity. A voice message again provides the only real satisfactory solution to this requirement. A precise voice warning message from the proper source to the population validates itself. Furthermore, a voice warning message validates and substantiates an alerting signal when the time delay between them is small.

E. RELIABILITY OF THE WARNING

The warning system must operate reliably and its capability to perform should not be subject to degradation due to malfunction, sabotage, or false triggering.

Redundancy (alternate links and warning devices) and a capability to test to ensure that the capabilities of the warning system are not degraded, must be provided. However, testing the system should not induce a cry-wolf incredulity in the public. For the same reason, the system must be protected against false triggering.

Although some delay in the transmission of warning messages due to malfunctions might be tolerated in moderate or long warning time categories, none can be tolerated for short or critically short categories. The extensive warning time category will permit loss of alerting capability and some loss of time for warning message dissemination.

Some degradation of the warning system as a result of attack and post-attack effects cannot be avoided. However, building a system that would operate somewhat reliably even under these conditions is necessary.

F. MAXIMUM WARNING COVERAGE

The warning system must be designed to provide warning to the vast majority of the population.

Simultaneous warning to all may be the ultimate goal of the warning system, but the practicalities of available warning time and economic outlay prohibit its attainment. Priority of warning and the maximization of warning results become issues at this point. For optimum results, maximum warning coverage must be given to urban-suburban areas even though this results in slower coverage in more sparsely populated areas. Rural areas, generally but not always more distant from the target areas, will probably have more time available to them in which to take proper protective measures.

Since a sizeable portion of the population will be in transit, methods of disseminating warning to such persons must also be considered.

Although the requirements for ultimate coverage are uniform for all classes of people and all warning time categories, the potential for extending coverage increases with the amount of available warning time. Maximizing coverage even under conditions of minimum warning time calls for great care in designing the system.

G. RESISTANCE TO DESTRUCTION

Destruction of one geographic segment of the warning network should not impair the capability of the warning to reach surviving segments.

The warning system design must be such that the failure of a part of the system due to damage or malfunction can be localized in the smallest area possible. In an era of critically short warning time it is very possible for at least part of the network to be damaged before a warning can be sent. If this occurs, no significantly large area should be severed from the warning system by damage in a localized area nor in another area. Some capability to warn should survive even in case of severe widespread damage even though service is rendered at a degraded level. The size of the segment disrupted, although it should be as small as possible, will be determined by cost-effectiveness studies and resultant system design.

For short or critically short warning time categories the warning capability must survive in undamaged areas. For moderate or long warning time categories back-up alerting devices somewhat less effective than the primary system are tolerable, thus permitting some degradation of the alerting facilities. The capability to provide warning messages must remain intact, however, even for extended warning time as time is available to work around some disruption.

H. CONSTANT READINESS

The warning system must be a full period system, in a state of constant readiness.

The means for generating and disseminating the warning must be in a constant state of readiness. This need is imposed principally by the shorter warning time categories, because any delay in the dissemination of warning degrades the effectiveness of the total system. A state of constant readiness means having full time staffing at all organizational levels as well as full period equipment availability.

One acceptable alternative could be the use of pre-planned recorded warning messages. Local officials responsible for civil defense would evaluate the protective measures provided in their community with respect to various attack configurations and, in cooperation with OCD, be able to prepare a suitable set of warning messages. These messages would be continuously subject to review and modification upon changes in either the protective measures available or the hazards which could obtain.

For shorter warning time categories, the warning system should be capable of automatically selecting the appropriate message and disseminating this message code along with the alert signal. For moderate or long warning time categories this capability is desirable but is not a minimum essential requirement. With extended warning time it is neither necessary nor desirable.

The capability for an automatic dissemination imposes upon the warning system a requirement that categorized and coded messages based on possible attack contingencies and their effects be provided and that their transmission be mechanized from the national to the local level.

I. MINIMAL WARNING DISSEMINATION TIME

Within the capabilities of detection facilities, public warning must be disseminated in sufficient time to permit the designed levels of protection to be achieved.

Because of the limitations imposed in the critically short warning time category, essentially no delay can be tolerated between initiation of warning at the national level and its receipt by the general public. The only way this objective can be approached is by automating the warning dissemination process to the greatest degree possible. This would eliminate all non-essential intermediate decision points and preclude any manual relay or switching operations. Since the non-military defense system itself has little or no capability for threat detection and evaluation, it must perforce base its warning upon the information derived from the military aerospace defense system.

Secondary levels of decision serve no useful purpose in this respect and would degrade system effectiveness through the introduction of delays. The national level must decide the manner in which it will disseminate the warning. Decisions would be based upon an evaluation of the threat, the time available for action, and the types of protective measures available. However, inasmuch as the first notification of attack may come in the form of a nuclear detonation, this system must also provide the capability for the local level to initiate the alert and warning message. Also, the warning system must be able to forward information to NORAD unless other systems for the detection of nuclear detonations are developed.

At the local level, decisions needed to protect the largest portion of the local population will be based on a thorough knowledge of local means and facilities as well as on information from the national level. Although this implies a second decision level for nuclear warning, these decisions will be made prior to an attack in order for them to be implemented either automatically or through established procedures. This allows the type of warning provided to local areas to be flexible enough to provide for local conditions, procedures, environments, or varying degrees of protective facilities available. The local level need not be directly tied to or contiguous with a local political subdivision.

III. WARNING OF ATTACK EFFECTS (RADIOLOGICAL, CHEMICAL, AND BIOLOGICAL) AND NATURAL DISASTERS

A. GENERAL

Confronted with threats or hazards of the nature of attack effects or natural disasters the warning system must, with certain exceptions, cope with an ex post facto situation. In contrast to conditions under a threat of nuclear attack, no clearly definable warning periods can be established. However, this is not entirely true for radiological hazards since, in the absence of a comprehensive system of blast shelters, the nuclear attack warning will be most effective in protecting the population from initial radiological effects. Similarly, the possibility of nuclear accidents such as a runaway reactor necessitates the ability to quickly alert and warn the public in the affected area.

In certain types of natural disasters (e.g. hurricanes, tidal waves and some floods) a period of time may exist between detection and occurrence during which protective measures may be taken to significantly mitigate the effects. For these cases, depending upon the warning time available and the area affected, warning requirements will be essentially the same as their counterpart in the nuclear attack situation.

The detection and monitoring of natural disasters, the assessing of their effects and determining appropriate measures is performed by various government organizations to whom these responsibilities have been assigned. These include various services within the Department, of Agriculture and Interior, the Weather Bureau, the U. S. Army Corps of Engineers, the various military air arms and local law enforcement units. Therefore, no useful purpose would be served in duplicating these capabilities within the warning system.

Chemical and biological agents can be introduced in a multiplicity of ways and at any time prior to, coincident with, or following a detected conventional or nuclear attack. Detection of the hazard rather than the threat of these agents will therefore be the normal precursor of the warning. Consequently, the most immediate need for protective reaction will be in the locality or localities where the hazard is introduced.

The ability to detect chemical and biological agents and to assess their effects is not well developed. Some Army installations have the capability to detect chemical agents, and studies are being conducted to develop a greater capability in this area. However, for the most part, present capabilities for detecting and, particularly, assessing these hazards, rest with organizations such as boards of health, water departments, and government medical departments. As in the case of radiological hazards, the detection and monitoring function, as it develops, can probably be most efficiently performed outside the framework of the warning system. At the present time it is difficult to predict what role the warning system could effectively fulfill in assessing these hazards. However, as the state of the art develops and well defined procedures are evolved, this capability could be added to that of radiological defense within the warning system.

The basic requirements for attack effects and natural disaster warning are discussed in the following pages. The fulfilling of these basic requirements involves many aspects of the total civil defense program, particularly at the local level. The requirements are those parts of the overall requirements for civil defense which are most closely related to the warning function.

B. LOCAL DETECTION CAPABILITY

Detection, monitoring, and assessing capabilities must be provided at the local level and assessing capabilities provided at successively higher organizational levels.

An effective program of public protection will depend upon a well developed detection, monitoring, and assessing capability at the local level and a continuous capability for rapid dissemination to the public of current information and.instructions.

The capability to detect and monitor radiological hazards has been established within a broad spectrum of government organizations, thereby providing fairly comprehensive coverage. Included are all military installations, all civil defense organizations, Department of Agriculture, field elements of the FAA, the Weather Bureau, and local police and fire departments. The capability to collate and assess these data has been developed in a nucleus civil defense RADEF organization at both state and OCD regional levels. This basic arrangement satisfies the requirements for broad detection and monitoring coverage when coupled with a centralized collating and assessing function.

To be effective when needed, the RADEF function must be capable of handling the required quantities of information and assure adequate flow without system overload. The RADEF function is an essential and integral part of the warning process as much as the plotting of raids and calculating of times of arrival and must be incorporated directly into the warning system. This will increase the efficiency of the operation in a number of ways, particularly at the local and intermediate levels. Personnel normally assigned to other functions can be given RADEF training, increasing the number of qualified personnel available in the time of need. Uniform operating, training, and exercising procedures must be developed to insure efficient and cohesive action.

C. INTERCOMMUNICATION CAPABILITY

A two-way communications capability between civil defense organizational elements at local, intermediate, and national levels must be provided with extensions to government elements responsible for public protection and welfare.

An important function of the warning system will be to provide the data communications capability between organizational elements at the following levels: between the local level and the intermediate level; between intermediate level and the national level. Also required are connecting links between this network and government entities at all levels and input circuits to the network, at the local level particularly, from the various detection and monitoring facilities. This communication capability must be reliable and relatively invulnerable; it must have adequate capacity at the various levels to handle the required flow of information without serious problems. Standardized formats and uniform reporting procedures will be required for efficiency and clarity.

The above communications capability is essential to the warning system in dealing with attack effects since the information handled is that upon which all warning messages and decisions will be based. As such it becomes an integral part of the warning function to be performed. In addition, the capability can be effectively used to support the operations of those organizations charged with the responsibility for dealing with natural disasters and to assist in coordinating their efforts.

D. COMMUNICATING WITH THE PUBLIC

The capability must exist to alert and disseminate information and instructions to the general public.

As in the case of nuclear attack, there is a fundamental requirement for the warning system to be able to disseminate a warning message (i.e., information and instructions) to the general public and in certain instances where the urgency of the situation warrants, to precede this warning message by an alert.

CHAPTER SIX

WARNING SYSTEM PERFORMANCE AND OPERATIONAL REQUIREMENTS

I. INTRODUCTION

The specification of performance and operational requirements for the warning system is accomplished by considering the basic requirements imposed by the various threats in light of a practical and feasible operational capability to perform the system mission.

In this chapter performance specifics will be outlined in light of the principal threats (i.e., nuclear attack and attack effects). Once these performance characteristics are established, the organization of the system can be determined, its operating functions specified, and the required communication networks developed.

II. SYSTEM CHARACTERISTICS

A. GENERAL

The system characteristics were developed from the basic requirements specified for the warning system (Chapter Five). From these characteristics the operational requirements will be derived (see Section III below).

B. SYSTEM CHARACTERISTICS

1. To satisfy the requirements that the alert and warning be distinctive, clearly recognizable, provide confidence in its validity, and provide all necessary information to permit carrying out prescribed activities, the attack warning to the general public shall be capable of being disseminated in two forms:

   a. An alerting signal plus a voice warning message.

   b. A voice warning message only.

2. Basic requirements dealing with timeliness, reliability, and warning of attack effects at the local level require that the warning system must provide the capability to:

   a. Simultaneously transmit warning both to the general population and civil defense organizational elements from a

National Warning Center without interruption or intervention at any lower organizational level.

b. Transmit warning to relevant civil defense organizational elements only.

c. Initiate warning at the local level for dissemination to that segment of the population that is within the jurisdiction of the local warning center. The means employed for dissemination of the warning shall be such that is is inherently capable of reaching essentially the entire population within the jurisdiction of a local warning center.

d. Disseminate a warning message either generally or selectively to the population from the major political levels above the local level (i.e., state and federal).

e. Maintain the capability to disseminate a voice message to the general public, even when sheltered, in any area subjected to damage short of total destruction.

3. Any public alerting signal must be capable of commanding the attention of the public and indicating that an extremely hazardous condition exists or is imminent. The alerting signal must be immediately followed by a warning message which will contain all necessary information.

4. The alerting signal shall have a clear and distinguishable meaning. It must not have been or be compromised by resemblance to other signaling devices in common use or by testing in a manner which will result in doubt whether the alert heralds a test or a hazardous condition.

5. All devices employed for alerting the general population and civil defense organizational elements shall be capable of activation by a common alert activation signal.

6. The warning system shall provide basic attack data in coded form from a National Warning Center which will result in automatic selection of several locally determined prerecorded messages and dissemination of these messages within the area of local jurisdiction. Basic attack data must also be provided in printed form from the National Warning Center to all civil defense organizational elements.

7. Inherent to the warning system must be the capability to disseminate a voice message from the principal governmental levels (i.e., city/county, state, and Federal) to the general population within their

respective areas of jurisdiction.

8. The alerting signal and warning message, where both are required, must be closely associated in time. To accomplish this, it is necessary that the warning message be transmitted immediately following the alert, and that only minimal delay be experienced after receipt of the alert and receipt of the message. The utilization of the same media to provide both the alert and warning would facilitate this process, as it would not require a specific action by the recipient before he could receive the warning.

9. To reach the vast majority of the population, the system must employ methods for dissemination of the warning which will not preclude receipt of the warning in any locality. The warning system shall provide:

a. Complete and immediate coverage in those areas having relatively high population densities and/or presumed to be "target" areas. This coverage shall include people indoors, outdoors, and in transit.

b. Coverage to the greatest degree possible within the limits of practicability to the sparsely populated areas of the country. In these areas, the threat of direct attack is more remote and the time available to take protective measures is proportionately greater.

10 The transmission of warning must be via a network of redundant links such that destruction of any single link cannot cause isolation of any element of the system.

11. The warning system shall be capable of detecting the failure or malfunction of any element of the network and restoring the path or substituting an alternate facility in order to ensure and maintain continuous and reliable operation of the system.

12. To provide reliable operation and ensure a high degree of capability, the warning system must be virtually immune to false triggering due to accident, sabotage, or malfunction.

a. Accidents must be precluded through appropriate personnel selection criteria, training programs, retraining programs for transitional personnel, and personnel and system testing and evaluation. Establishment of comprehensive procedures, check lists, and operational manuals is also a significant deterrent to accidents.

b. It is difficult to eliminate the possibility of sabotage from the system. Facilities should wherever possible be given adequate protection and other safeguards as required.

c. The possibility of operator malfunction in the warning system is considerably lessened when voice warning messages are used. Equipment malfunction is always possible, however, and rigid design standards of the system must therefore be imposed.

13. The warning system must be continuously in a state of readiness. This requires that:

a. The system shall not be disabled during periods of system test or training procedures.

b. The system must maintain capability to monitor actual conditions during training or testing periods.

c. Provisions must be made during training or testing periods for reactivation of total capability in the event of emergency.

III. SYSTEM OPERATIONAL REQUIREMENTS

A. GENERAL

Having established the characteristics of the warning system based on the nuclear attack hazard and the anticipated attack effects, these elements can be consolidated to form an integrated picture of over-all requirements for the system. The emphasis here is on the organizational structure, the points and levels of decision making, and the operational functions for the warning system.

In the event of strategic warning or warning of attack effects (radiological, biological, and chemical) or natural disasters, decisions will be made at the major government executive levels (national, state, and local) involving both the welfare and necessary actions of the populace. Under these conditions, the heads of government at these levels, or their designated representatives, will require the capability to utilize the warning system to disseminate information and instructions within their respective areas of jurisdiction.

Organizational levels for the warning system are required primarily for the making and implementing of critical decisions about warning. The decision to warn, determination of the best means to warn, and the decision to warn of attack effects are all crucial to the effective operation of the system. One of the decision points is national in scope, the other local. For this reason, a National Warning Center (including an alternate facility) is an absolute essential in the program. Because comprehensive and meaningful attack effects warning information is found at the local level, local warning centers are equally as essential in the program. These two centers are discussed first in the following pages.

In addition to the specific warning centers which are critical, due to their decision making responsibility, there is a need for an intermediate level of organization. Within this level, as will be noted in later pages, will be numerous functional responsibilities, some of which are oriented federally, some state and locally. Organization and functions within this level of intermediate centers are stated in this section and considered again in the implementation plan.

B. NATIONAL WARNING CENTER

1. Synopsis

The National Warning Center is the focal point of the Attack Warning System. For tactical warning it, in concert with NORAD and the Federal executive level, makes the decision to warn and implements that decision. The National Warning Center will disseminate the alert activation signal through lower organizational levels without interruption or intervention. In the critically short and short warning time periods the alerting signal will be disseminated through local warning centers, which in these time periods function primarily as distribution centers. The signal will automatically trigger local alerting devices, both indoor and outdoor, and will cause automatic selection and dissemination of locally prerecorded warning messages to the general public.

In the moderate, long, and extensive time periods, the alerting signal from the National Warning Center is disseminated to the local warning centers where, after a rapid evaluation of possible courses of action is made, the alerting signal and instructions will be transmitted to the general public.

The National Warning Center, in addition to having primary responsibility for tactical warning, should review, process, and assess attack effects data and disseminate this information to governmental agencies and lower organizational levels as an aid to planning and decision making functions.

The flow of tactical attack warning from the National Warning Center through the local warning center to the general public is shown in Figure 3.

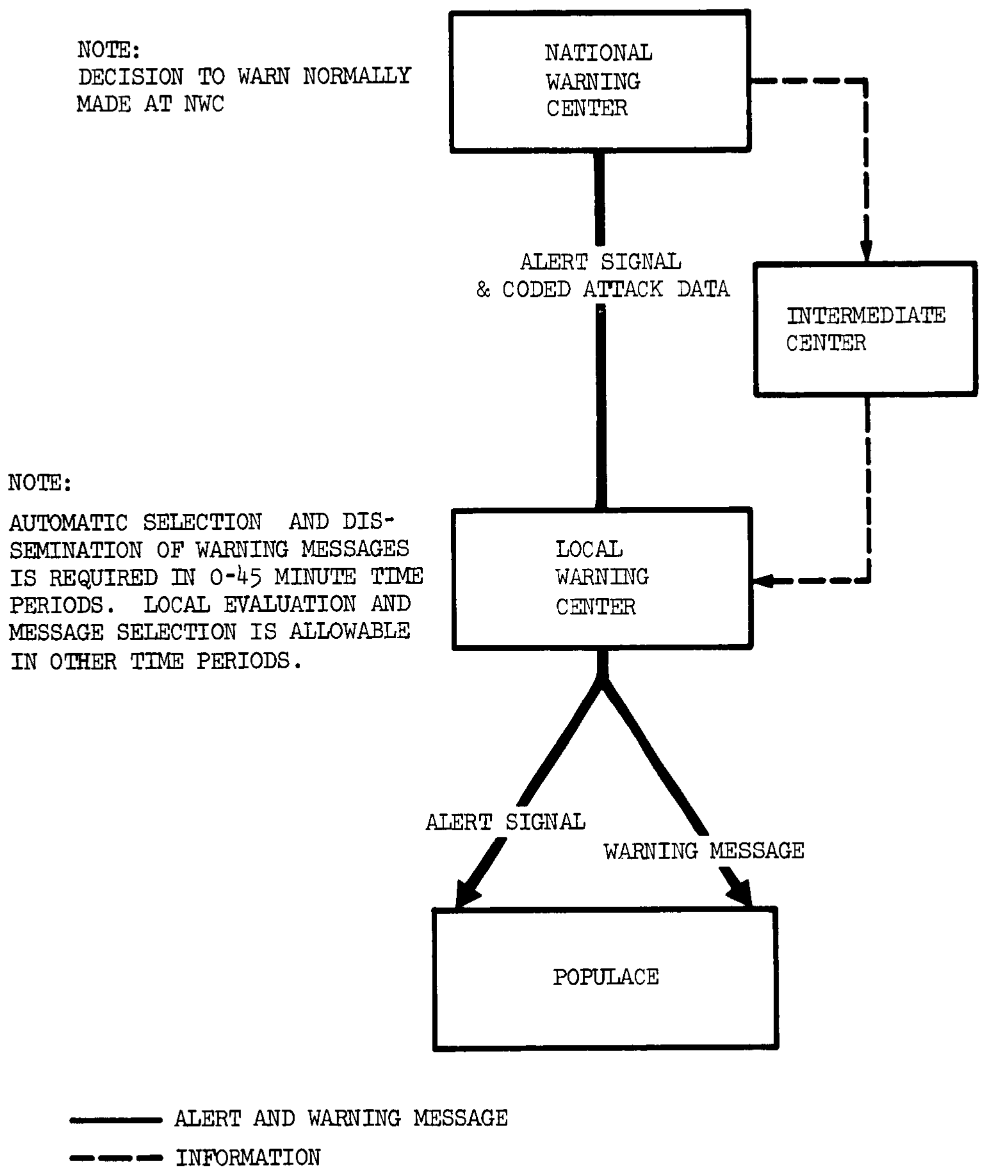

Figure 3. Nuclear Attack Warning and Information Flow

2. Organizational Structure

a. The National Warning Center shall be linked with the Office of the President or his delegated representative to ensure access to Presidential decisions and information affecting the survival of the nation.

b. The National Warning Center shall be co-located with, or invulnerably linked to, the NORAD COC to ensure uninterrupted access to current attack data.

c. It shall be linked with the national civil defense organizational headquarters for administrative interchange, system testing, and necessary support activity.

d. An alternate to the National Warning Center must be provided. This facility must have access to information affecting the survival of the nation; must have access to current attack data; and be linked to the national civil defense organizational headquarters for the same purposes as indicated for the National Warning Center. This facility should be provided a high degree of protection, so as to ensure its continued operation in the event the National Warning Center is not operational. The decisions and operational functions of the alternate are the same as those of the National Warning Center.

3. Decision Responsibilities

The National Warning Center is a focal point in the attack warning system. In the event of tactical warning, it shall have the following responsibilities:

a. It shall have the responsibility for the decision to warn the nation and the implementation of that decision.

b. It shall determine the form and content of the basic attack data to be disseminated.

c. It shall determine the necessity for transmitting the alert activation signal and the level to which it will be disseminated, depending upon the nature of the threat and in accordance with predetermined procedures.

4. Operational Functions

Numerous operational functions are the responsibility of the National Warning Center. Basically, these can be separated into those specific functions required for the initial attack warning, those required for subsequent warnings and warning of attack effects, and other functions as applicable.

a. Attack Warning

1) The National Warning Center shall simultaneously transmit the alert to the general population and other civil defense organizational levels.

2) It shall transmit basic attack data in coded form so that any one of several locally determined prerecorded messages may be automatically selected and disseminated within the area of local jurisdiction.

3) It shall transmit the alert to relevant civil defense organizational elements only.

4) It shall transmit information and instructions from the Office of the President, or his designated representatives, involving the welfare and necessary actions of the populace. The information or instructions must be distributed to both the general population and civil defense organizational elements.

b. Post Attack and Attack Effects Warning

1) The National Warning Center shall evaluate threat information available to it, process data from intermediate levels, collate and assess these data to determine national implications and long term effects.

2) It shall disseminate this information to all responsible governmental agencies and to lower organizational levels as an aid in their planning and decision making functions.

3) It shall collate and transmit attack effects data to warning centers at all levels either selectively or simultaneously.

c. General Functions

1) The National Warning Center shall have the capability of testing the entire system simultaneously or system elements selectively without disabling it.

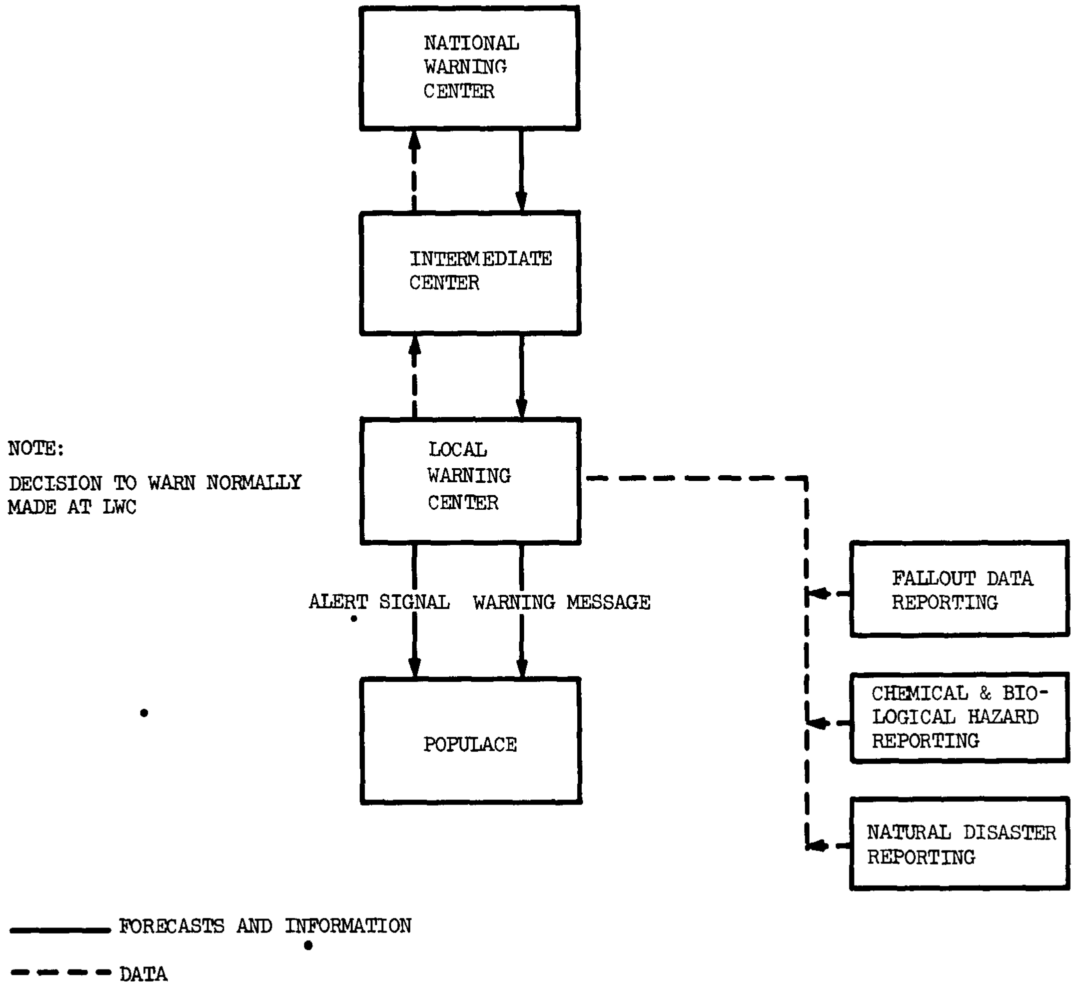

Figure 4. Attack Effects and Natural Disaster Warning

2) It shall maintain liaison and information transfer activities with civil defense organizations in adjacent countries.

3) It shall maintain liaison with lower levels of the warning system organization.

C. LOCAL WARNING CENTER

1. Synopsis

Local warning centers must be established at the levels where decisions on protective actions for a locality can best be made. Under conditions imposed by critically short or short warning times (up to 45 minutes), the local warning centers should be functioning primarily in an automatic mode. These centers must ensure that the alerting and coded data signal from the National Warning Center will cause local alerting devices to be activated, and cause the automatic selection and dissemination of prerecorded warning messages. The local warning center must ensure that these messages are received by the general public.

A prime responsibility of the local warning center is to implement the decision to warn the locality of the effects of an attack or of an impending natural disaster. To adequately perform assigned functions the local warning center must have direct access to the warning system.

Figure 4 outlines the role of the local warning center under varying threat situations.

2. Organizational Structure

a. Local warning centers shall be co-located or linked to the local civil defense organizations for system testing and support activity.

b. They shall be linked to the local radiological, biological, and chemical contamination detecting and monitoring facilities to ensure access to current data for its collating and assessing functions.

c. They shall be linked with the intermediate level of the warning system organization for hazard data exchange and for coordination of warning activities.

d. They shall be established at a level where decisions on alternative protective actions for a locality can be made. As such, they need not be directly tied to a specific political subdivision. Usually this level will be a city or county, but may be a group of adjacent counties or even an entire small state.

3. Decision Responsibilities

a. The local warning centers, in the event of tactical warning from the National Warning Center, shall determine (or previously have determined) current alternate courses of action for the locality to utilize available protective measures in meeting predescribed threats.

1) They shall determine the content of the warning messages so that all the information necessary to permit carrying out prescribed activities is provided.

2) They shall determine which warning message is to be implemented upon receipt of basic attack data.

3) They shall activate local alerting and warning devices when necessary and ensure the prompt receipt by the local population of the warning.

b. They shall implement the decision to warn the locality in the event of attack effects and/or natural disasters wherein decisions are made for the immediate welfare of the local populace.

1) They shall determine the content of the warning message so that all the information necessary to permit carrying out prescribed activities is provided.

2) They shall activate local alerting and warning devices when necessary and ensure the prompt receipt by the local population of the warning.

4. Operational Functions

a. Local warning centers shall be capable of disseminating the warning to the general public in two forms:

1) An alerting signal and a voice warning message.

2) A voice warning message only.

b. They shall activate all devices employed for alerting the general population and civil defense organizational elements by a common alert activation signal from the National Warning Center.

c. They shall initiate the alert to that segment of the population that is within the jurisdiction of the local warning center.

d. They shall employ a public alerting signal that is singular in its meaning. It shall be used to indicate that an extremely hazardous condition exists or is imminent and that a warning message will immediately follow.

e. They shall employ a public alerting signal that has not been compromised by resemblance to other signaling devices in common use or excessive testing or testing in a manner which will result in doubt whether the alert heralds a test or a hazardous condition.

f. They shall disseminate a voice warning message to the public. This capability must be maintained even in any area subjected to damage short of total destruction.

g. They shall be capable of closely associating in time the alert and the voice warning message, where both are required. Therefore, it is necessary that the voice message be transmitted immediately following the alert, and that the method of dissemination shall ensure that essentially no delay is normally experienced between receipt of the alert and receipt of the voice message.

h. They shall ensure that the warning message will reach the entire population within their jurisdiction. This requires:

1) Complete and immediate coverage in those areas having a relatively high population densities and/or presumed to be target areas. This coverage shall include people in transit as well as those indoors and outdoors.

2) Coverage to the greatest degree possible within the limits of practicability to the sparsely populated areas, wherein the threat of direct attack is more remote and the time available for protective measures is proportionately greater.

i. They shall transmit information and instructions from the city/county government head involving the welfare and necessary actions of the populace to the general population and civil defense organizational elements within their area of jurisdiction.

j. They shall receive, collate, and assess attack effects data from the local hazard detecting and monitoring facilities and forward these collated data to their intermediate center.

D. INTERMEDIATE ORGANIZATIONAL LEVEL

1. Organizational Structure

The need for intermediate organizational levels is occasioned by:

a. The impracticability of directly interconnecting a very large number of local warning centers into a warning distribution network.

b. The need for consolidation and transmission of hazard data prior to transmission to the National Warning Center.

c. The need to interact with NORAD regional forces.

d. The number of elements at this organizational level shall be such that an adequate number of nodes and redundant links are provided to ensure survivability of the warning distribution network.

2. Decision Levels

The intermediate level of the warning system organization will be primarily for support and maintenance. This level will normally have no direct command responsibility for warning dissemination of a nuclear attack hazard, or for the warning of the effects of an attack.

3. Operational Functions

The intermediate level must be capable of providing the following functions, as necessary:

a. Assisting individual local levels which do not have sufficient facilities within their own jurisdiction to enable effective monitoring and coordination capabilities to be performed.

b. Providing civil defense assessments, coordinating warning information and effects data, and general coordination and liaison with NORAD regions.

c. Receiving, collating, assessing, and consolidating attack effects data from local warning centers; selectively forwarding this compiled information to the National Warning Center; exchanging this data with adjacent intermediate levels.

d. Maintaining liaison with state governments, state civil defense organizations, and Federal agencies within states.

e. Transmitting information and instructions from the governor of a state(s) involving the welfare and necessary actions of the populace and civil defense organizational elements within its area of juisdiction.

IV. SYSTEM COMMUNICATIONS REQUIREMENTS

A. GENERAL

Each level of the warning system organization has varying communications requirements. The three networks necessary to fulfill these requirements are described in the following paragraphs. These networks must ensure that all functions of the system at each level, are adequately and completely carried out. A common characteristic of each network is that of uninterrupted transmission of the alert activation signal and coded attack data from the National Warning Center to the local alerting devices.

B. PRIMARY NETWORK

1. The primary communications network for the warning system must be composed of a network of redundant links between the national and intermediate centers, so that destruction of any single link cannot cause isolation of any element of the warning system.

2. The number of warning centers must be sufficient to provide a distributed network enabling automatic switching and/or rerouting required to bypass outages.

3. Characteristics and capabilities of the primary network are as follows:

   a. Be continuously in a state of complete readiness.

   b. Be capable of transmitting the alert activation signal and basic attack data from the National Warning Center to the local alert devices with drops at the intermediate and local warning centers.

   c. Have a voice channel.

   d. Be capable of transmitting attack data and attack effects assessments from the National Warning Center to any one or any combination of intermediate centers in printed form.

e. Have a high data rate channel for transmission of attack effects data from intermediate centers to the National Warning Center.

f. Have voice and low data rate channels between adjacent intermediate warning centers for exchange of attack effects data and assessments.

C. SECONDARY NETWORK

1. The secondary network must be composed of a network of links between the intermediate and local warning centers with alternate modes of communications and/or alternate paths to be utilized in achieving the highest level of survivability.

2. The number of local warning centers under the jurisdication of an intermediate center will be restricted only by the amount of attack effects data each is able to handle and the feasibility of direct circuits between them.

3. The secondary network shall have the following characteristics and capabilities:

a. Be continuously in a state of complete readiness.

b. Be capable of transmitting the alert activation signal and basic attack data from the National Warning Center to the local alert devices with a drop at local warning centers.

c. Be capable of transmitting hard copy attack data and attack effects assessments from the intermediate centers to any one or any combination of local warning centers.

d. Have a two-way voice channel.

e. Have a low data rate channel for transmission of attack effects data from local warning centers to the intermediate center.

f. Have voice and low data rate channels between adjacent local warning centers for exchange of attack effects data and assessments.

D. PUBLIC DISTRIBUTION NETWORK

1. The public distribution network links the local warning center to the local alert and warning devices and/or facilities within its

jurisdiction. This network links the local center to the hazard detection and monitoring facilities within its jurisdiction also.

2. The public distribution network shall have the following characteristics and capabilities:

a. Be capable of transmitting the alert activation signal from the national center to the alert devices.

b. Have a low data rate channel for transmission of attack effects data from hazard detection and monitoring facilities to local warning centers.

c. Be capable of transmitting the selected prerecorded warning message (per the coded basic attack data) to warning dissemination devices and/or facilities.

d. Be capable of transmitting information and instructions from the national, state, and local government heads involving the welfare and necessary actions of the populace.

CHAPTER SEVEN

SURVEY AND EVALUATION OF METHODS AND MEANS FOR DISSEMINATING AN ALERTING SIGNAL AND WARNING MESSAGE

I. INTRODUCTION

Chapter Five established the more general requirements for the warning system. Inherent in any system there are also implied requirements imposed upon the hardware or devices within the system. It is necessary to consider both of these types of requirements in the evaluation of the types of systems or devices employed to disseminate the alerting signal and warning message. The requirements for the equipment part of the warning system are the following:

1. It should be simple.
2. It must be highly reliable.
3. It should have a low maintenance cost.
4. It should be capable of transmitting a unique alerting signal.
5. It should be capable of transmitting the warning message and instructions immediately following the alerting signal.
6. It should be capable of being tested at regular intervals without compromising the alerting signal (i.e., it must not cry wolf).
7. It must be capable of automatic reset.
8. The signal must have a very low false alarm probability.
9. The system should be capable of reaching a large fraction of the population, including those in transit.

In addition to the above requirements it is also desirable for the warning device to be inexpensive when produced in large quantities and for the signal generating system to require a small investment. However, the total system cost taken over a 10 year period provides a better basis for making cost comparisons.

There are three basic media for transmitting alert and warning to the populace which must be evaluated. These are power lines, telephone lines, and electromagnetic radiation.

Also, a variety of devices may be utilized to disseminate either an alert signal or the entire warning. Included among such existing or proposed devices are: sirens, buzzers, radio sets, outdoor loudspeakers, telephones, and pyrotechnics. In this chapter the various media will be discussed first and then the specific devices will be evaluated. Many of the devices can be activated by means of any of the basic transmission media and therefore might be utilized whenever their attributes best fit a specific situation.

II. POWER LINE SYSTEMS

A. GENERAL

The use of the nation's power distribution systems to disseminate a warning to the public is a basic approach that has been the subject of extensive investigation. Various techniques for exploiting this capability have been explored including ripple systems, systems in which the basic parameters of frequency, voltage, and current are varied, and carrier current communications systems.

Carrier current systems, which would allow a voice broadcast capability, were considered to be not feasible because of the prohibitive expense and technical difficulties entailed in implementing this scheme on a mass distribution basis.

One of the proposed schemes for varying one or more of the basic electrical parameters to generate a warning signal is WARN (War Air Raid Notification), designed by Lockheed Electronics Company. For illustrative purposes, and because it typifies this basic approach, the proposals and the related problems are summarized at the end of this chapter in Section J. In essence, the basic approach presented in this and other such proposals was not considered feasible for both technical and economic reasons.

The most promising approach was that of using the ripple system concept with which extensive experience had been gained, principally in Europe, in the control of appliances. The Armour Research Foundation, among others, conducted a detailed investigation which confirmed the feasibility of using a superimposed signal on the power grid and recommended a frequency on the order of 200 cycles per second as the most economical range. Subsequently, several years of development of power line systems have resulted in NEAR, the system presently being tested by OCD. Because of the emphasis being placed on this system and because it is representative of a type of power line systems, the following discussion is directly focussed on NEAR.

B. HISTORICAL SUMMARY

The Midwest Research Institute, in the course of its own studies, developed a system called NEAR (National Emergency Alarm Repeater).[1] This system employed saturable reactors to generate the fourth harmonic of the fundamental power frequency, 240 cycles. The reactors were connected to the power system so that they were excited directly from the line and introduced the ripple frequency into the power system in phase synchronism with the fundamental frequency. The signal was detected by a receiver employing a frequency sensitive vibrating reed relay and having a minimum signal level requirement of one volt. The proposed method for disseminating this signal throughout the nation envisioned the use of a repeatering technique whereby the key generator would transmit a coded signal before going on-line with the steady state signal. This coded signal would activate the first ring of generators which would repeat the code before transmitting the alarm tone. This would activate the second ring of generators and the cycle would be repeated until all generators in the country were activated.

Tests of the NEAR system were conducted in 1959 in cooperation with the Consumers Power Company of Michigan with generator installations at Grand Rapids and Battle Creek.[1] An additional test was conducted in 1960 in Charlotte, Michigan.[2] These tests demonstrated the feasibility of disseminating an alerting signal to people indoors, within earshot of the device, for a reasonable cost outlay in generating equipment per meter served. The results were sufficiently encouraging to warrant further study, development and testing of the concept.

In the meantime, development of silicon controlled rectifiers had reached a point where the use of these devices had become practical in a variety of commercial and industrial applications (e.g., motor controllers and light dimmers). This created a serious problem for the NEAR concept. Previously, studies had indicated a very low noise level due to harmonic generation in the vicinity of 240 cycles. This made practical the economic generation of the fourth harmonic using saturable reactors and the attendant simplicity of phase control. Silicon controlled rectifiers, however, generate a strong fourth harmonic component and their use in

1. Arthur Laudel, et al. Field Installation and Evaluation of National Emergency Alarm Repeater (NEAR) System, Midwest Research Institute, Kansas City, April 18, 1960.

2. Office of Civil and Defense Mobilization, Report on NEAR System - Charlotte, Michigan Demonstration, BC 11811, October 11, 1960.

proximity to a NEAR receiver would result in a high incidence of false alarms.

Fleeting consideration was given to the possibility of requesting legislation to restrict interference at 240 cycles. However, this was rejected as impractical and efforts were directed to the selection of a frequency which would be unaffected by noise components harmonically related to the fundamental frequency and the development of a practicable method for utilizing it. A frequency of 255 cycles per second was selected and development of a frequency changer employing high powered silicon controlled rectifiers initiated. The frequency changer was to be capable of generating a secondary or auxiliary frequency which could be employed by the electric utility industry for control purposes.

An extensive series of tests is planned utilizing this new approach. The first tests employing a 50 kva generator installed on the system of Arizona Public Service Co., Phoenix, Arizona, commenced on October 12, 1962.

C. COVERAGE

Interest in warning systems utilizing power lines (and NEAR in particular), stemmed from recognition of the limitations and inadequacies of conventional outdoor warning devices, i.e., sirens. Two of the more serious objections are the economic impracticability of providing adequate coverage in areas with a low population density and the difficulty in hearing outdoor warning devices by a large proportion of those people who are indoors. The NEAR concept was particularly attractive because it appeared to provide an effective solution to these two problems. The electrical distribution system provides service to essentially all the population in all areas of the country and a NEAR signal could be provided at an estimated relatively low cost per capita.

The figures most generally quoted in support of the concept are that power lines serve approximately 97% of the population--99% in urban areas and 96% in rural areas. These figures accurately, or possibly conservatively, reflect the degree of service provided. The Edison Electric Institute Statistical Year Book for 1960[1] states that there are few unserved households and that future growth, in large measure, will be keyed to the formation of new households. In terms of warning system coverage, however, this is too broad a generalization and tends to be misleading. The stated primary objectives of a system such as NEAR are (1) to provide an alerting signal to those people not adequately served by conventional outdoor

1. Edison Electric Institute, Statistical Year Book of the Electric Utility Industry for 1960, Number 28, Publication No. 61-46, September 1961.

alerting devices, and (2) where 100% coverage cannot be achieved, to maximize alerting capabilities where the need is most critical. It is in this context that coverage must be evaluated.

Among the more important questions arising in this evaluation process are:

a. What percentage of the population will be in vehicles at any given time?

b. What is rural and what is urban for purposes of NEAR evaluation?

c. What percentage of the rural population will receive a NEAR alert if it is sounded?

d. What percentage of the urban population will receive a NEAR alert and will not be within acceptable audible range of conventional outdoor devices?

The number of people in vehicles at any given instant is considered important for two reasons: they are incapable of receiving a NEAR alert; in nearly all instances an alert signal from outdoor warning devices will be effectively masked by the ambient noise level within the vehicle and the screening effect of the vehicle itself.

Preliminary investigations revealed that finding a way to determine the number of people in vehicles at any given instant would require a research program the magnitude of which would be totally disproportionate in relation to its importance to the study as a whole. However, discussions were held with the Advanced Planning Department of the California State Department of Highways and the City of Los Angeles Traffic Department, and enough material and data were made available to provide a more knowledgeable appreciation of traffic magnitudes and predicate an "educated guess" as to what would be a conservative percentage figure. Material and data made available to us included: the Chicago Area Transportation Study of 1959 (CATS)[1] conducted by the State of Illinois, Cook County, and City of Chicago in cooperation with the U.S. Department of Commerce; preliminary data from the Los Angeles Regional Transportation Study (LARTS)[2] being conducted by the California State Division of Highways, Advanced Planning Department; and cordon counts of the downtown Los Angeles area.

1. State of Illinois, County of Cook, City of Chicago, Chicago Area Transportation Study, Vol. I and II, December 1959.
2. State of California, Division of Highways, LARTS - Los Angeles Regional Transportation Study, Preliminary Results 1961 Shopping Center Study, February 1, 1962.

The area encompassed by CATS included a population of 5.2 million people (in 1956) and may be approximately described as a semicircle aligned with the shores of Lake Michigan, with a 25 mile radius originating in the center of Chicago adjacent to Lake Michigan.

Figure 5, reproduced from this study, shows the hourly distribution of trips by trip purpose within the study area. The fact that the general shape of this curve is broadly representative of metropolitan areas is borne out by Table 1. Table 1 is an extract of a cordon count of city streets in a considerably smaller study area--the downtown Los Angeles area, approximately bounded by the Harbor Freeway, Hollywood Freeway, Los Angeles Street and Pico Boulevard. It does not include freeway traffic.

Table 1

Cordon Count of Los Angeles City Streets

Period Ending	In	Out	Accumulation (In minus Out)
0630	4,100	3,300	9,200
0700	8,200	6,100	11,300
0730	15,500	10,900	16,650
0800	22,100	17,700	26,000
0830	18,600	11,650	32,500
0900	16,300	9,500	39,600
0930	12,900	8,600	43,000
1230	9,500	9,800	48,000
1630	13,400	17,000	40,200
1700	15,600	22,700	33,000
1730	14,000	22,300	29,000
1800	10,000	15,900	18,000

For the 16 hour period from 0600 to 2000 hours total traffic was
in - 372,000 out - 323,600

Figure 6 represents an effort to derive a generalized view of urban traffic on a national scale. It is a composite curve of Figure 1 repeated four times, once for each of the time zones with numbers of person trips converted to a percentage of the study area population. Discussions with local officials indicate that on the West Coast, the valleys of its curve would be somewhat shallower because a relatively higher plateau of traffic is maintained between peaks, but that the two peak form is representative. It is interesting to note that in "A Study of Traffic Generated from Limited Access Housing Tracts in Los Angeles," by Edward Klein in 1957, it was found that for a typical suburban housing tract there was an average of 8.3 vehicle trips per dwelling unit per day.

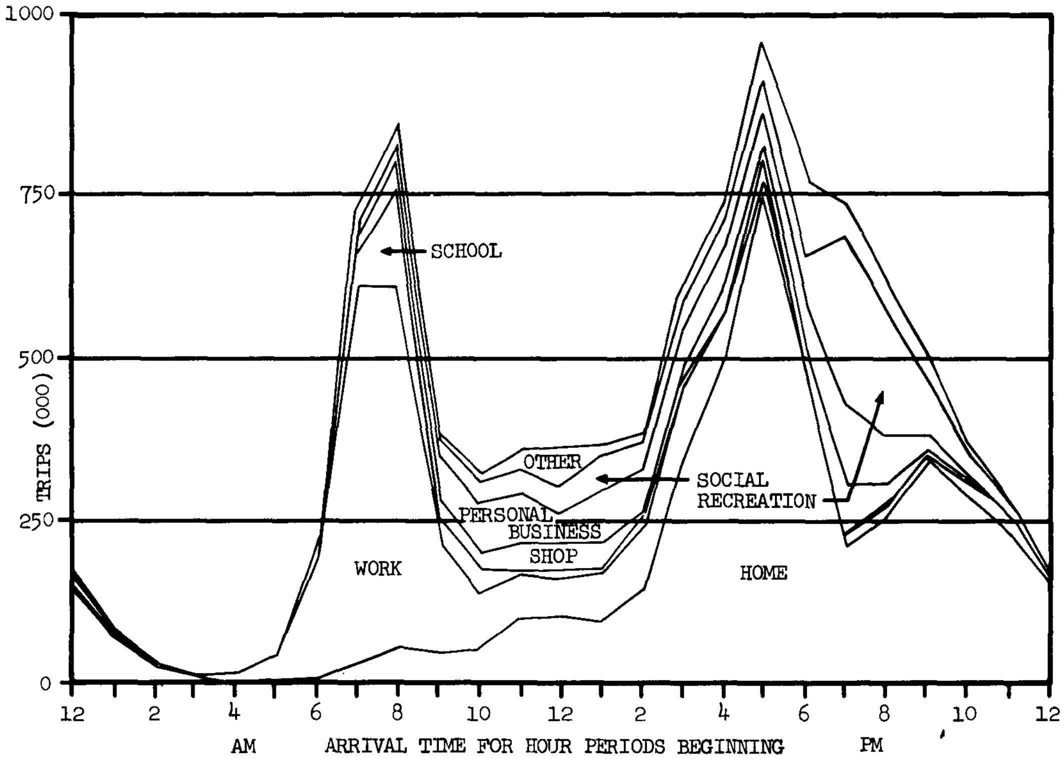

Figure 5. Hourly Distribution of Trips by Purpose
(Chicago Area Transportation Study)

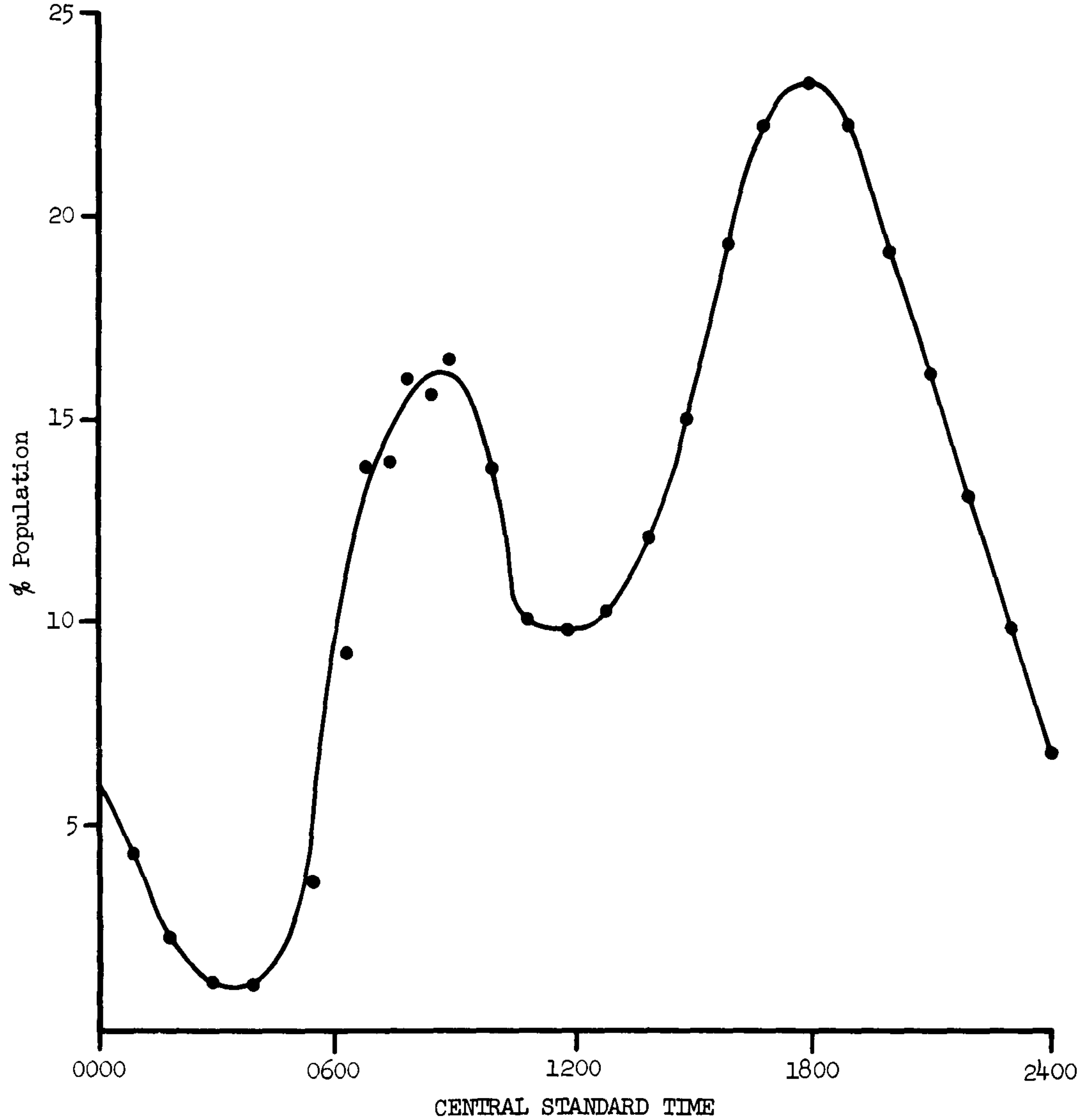

Figure 6. Per Cent of Nationwide Urban Population on Trips by Time of Day (Referred to C.S.T.)

It is conservatively estimated that an average of 10% of the urban population nationwide will be in vehicles at any given time with peaks as high as 25%. Additionally, as pointed out in CATS, "it is clear from the economic forecast that trip making and car ownership will rise at a faster rate than population growth."[1]

A large quantity of documentation relating to warning of urban population was researched in an effort to develop a credible data base for evaluating other factors influencing warning capabilities. This resulted in an enhanced appreciation of the problem but very little directly applicable or positive data. The following represent, in our opinion, conservative estimates of nationwide averages.

Percent of urban population outdoors but not in vehicles	5%
Percent of urban population indoors served by an acceptable acoustical level from outdoor devices	10%

If we take the lower figure of 10% for persons in vehicles, and add it to the above, there is, nationwide, an average of 25% of the urban population that would be either not served by NEAR or not adequately covered by outdoor warning devices. During certain times of the day this percentage may go as high as 50%.

Very little applicable statistical data is available concerning the distribution of activities of the "rural" population. Consequently, we must rely largely upon intuitive judgment and evaluation. However, we can estimate with relative certainty because of the general nature of rural activities, that at least 15% of the rural population will, on average, be engaged in outdoor activities. Secondly, because of the lower population densities and greater distances to be travelled, an additional average of 10% will be in vehicles. These figures indicate that, conservatively speaking, approximately 25% of the rural population will not be served by NEAR.

Comparing figures for urban and rural population we find that the most conservative estimates are approximately uniform and that therefore the maximum possible coverage that could be expected for an indoor alerting device keyed to the power line distribution system, on a nationwide average, is 75%. This figure can drop to between 50% and 60% during certain periods of the day.

It should be pointed out however, that if a single time zone is considered, at least 90% of the population in that zone will be served by NEAR for at

1. Chicago Area Transportation Study, op. cit., Vol. II, p. 12.

least one third of the day, represented by the normal sleeping hours. During these hours conventional outdoor warning devices will have only marginal value.

D. RELIABILITY AND SURVIVABILITY

The Prototype Production Specification - Noncoded NEAR Receiver, issued by DOD-OCD on May 19, 1962, treats the reliability requirements with sufficient specificity to permit an accurate appraisal of failure rates for the receivers. It is broadly specified that the receiver shall be designed for an operating life of 6000 complete cycles within 5 years and that "no maintenance or routine replacement of components shall be required for the normal expected operational life of the receiver which is 5 years."[1] The words "designed for" and "normal expected operational life" raise questions as to intended failure rates and reliability risks.

If we assume that commonly used quality control measures are to be used whereby the reliability risk of the acceptance test is set at 10%, then we can state that at the end of 5 years 90% of the receivers will still be operational.

Let F = failure rate

N = number of sets

$$\text{Then } 0.1N = F \times N \times 8.76 \times 10^3 \times 5$$

$$\text{and } F = \frac{1 \times 10^{-6}}{.438} \simeq 2.3 \times 10^{-6} \text{ failures/hour/set}$$

If we assume, as we will in the evaluation of broadcast systems, that 70×10^6 sets are in use, then the failure rate will be 161 sets/hour or 1.4 million failures per year.

We are faced with a more complex situation in evaluating the reliability of the generating system. If we define this as the probability that the system will be capable of producing the required minimum signal at all receiver locations at all times, a number of factors must be considered.

The first of these is the reliability of the distribution system itself and the associated primary power generation facilities. Considered as a whole, the nationwide power grid and generating facilities have a sufficiently high reliability that reliability may be disregarded as a significant factor. However, at a more localized level, reliability is somewhat

1. Office of Civil Defense, Prototype Production Specification - Noncoded NEAR Receiver, May 19, 1962, p. 2.

degraded. Failures, sometimes of several hours duration, are experienced and occasionally occur in densely populated metropolitan areas. These are the result of a variety of causes. Storms and high winds are a common cause of failure. System overload, such as has occurred in New York City on days of high heat and humidity, is an infrequent but serious contributor. However, if the probability of failure occurrence is multiplied by the probability of coincidence of failure and an enemy attack, the resultant probability of critical failure is so infinitesimally small that it may be ignored.

Of greater concern are the reliability problems directly associated with NEAR. Localized load increases on the primary power system can result in the reduction of the NEAR signal amplitude to an unacceptable level in some areas for an extended period of time. This condition can exist unless the NEAR system is subject to continuing review, these cases are detected, and the necessary NEAR generating system modifications are completed beforehand. Another area of concern is the reliability of the NEAR generating equipments. High-powered silicon controlled rectifiers, for example, can still be considered experimental and there is little or no operational data upon which to evaluate their performance and reliability. Consequently, unless a sufficient redundancy in generating equipment is provided within the system, reliability may be seriously degraded by outages owing to both failures and routine maintenance.

The survivability of the system as a whole is directly dependent on the survivability of the network used to distribute the alert activation signal. Using the distributed network concept insures the maximum level of system survivability whereby damage in one service area will not impair the warning capability in other areas. The size of the area suffering warning capability failure will be a function of the number of nodes or activation points, the configuration of the power distribution system and the number of NEAR generators. Damage to one utility system will not cause loss of service to another. There are general agreements between adjacent systems whereby when one system experiences trouble, the other will supply power to the system within tolerable limits of frequency sagging. However, in case of serious trouble where the adjacent system cannot provide this support without jeopardizing its own operation, it will disengage, thereby localizing the loss of service.

For any alerting system using the power distribution system severe damage to the distribution system in a given area will result in the total loss of alerting capability in that area since there are essentially no alternates or backup facilities for power lines. How serious this is, is questionable. In the treatment of basic requirements it was pointed out that survival of the alerting capability following an attack was not of paramount importance so long as the ability to disseminate a voice warning message is maintained.

E. SUSCEPTIBILITY TO SABOTAGE AND FALSE TRIGGERING

In general, the NEAR concept has a very low inherent susceptibility to these hazards. The actual susceptibility level may be closely controlled through system design both of NEAR and the alert activation signal network.

Susceptibility to false triggering, accidental or due to a system failure, merits careful consideration because of the reduction in the effectiveness of the alerting signal it causes. However, sabotage is not a significant factor in the design or evaluation of any civil warning system if the capability to immediately detect and identify it as such is provided. Under these conditions, the probability that the use of this tactic will increase the warning time available to the retaliatory forces of the defending nation, with the result that an unacceptable level of damage will be experienced by the aggressor nation, is sufficiently high to warrant the assumption that it will not be employed by a rational tactician.

F. THE QUALITY OF THE WARNING

The NEAR system is inherently capable of fulfilling all of the response orientated requirements, within its coverage limits, for an alert signal. The signal is unique and will not be readily confused with those commonly used in other emergency situations, as is the case with sirens. The meaning of the signal, confidence in its validity, and the resultant response have not been compromised through previous usage, the methods of testing employed, and the educational program that is developed. Through proper system design, the alert activation signal for NEAR can also be used to trigger other alerting or warning media simultaneously (e.g., sirens, pyrotechnics, or special radio receivers). Again, through proper system design, the signal can be disseminated with essentially no delay, either on a nationwide basis from a central point, or from lower organizational echelons to the areas within their jurisdictions.

The principal factor that must be borne in mind, however, when evaluating the quality of the NEAR signal is that, within the content of the basic requirements that have been developed, NEAR is only capable of fulfilling the alerting requirements. The voice warning message is required and its receipt must be closely associated in time with receipt of the alerting signal. Consequently, a qualitative evaluation must be performed on the complete warning structure rather than its component parts if it is to be meaningful. For any alerting signal to fulfill the complete requirements for a public warning, it would be necessary to limit its use to a single threat or hazard, with a single warning time category, and have associated with it a single, nationwide, course of action.

G. MISCELLANEOUS TECHNICAL ASPECTS

The following factors are discussed briefly because of their possible influence on system design.

1. Phasing

Phasing is not a serious problem. The techniques are well within the state of the art but the cost and complexity will be considerably higher using 255 cycles than would have been the case if a frequency of 240 cycles per second were used.

2. Secondary Control Frequency

The opinions of various members of the utility industry relative to the utility of the proposed auxiliary 270 cps frequency for control purposes are fairly evenly divided. Some feel the frequency would be useful and create no problems in the operation of NEAR. Others consider it to be of marginal utility in the light of their current operations or else express reservations based upon possible interference with the NEAR signal.

3. Singing in Electrical Machinery

The auxiliary frequency would have a relatively high use factor. There is a possibility that superimposing this frequency on the line would result in high frequency singing in electrical machinery, transformers, and electronic equipment with resultant customer irritation. Even though the NEAR tests in Michigan have not produced comments by the recipients in this regard, surveillance of this potential problem area should be maintained.

4. Communications Interference

No difficulty is anticipated with interference from the NEAR or the auxiliary frequency in wire communications circuits. This does not imply that interference is not possible, only that the means exist in the form of the Joint Pole-Usage Committee to resolve these problems as they arise. However, the possibility does exist that the use of high level silicon controlled rectifiers may result in radio interferences due to the highly distorted waveforms developed. It may therefore be necessary to employ radiation suppression techniques at NEAR generator installations.

5. Voltage Levels and Long Line Effects

For one utility system, the required NEAR signal voltage injection levels, referred to the various buss voltages, would be: 0.78% at 120 v; 1.2% at 12 or 16 kv; 1.5% at 66 kv; and 3% at 220 kv. Where long transmission lines comprise a part of the distribution system and these lines approach or exceed an electrical quarter wave in length at the signal frequency, the signal voltage creates a standing wave on the line. For the system referred to above, network analyzer studies revealed that the 240 cycle signal would rise to 23% of the 220 kv level on one of the long lines. Such analyzer studies revealed the possibility of developing a voltage standing wave ratio of 8:1 or greater resulting from the signal frequency impedance mismatch at the line terminals.

Owing to the electrical parameters of the transmission line, its electrical wave length is significantly shorter than the wave length in free space. It is necessary to eliminate large standing waves by trapping or "stubbing" techniques at the quarter-wave point. The cost of installing these devices can approach the cost of a generator installation at the same voltage level.

6. Signal Voltage Effects on Safety Factors

Dielectric strength of electrical insulating materials decreases approximately linearly with increasing frequency and is approximately 82% of the 60 cycle level at 255 cycles. However, because of the relative levels involved, the effect of the signal voltage upon the insulation safety factor is expected to be negligible, except in the case when a voltage standing wave ratio exists, where it could be very serious. The effect on other elements of the system such as transformers, protective relays, and circuit breakers has not yet been fully determined.

7. Sudden Overload

The sudden "lights plus radio" load that could follow an alerting signal has been a subject of concern and investigation by the power industry. In a system supplied largely by hydro-electric power, breakdown is not probable, although some frequency sagging could occur. This type of generation has inherently more immediately available reserve and can respond more quickly to sudden drastic load changes. However, steam driven turbo generators are becoming predominant and are less capable of coping with this problem. Some power systems would collapse under this type of load. Aside from the overall problem of power loss, this factor has serious implications for a warning system wholly dependent on the power distribution system. The loss of power will result in the loss of warning.

H. NON-TECHNICAL ASPECTS: LEGAL, ECONOMIC AND ADMINISTRATIVE

A comprehensive review of minutes of the NEAR meetings held in various sections of the country, addresses by executives of the utility industry, presentations to Congressional committees, and discussions held with members of the industry reveals that considerable concern exists over a number of unresolved operational problems associated with the NEAR program. The general consensus is that the technical problems are serious but not insurmountable, given enough money, but that the real problems are associated with the administrative, economic, legal, and public relations aspects of the program. A representative sampling of these problems is outlined below.

1. Operational Authority

The basic authority to engage in the NEAR service will depend upon the corporate charter and franchises of the particular utility and the regulatory laws of the state or states in which it operates. Consequently it may be necessary, in many instances, for enabling legislation to be enacted at the municipal and state levels.

2. Provision of NEAR Service

To the extent that we have been able to determine, no agency, Federal, state, or local, has the authority under existing law to require participation by a utility in the NEAR program or to require the public to install receivers on their premises and pay for the service. If legislation to this effect were, through necessity, introduced, there is some question as to whether it could be constitutionally upheld.

3. Rate Structures

No acceptable method of levying charges for NEAR service has been proposed to date. Two proposed methods, one whereby an overall rate increase would be put into effect and the other whereby a surcharge would be made specifically for NEAR service, directly involve the utility company and leave a number of questions unresolved. Typical of these are: Can a utility's customers be required to install receivers and pay for service? If not, how does the utility determine the charge for this kind of service? What saturation is assumed? How does the utility cope with the problem of customers moving in from another area and plugging in receivers without notifying the utility? If a customer is delinquent or refuses to pay the NEAR charge, does the utility discontinue electrical service? How would charges be adjusted where one meter may serve perhaps fifty separate units such as in apartment houses or office buildings?

Assuming these problems are resolved there is still a serious problem with establishing rates to insure adequate compensation. The initial investment in generators and the continuing expenses of installation, maintenance, and repair must be weighed against a realistic appraisal of system life. Early obsolescence of the system could result in substantial losses to the utility company.

4. Receiver Distribution

Considering the reliability requirements of the system, the utility company would be obliged to maintain a fairly large staff to sell or distribute, install, maintain, and service receivers. A contract arrangement would be necessary between the customer and the company whereby a company representative would install the receiver, test it, demonstrate its operation, and provide adequate maintenance and service.

5. Legal Liability

This is a problem the ramifications and implications of which are well recognized within OCD. Legislation would undoubtedly be required to protect the utility from legal liability in the event of a system failure. Aside from this, however, the subject of public relations is a matter of real concern to the industry. It is virtually impossible to guarantee a usable signal at every meter on a system. Although this limitation may be acceptable in an overall sense, those people not served can create a public relations problem of significant proportions where there is a direct relationship between the supplier and the customer.

6. System Design and Considerations

Nationwide implementation of NEAR would, of necessity, require that a detailed analysis of each participating utility be performed to establish the optimum design and costs for each system. These studies would have to be coordinated to insure proper service at the interfaces. Furthermore, system changes, load growth, and system rearrangements would require that a continuing systems engineering capability be maintained. Consequently, the NEAR system cannot be treated for design purposes simply as another voltage imposed on an existing system. It actually represents a completely separate system, heavily influenced by the primary system, but with its own problems, design parameters, and requirements. It therefore represents a significant additional burden on the system engineering capabilities of the company. "To determine the best locations for a set of signal generators to 'cover' the power system with an adequate signal, it is necessary to repeatedly change the signal generator configuration and recalculate the response until a satisfactory signal level is obtained."[1]

1. Arthur Laudel, et al., Study of Requirements for Installing the NEAR System in the State of Michigan, Midwest Research Institute, March 1962, p. 3.

One approach to many of the problems indicated, which might resolve a number of questions, would be for the Federal Government to assume all direct responsibility for the program (including ownership of the equipment), establish service costs through the tax structure, and retain the separate utility companies as operating contractors.

I. COSTS

Any treatment of costs for the full scale implementation of a NEAR alerting system must, of necessity, be considered a gross approximation at the present stage of development. However, it serves a useful purpose by indicating at least an order of magnitude and an approximate minimum as an aid in evaluating the relative cost-effectiveness of the particular approach.

The cost figures generally quoted by OCD are based upon studies by the Midwest Research Institute and figures developed during the test of the Grand Rapids/Battle Creek installation on the Consumers Power Company system. These cost estimates and the method by which they were determined are set forth in an OCD Memorandum, dated September 24, 1962, prepared by Mr. A. P. Miller and addressed to Mr. Vincent V. McRae. Part 1 of the attachment to this memorandum, which contains the applicable data, is reproduced for convenient reference in Section J.

Summarizing, the MRI studies were based upon the use of 240 cps to serve a population of 50×10^6 meters. The first estimate was based upon a nationwide extrapolation of the Grand Rapids/Battle Creek generator installation. The basis for this was a stated coverage of 1.2×10^6 people at a cost of $200,000. This was extrapolated to a nationwide cost of $50,000,000. The second estimate was predicated on total estimated generating costs for Michigan using projected 1966 loads and arrived at an extrapolated nationwide 1962 cost of $67,000,000. Allowing a factor of 2.0 for the increased cost of 255 cps and other contingencies brought the total estimated maximum cost of generation for a 255 cps NEAR system to $150,000,000, or approximately $3.00 per meter.

Another study, covering the Pacific Northwest, was prepared on January 30, 1962. (See Section J.) In essence, it develops an approximate cost per meter of $4.70 for a 240 cycle per second system. Costs for the 255 cycle per second system were not included.

Discussions were held with another large utility company which had made a study for its own use. This company serves approximately 1.75×10^6 meters. Its studies were based upon the following assumptions: a) a 240 cps signal with a minimum amplitude of 1.0 volt at all meters on the system; b) the most economical generation level for this system is 220 kv. Using two generators at the 220 kv level and three supplemental generators at the 66 kv level, the installed cost of generators, traps, and communications (phasing and control) circuits amounted to $6,000,000 or approximately $3.40 per meter.

Since the latter two estimates would have to be multiplied by some factor to reflect the increased cost of utilizing 255 cps, it is clear that the range of estimated costs is very broad and requires a much closer study. This study should take into account the following factors:

a. A detailed analysis of each participating utility will be required to refine the estimates since local conditions will affect the actual number of generators required. In all probability this will be higher than the theoretical optimum.

b. None of the estimates to date have allowed for equipment redundancies to provide for outage or routine maintenance.

c. The effect of system load growth will have to be evaluated. The Statistical Year Book of the Electric Utility Industry for 1960[1] shows that the total installed capacity of the electric utility industry, as of December 31, 1961 was 180,119,000 kilowatts. Gross additions during 1961 totalled 12,530,000 kilowatts. It is estimated that in excess of 140,000,000 kilowatts will be added over the next ten years and currently scheduled additions for the next four years total 39,100,000 kilowatts. Costs will be affected not only by this growth in load, but also by the system changes and rearrangements that necessarily accompany this growth.

d. It is necessary to consider the recurring costs of operation, maintenance, and systems engineering to get a true picture of the system costs.

After a review of related studies, discussions with a number of responsible members of the utility industry, and considering the above listed factors, there exists serious doubt as to whether total implementation of the NEAR generating system could be accomplished for less than 0.5 billion dollars. This does not include the cost of the distribution network for the alert activation signal nor any of the recurring costs which would be involved.

The latest information available at the time of writing indicates that a NEAR receiver can be produced at a factory cost of approximately $10.00. Allowing for normal marketing and distribution costs, the consumer price would then be approximately $15.00.[2] The validity of these figures is uncertain due to the lack of detailed information concerning the provisions of the qualification and acceptance test specifications. The rigorousness of these specifications can have considerable influence on the final cost.

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1. Edison Electric Institute, op. cit.
2. Department of Defense, Office of Public Affairs, News Release No. 1142-62, 6 July 1962.

An additional factor affecting receiver cost is the cost of installation and check out. In discussions with utility industry executives it was pointed out that if the industry were charged with the responsibility for receiver distribution, the company would feel obligated to install the receiver, test it and demonstrate its operation. The cost of this service is estimated to be approximately $3.50 per meter.

Using the gross approximation of 0.5 billion for the generating system, 0.6 billion for $50x10^6$ receivers, and 0.175 billion for receiver installation, a total installed cost for the NEAR system of 1.275 billion dollars is indicated. It should be emphasized that these figures indicate only an order of magnitude and the principal purpose served in their development is to indicate a need for an exhaustive study of the costs.

J. SUPPLEMENTAL MATERIAL RELATING TO POWER LINE SYSTEMS

1. War Air Raid Notification (WARN)[1]

The WARN system is a power network warning system proposed by Lockheed Electronics Company, a Division of Lockheed Aircraft Company, in November 1961.

WARN is based on a short-duration change in the frequency of electric utility power systems. The frequency of 60 cps would be increased (or decreased) at a controlled rate for a period of time, held at an alarm frequency (61.5 cps used as illustration) momentarily, and then lowered (or raised) at a controlled rate to the base 60 cps. The change in frequency would be brought about by raising the set points of as many governors as possible, which would in turn adjust valves for generator change to meet the load change. Thus additional power would become available for the generators to raise the frequency to the alarm level. The control mechanism of the centrally-located load-frequency dispatcher could by remote control send a pulsed electrical signal to the motor-driven set point controls on the governor or by voice, in some cases, have the set point control manually changed.

The alarm frequency would be detected by a subscriber's receiver, utilizing a vibrating metal reed, energized by an electromagnet connected across the power line. This vibrating reed would trip a low-friction device such as a mercury switch to activate the alert alarm.

Since WARN was a proposed warning system, the proposal pointed out areas needing detailed study and was able to only estimate hardware and

1. Lockheed Electronics Company, Information Technology Division, Unsolicited Proposal to the Office of Civil Defense, Power Network Warning System, War Air Raid Notification, Metuchen, New Jersey, November 1961.

installation costs. Some of the problems associated with the proposed frequency deviation for an alarm system are concerned with frequency rise time coordination, power demand due to increased frequency, overload capacity, effect on consumers' equipment, test procedures, time error, dumping of loads, and instrumentation. Estimated costs were as follows:

8,000 automatic governor set point modifications at $500 each - $4,000,000

400 control points for automatic load-frequency control at $4,000 each - $1,600,000

Installation costs - $1,100,000

Total generator costs - $6,700,000

Receiver costs - less than $5.00 each

2. Basis Used by OCD for Estimating Nationwide Cost of NEAR System[1]

Two methods were used for computing national cost figures. The original estimate of 40 to 50 million dollars was based on the studies made by Midwest Research Institute (MRI) on their contract extending from October 1, 1957, to December 31, 1959, and forwarded by a final report dated January 1961. A second contract to this same firm covered a detailed study of the NEAR requirements for the State of Michigan. The final reports dated March 1962, Volumes I and II, developed a revised national estimate which reduced the original estimate of 40¢ per KVA to 28¢. Details are as follows:

a. First Estimate - 1959

1)	Total 1959 generating capacity for Michigan	5,863,207 KVA
2)	Battle Creek and Grand Rapids generator covered a population of	1,200,000
3)	Cost of generators	$ 200,000
4)	Average cost per person	16.6¢
5)	Average cost per family (based on 4 per family)	67¢

1. Attachment to letter, A. P. Miller to Vincent V. McRae, Office of Civil Defense, Communications and Warning Division, Subject: NEAR Program, September 24, 1962. The text reproduces the pertinent portions of the reference in full.

6)	MRI estimated that on a nationwide basis cost would be less than $1 per family unit. OCD used a family estimate of	1.00[1]
7)	Estimated total number of families	50,000,000
8)	Estimated total nationwide cost	$50,000,000
9)	1959 KVA capacity	123,200,000
10)	Cost per KVA of generated capacity	40¢

1/ The tests in Michigan utilized a signal of less than one volt in estimating population coverage. On a nationwide basis, OCD has established a conservative signal strength of not less than one volt. This will assure more reliability at lower receiver costs. In addition to signal strength considerations on a nationwide system, other factors such as system interconnections, heavy industrial loads, and isolated systems prompted the use of a conservative cost figure per family of $1 rather than 67¢ as developed in the Consumer Power study.

b. Second Estimate - 1961

This estimate is based on more detailed studies than the estimate covered in a. above. It covers a cost analysis study made on the power companies of Michigan (excluding the upper peninsula). The purpose of this study was to determine the size, number, and location of the generators required to saturate the area with a signal strength of one volt or more realizing that in some instances this signal may be less and would have to be compensated for. Actual installations would determine such isolated areas and corrections would be required. The area under study covered most situations that could be anticipated in other states including heavy loads in cables (Detroit), light loads and rural areas.

1)	Total estimated cost of signal generators for Michigan using projected 1966 loads [2]	$2,230,100
2)	Total generated KVA of the systems studies	8,000,000
3)	Cost per KVA	28¢

2/ See page 5 of Final Report, Volume II, "Network Analyzer Study" dated March 1962, MRI Project No. 2526-E.
(Copy forwarded)

4) Total 1962 nationwide estimated power generation — 222,324,000 KVA

5) Total 1962 cost (240 cps equipment) generation — $67,000,000

c. The above estimates are all based on the 240 cps mode of signal generation. It is estimated, based on current contracts for inverters, that the costs for the 255 cps signal generators will be 1.50 to 2.00 times that of the 240 cps. On this basis, the total cost would be between $103,000,000 and $134,000,000.

To take care of contingencies and interconnections of isolated systems, this figure of $134,000,000 has been raised to $150,000,000. This safety factor will also reflect increases in connected KVA loads between 1962 and completion of the system in 1965.

Estimated Maximum Cost — $150,000,000

3. NEAR Warning System for Pacific Northwest[1]

Assumption

a. The area assumed to be covered includes all of Washington, all of Oregon except the portion served by California-Pacific and Idaho Power, the portion of California served by PP&L, the northern portion of Idaho and western Montana (west of Hungry Horse and Kerr).

b. It is assumed that inductors may be connected to 230, 115, or 69 kv.

c. Forty-six locations are assumed, and the average rating is assumed to be 15,000 kva. Of the 46 sets, 3 are at 230 kv, 31 at 115 kv and 12 at 69 kv.

d. The cost of a 115 kv installation with minimum switching and protective devices is estimated to be 180,000. The 230 kv units would be approximately twice this or 360,000, and the 69 kv units approximately 4/5 of 180,000, or 144,000.

1. Pacific Northwest Utilities Conference Committee, Subcommittee Report, The Status of Alert Systems, January 30, 1962. The text reproduces the pertinent portions of the reference in full.

Total Costs

3 x 360,000 =	$1,080,000	
31 x 180,000 =	5,580,000	
12 x 144,000 =	1,730,000	
Total	$8,390,000	

Area Covered

235,000 square miles

or

235,000/46 = 5,100 square miles per inductor[1]

Customers Covered

1,786,000 customers

1,786,000/46 = 38,800 customers per inductor

$8,390,000/1,786,000 = $4.70 per customer

III. WIRE LINE WARNING SYSTEMS

A. INTRODUCTION

The capability of the nation's telephone and telegraph systems to disseminate an alerting signal and a warning message from the National Warning Center to warning points at a local level is a reality. The extension of this capability to provide warning to the public at large is the subject of the investigation in this section. There are two ways in which this may be accomplished: (1) over regular telephone facilities, or (2) over separate telephone lines and equipment. The consideration of both these approaches will be detailed, examples provided, and evaluations made of their ability to meet operational requirements.

B. REGULAR TELEPHONE FACILITIES

1. Description

The normal telephone plant is comprised of one or more central offices connected to its subscribers by means of multi-conductor cables or open wire lines. The central offices are now mostly automatic

1. Compare with 7,000 square miles per inductor in Michigan tests.

exchanges which are linked together by various types of circuits, depending on the distance involved. These circuits are voice and carrier cable, coaxial carrier, and microwave carrier. To utilize existing telephone facilities, modifications to the central office equipment would be required in order to transmit the alerting signal and the warning message to a large block of subscribers at the same time. A large central office can accommodate a maximum of ten thousand numbers, one or two party lines. However, much of the equipment involved in completing a call from one party to another is provided on the basis of the probability that a certain number of subscribers will demand service at the same time. That is to say, the telephone exchange equipment is not designed so that one half of the exchange's subscribers can talk to the other half. The ringing generators and the main battery would have to be augmented for providing an alerting signal and warning message. Otherwise, only a small block of subscribers could be alerted and warned simultaneously. Additionally, means would have to be provided for connecting the desired number of lines together for alerting and then transferring the lines to the warning message reproducer.

A study of warning techniques based on telephone system signalling[1] was completed by the Armour Research Foundation for the Federal Civil Defense Administration in February 1958. The study was made to determine the feasibility of generating, transmitting, and receiving warning signals by utilizing existing telephone systems. Alert receivers utilized in the study consisted of existing subset ringers and receivers in one case and specially installed separate alert receivers at each subscriber location in another. The preliminary phase of the study considered the merits of five general systems for alert dissemination utilizing existing subscriber equipment and the merits of single or two-frequency systems utilizing additional apparatus. The final phase of the program involved the design, construction, and testing of pilot warning systems in an operating telephone exchange. The following discussion summarizes the final phase of the study.

a. Using Existing Subset Ringers and Receivers

It was established that any system which utilizes existing subset ringers as warning devices must incorporate some means for freeing the lines from the line relay coils and some additional means for limiting the current drawn by lines on which subsets are in use. It was also established that ringing generators would need much greater capacity than those presently in use, if all ringers associated with a central office were to be operated in a short

1. Armour Research Foundation, Study of Warning Techniques Based on Telephone System Signalling, Final Report, February 28, 1958.

interval of time. It was found that presently installed equipment could be left unaltered and the proposed warning system superimposed on the existing telephone system by coupling an alarm generator to the subscribers' lines at the main distributing frame.

The particular system deemed most practical was based on the assumption that the load current drawn during the alerting period could be limited to some acceptable value by coupling each line to the alert generator through an appropriate resistor. These resistors and the telephone subsets would act as voltage dividers and thereby limit the current drawn by lines having lifted receivers. The tested system also included control and timing circuits which produced a distinctive signal and achieved a conservation of signal power by alternating the alert generator between subgroups of subscriber lines. In larger exchanges than the one used for the tests, the control circuits could be used to sequence the alert generator through groups of subscribers' lines. Because of its distinctiveness and conveyance of a sense of urgency, an alarm signal consisting of a ten-second series of rapid "on-off" pulses was used.

Field testing of the system demonstrated "that an alarm signal could be disseminated to all subscribers' homes in a short period of time and that, with only minor adjustments after the initial installation of the system, this signal would be audible in all homes to the same extent as the normal telephone ring."[1] Two improvements were suggested: (1) a reduction of the average power requirements per home to be alerted by optimizing the alerting signal in terms of the frequency of the voltage used to activate the ringers, and (2) the addition of voice instructions delivered to the telephone receiver following the alerting signal. The system would then provide both the alerting signal and warning message.

The estimated cost of alerting all subscribers associated with a 10,000 line exchange in a 20 second time interval would be $4.25 per line ($2.50 for generator plus $1.75 for relays, resistors, wire, and housing) if several generators could be accommodated; or in approximately 90 seconds at a cost of $1.70 per line ($.10 for generator and sequencing equipment plus $1.60 for relays, etc.) if one generator and a sequencing arrangement were employed. The addition of voice instructions would add approximately $.10 per line to either of the figures given above.[2]

1. _Ibid._, p. 17
2. _Loc. cit._

b. Using Special Alert Receivers

The system which was tested using special alert receivers consisted of three elementary components: the signal source, distribution equipment, and individual alert receivers. The warning signal was generated by two master oscillators providing separate audio-frequency and trigger-frequency voltages, which were mixed in a power amplifier unit and applied to the distribution system. This distribution was, in essence, a relay tree which allowed the division of subscriber lines into groups and sub-groups under control of timing circuits. The alert signal was placed across the tip and ring conductors of individual subscriber lines at the central office, and the receiving devices were similarly connected at the subscriber locations. The individual receiver unit consisted essentially of a loudspeaker which was coupled to the line conductors under control of a frequency-sensitive relay. A triggering frequency of 10 kc was used.

Field testing of the system indicated that, with only minor modifications, "complete and satisfactory coverage of all subscribers in a given telephone exchange could be provided."[1] Several improvements were suggested, namely, the insertion of a small value of inductance in the secondary of the transducer matching transformer of the alert receiver loud-speaker circuit to reduce the total power requirements of the system, the employment of some means of power factor correction in order to compensate for the effects of line capacitance to further reduce the triggering current requirement, and the change from a two component alerting signal to a single-frequency system to overcome complications in the generation and transmission of the signal.

The cost of an individual receiver as used in the field test was approximately $11.00. The estimated cost of a system in operation would be $4.25 per receiver (which could be reduced through large production quantities), $1.50 for receiver installation, $.50 for signal source, $.50 for control and coupling equipment and $.50 for central office installation, or $7.25 per subscriber.

2. Evaluation

a. Coverage

Statistical information included in the above study indicated the extent of coverage which might be attained with any warning system in which existing telephone systems are utilized.[2]

1. Ibid., p. 31
2. Armour Research Foundation, Study of Warning Techniques Based on Telephone System Signalling, Final Report, Phase 1, March 1957, p. 4.

(1) Per cent of 48.2 million homes having telephone service, 75%

(2) Per cent of homes in critical target areas having telephone service, 83%

(3) Per cent of farms having telephone service, 49%

The limitation on coverage of the telephone system in reaching only 75% of the homes is a definite drawback. The percentage of the population having access to a telephone would be much smaller during much of the day, since many would be enroute to work, at work, shopping, or engaging in activities out-of-doors. Outdoor warning devices could reach many of these people, but vehicular traffic would not be adequately covered.

b. Reliability and Survivability

The reliability of the telephone facilities and distribution network is sufficiently high that it may be disregarded as a significant factor. Commercial service demands have brought about this high reliability for all types of service, local, long-distance, and data transmission.

The survivability of the system is directly dependent on the survivability of the circuits that are both under and above ground. Whereas redundancy is available in long distance circuits, local circuits between exchange and subscriber are not redundant. Local circuit interruption at any point means the loss of the entire alerting and warning capability to that portion of the population served by that circuit. Damage in an area resulting in exchange disablement or circuit outages, even though short of total destruction, would mean isolation of that area from further warning information. Receiver instruments would necessarily have to be provided in shelter areas as well as in the normal living area, in order to disseminate attack effects information.

c. Susceptibility to Sabotage and False Triggering

Because the system is connected by wire, it is low in susceptibility to sabotage through circuit interruption or jamming on a local basis.

Safeguards to prevent false triggering merit consideration in the design of the central office equipment for signal generation.

d. The Quality of the Warning

Special alert and warning receivers are capable of fulfilling all of the response oriented requirements. However, if the existing ringers were used as an alerting device the alerting signal would not be entirely unique or free of compromise due to daily usage, even if a special ringing signal were used. Additionally, the use of existing ringers and receivers would cause some delay between the receipt of the alert and the receipt of the voice message due to the inherent delay between hearing the ring and being able to reach the instrument to hear the message.

If organizational elements and the general public were warned at the same time, the telephone system would be blocked at the exchange to prevent calls from being made. Calls in progress would have to be alerted to terminate immediately or, preferable, to be overriden automatically by the warning. Total interruption of telephone service would result while the lines were being used for the alerting signal and the warning message distribution. A time range of 20 to 90 seconds would be required to sound the alerting device. An additional time of 90 to 120 seconds would be needed for disseminating a prerecorded message. This total time amounts to a range of 110 to 210 seconds or from 2 to 4 minutes.

If separate warning were available to organizational elements and to the general public, part of the telephone system could be blocked and some phones could be made available for intra- or interorganizational usage free from the public warning dissemination. Calls from these phones to phones in the process of receiving the warning could be permitted. Thus, essential telephone service would experience no total interruption.

e. Non-Technical Aspects

Since telephone service is currently being supplied to subscribers, this system has no inherent problems concerned with operational authority, receiver distribution, provision of service, and administrative details, although considerable costs for personnel and equipments would be necessitated. Legal liability problems would be present in this system as in the others.

f. Cost

The cost estimates for a system using special alerting and warning receivers total $7.25, whereas the system utilizing the existing telephone system ranges from $1.80 to $4.35 per subscriber. Both of these costs include those necessitated by provision of a voice message capability, according to approximations by the study participants. Cost estimates by the Bell Telephone Laboratories were quoted in a statement by Paul Visher, former Deputy Assistant Secretary of Defense (Civil Defense)[1] as $40 or $50 per subscriber for a system using the telephones. Information is unavailable to detail the difference in costs between systems that were evaluated and referred to here, but the variance of $30 to $40 reflects a significant and irreconcilable difference.

The cost estimates made by Armour Research Foundation appear to be unrealistically low. For example, a large Southern California utility has found its minimum cost of a service call to be $3.50. In order to establish a frame of reference for telephone system cost, it is instructive to determine the average cost per telephone of the existing telephone system. By examining the 1960 census data as given in the Statistical Abstracts, the average plant cost is found to be approximately $350 per phone for both the Bell System and independent companies.

C. SPECIAL SYSTEMS

A separate system could be designed to utilize its own or leased lines to connect the local warning center to the points where the alerting signal and warning message is to be disseminated. The terminal equipment would probably be more like a sound or paging system than a telephone system. An example of such a special purpose system is the MUZAK wired music distribution system. It is a special purpose system, separate and distinct from the telephone or telegraph system, except for one factor: lines are normally leased from one of the communication common carriers, local telephone companies, or Western Union. It is clear that if a large fraction of homes and business establishments were to be served by a private wire system, the existing telephone cable distribution system now serving subscribers would be inadequate and ultimately would have to be duplicated.

1. Teleglobe[2]

A wire communications system using conductors separate from those supplying normal phone service is the Teleglobe Automatic Alert Air Warning and Radiation Sensing System. It provides one-way communication via special telephone lines to indoor speakers or outdoor and

1. U.S. Government Hearings before a Subcommittee of the Committee on Government Operations, House of Representatives, 87th Congress, Second Session. Civil Defense, 1962, February 1962, pp. 172-173.
2. Ira Kamen, A New Departure in Disaster Communication and Control Systems, Conference Paper for AIEE Summer General Meeting, June 17-22, 1962. Also, "Telephone Company Plays Major Role in Civil Defense Test," Telephone Engineer and Management, January 1, 1962, pp. 18, 19, 42.

community shelter versions in individual locations from a central control panel. Home speakers would be capable of operating on commercial or battery power. Information is transmitted over the system via microphone from the central control panel. An electronic scanning device can determine whether any of the system lines are inoperative due to blast or other damage.

Additionally, the system features the use of stationary, unattended fallout detection devices which can automatically feed local radiation information to the central control panel.

2. Bell and Lights[1]

The Bell and Lights Air Defense Warning System is an operational means of sending out raid warning alerts via private one-way circuits to individual locations. The system was developed by Bell Telephone Laboratories. It is presently using normal telephone company circuits and is handled under regular business procedures for installation, billing, and maintenance by the telephone companies. A five hole special telephone dial, located at a central point, is capable of sending five different warning signals to bell and light signal boxes and of activating connected sirens. The central point and individual locations of bell and light signal boxes are directly connected via private one-way circuits that are separate from normal subscriber telephone circuits and require no switching intervention. In each bell and light signal box, a distinctive ring occurs for each degree of warning and a light flashes from behind a colored panel indicating the appropriate information on the extant alert condition. All power required to operate the network is supplied from the telephone offices which are equipped with emergency power sources.

3. Evaluation

a. Coverage

The only limitations on coverage of a specially erected system are the cost and the number of private lines (even with 4-8 parties) capable of being terminated at a central point. Private lines could tie all indoor and outdoor loudspeakers to the central console. Radio telephones or receivers could be installed in all vehicles for coverage of that element.

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1. "Bell and Lights Warning System," Michigan Bell Telephone Company Brochure, no date given. Also, "Bell and Lights Air Raid Warning System," Northwestern Bell Telephone Company Brochure, no date given; and personal interviews with civil defense warning officials.

b. Reliability and Survivability

The reliability could be higher than that of the existing telephone facilities since less demanding central office equipment is necessary. High reliability of the receivers could be provided through design. The survivability would be similar to that of the system utilizing existing telephone facilities. Additional receivers could be installed in the shelters.

c. Susceptibility to Sabotage and False Triggering

The susceptibility to these elements would be similar to those for a system utilizing existing telephone equipment.

d. The Quality of Warning

The receivers could be designed to meet all of the response oriented requirements. The absence of the capability for disseminating a voice warning message makes the Bell and Light system unacceptable for usage as a general population warning system.

e. Non-Technical Aspects

These are similar for the existing telephone system and the special systems.

f. Cost

The cost of the Teleglobe system is approximately $5,000 per control center plus a subscriber cost of $36.00 yearly.[1] The Bell and Light individual installations and monthly charges vary by area and company, but $15 per installation and $60-90 yearly cost per subscriber would be representative costs. These two examples of special systems do not take into consideration the vehicular traffic, so any attempt to include that capability would increase the cost. However, the cost of any special system comparable to these two examples is excessive for general population usage. Subscribers are willing to pay for telephone service for personal communication, but would be unwilling to pay a matching amount for a warning service that may never be used.

IV. ELECTROMAGNETIC RADIATION

A. GENERAL

There are three media under control of the Federal Communications Commission which must be considered for dissemination of civil defense warning. These are 1) television, 2) frequency modulation radio, and 3) amplitude modulation or broadcast radio.

1. Personal communication from Ira Kamen, Teleglobe, June 18, 1962.

Television operates in three distinct portions of the electromagnetic spectrum. Channels 2 through 6 range from 54 to 88 megacycles/sec. Channels 7 through 13 range from 174 to 216 megacycles/sec. Channels 14 through 73 range from 470 to 890 megacycles/sec. FM radio operates in a band from 88 to 108 megacycles/sec. AM radio operates in the band extending from 540 to 1600 kilocycles/sec.

FM radio and the first 12 TV channels are located in what is known as the Very High Frequency band while the 60 additional TV channels are located in the Ultra High Frequency band. One fact which is important to this discussion is that to a first approximation, the higher the frequency, the more directional radio waves become. Long wave length, low frequency radiation diffracts or "bends" around obstacles and to some extent "hugs" the ground. In the UHF band, hills and reinforced or metallic buildings cause shadow zones. In addition, when structures such as flag poles, slender building towers, etc., bear a proper relation to the wave length of a signal, they re-radiate the signal and cause multi-path interference. As a result, the transmission of energy in both of these bands is essentially on a "line of sight" basis from transmitting to receiving antenna.

A second important point is that in addition to the diminution of energy in a wave as it spreads out more or less spherically from the antenna, there is a loss which is inversely proportional to the ground conductivity. Hence, radio propagation is excellent over water and marsh lands and very poor over dry, arid, or rocky regions.

A third important point is that the excess attenuation mentioned above increases with frequency.

B. COVERAGE

1. By FM and TV

The propagation of VHF and UHF waves is exceedingly complex and is influenced by a number of factors not the least of which is terrain. Man-made additions to the terrain make exact signal strength predictions virtually impossible. However, in general, for ordinary conditions, the range of FM and TV stations can be considered as being line of sight from antenna to antenna. When reception is obtained at greater than line of sight distance, either obstacle diffraction or abnormal atmospheric refraction or ducting of the waves in layers of high water vapor content is involved. Of course, for such range to be effective the transmitter must have enough power to supply a usable signal at the distant receiver. For average refractive conditions in the U.S., the line of sight range in statute miles is equal to about 1.34 times the sum of the square roots of the two antenna heights in feet, i.e., $R = 1.34 \left(\sqrt{h_t} + \sqrt{h_r}\right)$. Thus, for a transmitting antenna 1000' high and a receiving antenna 25' high a range of 50 miles could be expected. To achieve this range, approximately 5 kw of effective power would be required.

It is of some interest to estimate the approximate number of FM or TV stations having the above mentioned 50 mile range that would be required to cover the entire area of the continental U.S. if all other aspects of station locations are neglected. That is, how many 50 mile circles are required to cover the area of the U.S.? The 50 mile circle is equivalent to a 71 mile square and covers an area of 5000 square miles. Since the U.S. has a land area of three million square miles about 600 stations would be required.

However, since at least one million square miles are comprised of mountains, deserts, forests, plains, etc., 500 stations would probably do the job. There are approximately 650 TV stations in the U.S. covering the larger urban areas of the country. There are more FM stations (over 800) in existence in the U.S. but their coverage is not as widely distributed, there being an extremely heavy concentration of stations in the North Central, Mid-Atlantic and New England regions as well as in California. Vermont, Montana, Wyoming, and the Dakotas appear to be devoid of FM coverage while they do have TV coverage.

At this point it may be of interest to examine the 1960 population distribution of the U.S. as found in the Statistical Abstract of the U.S.[1]

Continental U.S. population	179.3 million (in 1963, estimated 188 million)
Urban population	126 million (70.4%)
Metropolitan Statistical Area	112.9 million (63.2%)
Urban Portion of Metropolitan Statistical Area	100.0 million (32.4%)
Central City	58.0 million (32.4%)
Rural population	53 million (29.6%)

Thus 70% of the U.S. population reside in urban areas comprising 2500 or more people and 63% live in or near cities comprising 50,000 or more people, but only 32% live within the central cities. From these figures it is clear that if 90% or more of the population are to be reached with a verbal warning message as well as an alerting signal,

1. Department of Commerce, Statistical Abstract of the United States - 1962, USGPO, 1962, pp. 1-21.

a large fraction of the pooulation classed as "rural" must be reached. It is also clear that the only means by which most of these people can be reached with a warning message is through radio broadcast.

2. By AM Broadcast

The propagation characteristics of the medium frequency or broadcast band which endow it with greater coverage potential than that of the FM and TV bands are due to the effects of the ionosphere on electromagnetic waves. The ionosphere produces both bending and attenuation of radio waves. These effects depend on the frequency of the waves and the electron density of the ionosphere. During the daylight hours waves in the broadcast band which enter the ionosphere are completely absorbed; hence broadcast station coverage is due to the ground wave only. At nighttime waves in the broadcast band are returned to earth so that broadcast station coverage is due to both a ground wave and a sky wave.

Since the ionosphere is continually in motion the sky wave signal strength rises and falls. This condition is called fading. In the region where the two signals are approximately equal, interference results because a receiver senses the vector sum of the two signals. The relative magnitude of the sky wave and ground wave is independent of transmitter power; hence, more power does not improve or increase the range to the interference zone. A more detailed discussion of the ionosphere is given in Appendix C, together with a description of the various classes to which AM stations may be assigned and the number of stations which have been assigned to each class in the United States.

Of the approximately 3700 broadcast stations in the United States in 1961, 24 were 50 kw clear channel stations with daytime ranges of one to two hundred miles and nighttime sky wave ranges up to 1000 miles; nearly 800 were full time regional stations with ranges of 25 to 50 miles and nearly 1000 were local stations with ranges as low as five miles. Of the 24 clear channel stations 19 operate 24 hours per day. The other 5 operate from 18.5 to 22 hours per day. In the larger metropolitan areas most full time stations operate 24 hours per day; of those that do not, 18 hours from 6 a.m. to midnight is a typical schedule.

3. Summary of Broadcast Coverage

It may be said that radio or the use of electromagnetic communication provides the only feasible means for reaching a large fraction of the population with a voice message. This is particularly true of that portion of the population which is in transit by automobile, bus, train, or airplane, as well as the large rural population.[1] The Clear Channel

1. See the discussion of traffic surveys and the resulting estimate of the number of people in vehicles in Section II above.

Broadcasters Service in testimony before the House Interstate Commerce Committee stated that "clear channel radio is the only source of nighttime radio service to over 25 million Americans living in nearly 60% of the U.S. land area."[1]

The employment of the low frequency portion of the spectrum would require, first, wresting the necessary spectrum space from some other user and then establishing and operating the required stations. While the radio broadcast band reaches a large portion of the population (approximately 50 million of the 54 million households in the U.S. are estimated to have one or more receivers[2]), this band is plagued with nighttime skywave interference in the range of 50 to 70 miles from transmitters. On the other hand, relatively simple antenna requirements exist for radio broadcast (a loop stick or capacitive coupling to the power line suffice in good signal areas), simple and inexpensive receivers can be built, good propagation exists among buildings in cities, and traveling vehicles can be reached.

Although FM and TV signals propagate essentially along line of sight paths, the signal may be severely perturbed by buildings in cities, thus requiring directional antennas to receive a good signal.

Even though FM car radios are now available, their range is limited by low antenna height. Owing to the economics of the broadcast industry, FM and TV coverage is limited to urban areas. From the standpoint of cost alone then, the legacy value of the facilities provided by the broadcast industry is an impressive asset. In addition, the program underway to provide selected broadcast stations with fallout protection and emergency power is not insignificant. Also very important is the fact that the transmitting capability does not have to be modified or expanded as the population increases, as must be done with power line generators.

Since an alerting signal can be used only to instruct the populace to "turn on your radio," an acceptance of the adequacy of the coverage of broadcast radio for the purposes of civil defense warning has been indicated. However, a more thorough evaluation of the capabilities and cost of using various portions of the electromagnetic spectrum should be undertaken. Since such a study requires an investigation beyond the scope of this project, only the general considerations which can be made of such a system are included in this report.

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1. Statement of Roy Battles before the Subcommittee of the House Interstate and Foreign Commerce Committee hearings on HR 8210, 8211, 8228, and 8274, 31 January, 1, 2 February 1962.
2. Standard Rate and Data Service, Inc., Spot Radio Rates and Data, Skokie, Illinois.

C. DESCRIPTION AND EVALUATION OF DEVICES WHICH UTILIZE RADIO

The principal difficulty with any device utilizing radio waves for transmitting either or both an alerting signal or warning message is that the receiver must not only be turned on but must be tuned to the station transmitting the warning. To activate a device by strictly radio means requires a certain portion of a radio receiver to be on a standby condition at all times. In addition, some coded signal must be provided to activate the audio portion of the set in order to disseminate the warning. To accomplish this function, a number of devices have been proposed to OCD. They fall into two general categories: 1) those which make use of the CONELRAD signal or code, and 2) those which employ a subcarrier.

The CONELRAD code and signal comprises the following steps:

1. Discontinue normal program.
2. Discontinue station carrier for 5 seconds.
3. Return unmodulated carrier to the air for 5 seconds.
4. Remove carrier from the air for 5 seconds.
5. Return carrier to the air.
6. Broadcast a 1000 cps tone for 15 seconds.
7. Broadcast the message.

Among the devices which respond to CONELRAD signals are CONELRAD Receivers, Conel-Flash, and SIGALERT.

Since the DOD has advised the FCC[1] that the need for CONELRAD no longer exists, it appears inadvisable to utilize a code based on an obsolete requirement. Of greater importance is the fact that the use of a 1000 cps tone as an activating signal results in an extremely high false alarm probability. It is common practice to check the audio portion of transmitters periodically. In so doing, 1000 cps is often applied to the transmitter for several seconds at a time and in the past has resulted in setting off sirens which were connected to CONELRAD-type receivers. To minimize the false alarm probability, the activating signal should be unique to the extent that it has no chance of being duplicated by the contents of normal programs or tests.

Among the subcarrier actuated devices distinct from those which employ the 1000 cps tone discussed above, are such devices as SENTINAL[2] and the Disaster Alerting Device (DAD).[3]

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1. Letter Dep. Sec. Def. Roswell Gilpatric to Newton M. Minow, Chairman FCC, April 23, 1962. See also FCC Public Notice G, April 24, 1962 and Address of Commissioner Robert T. Bartley before the Oregon Association of Broadcasters, April 27, 1962.
2. Proprietary item of Philco, Division of FORD Motor Co., Philadelphia, Penna.
3. Proprietary item of Joe Simpkins Oil Development Co., T. W. Powell, inventor.

SENTINAL employs a 37 cps tone to activate the audio portion of a receiver. This suffers from the same disadvantage as the 1000 cps tone in that it would occur in normal routine testing. In addition it occurs in the range of several bass and percussion instruments as well as in organ pedal tones.

DAD employs a 1000 cps tone modulated by 40 cps to perform the activation function. Such modulation of a subcarrier overcomes the false alarm problem. However, since the 1000 cps subcarrier lies approximately in the center of the speech range, the modulated tone cannot be left on to control the capture of the receiver.

As far as can be told from available information, all of the radio devices proposed so far depend on a signal to activate the set but anticipate manual operation of a switch to turn them off. In order for a device to be a satisfactory one it is necessary that it be suitable not only for warning but also for training. Therefore, devices must be under the positive control of the warning system. Thus, the warning system should be capable of turning any devices off and have them revert to the standby condition by removing the activating signal. After tests and training exercises, it is not desirable to have unattended sets remain in the "on" condition.

An additional factor to be considered in evaluating devices which utilize AM radio broadcast is the following. As discussed earlier, distant night-time signals are subject to fading. Even during the daytime, distant signals, particularly for people in automobiles passing near electrical power lines, are periodically obliterated by noise. Hence, it is highly probable that a single activating signal would be missed by a significant number of sets, whereas an activating signal which was continuously present could capture the set when receiving conditions were good and thereby supply the required message. By maintaining the activating signal and repeating the message several times, the probability is high that the entire message would be heard.

D. THE NEED FOR RELIABILITY

A staggering number of receiver hours would be generated each year if we assume that 70 million warning receivers would be in use. This would amount to one each for 60 million families plus 10 million for business establishments, duplicate installations and outdoor use, all operating 24 hours per day.

If the warning receiver contains eight critical parts (including transistors and diodes), which must operate continuously and are most likely to control its failure rate, the expected number of set failures which will occur each year for various reliability levels can be determined as follows:

First, assume a failure rate of 3% per 1000 hours, approximately that of ordinary entertainment receiving tubes.

16800 sets would fail each hour or 140×10^6 sets would fail every year - assuming independent behavior of the eight critical parts and immediate replacement of each failed set. If the part failure rate is reduced to only 0.001% per 1000 hours, then only 5.6 set failures would occur each hour for a total of 46,100 set failures per year.

Clearly the first failure rate would be intolerable for the intended usage of the receivers. The second failure rate results in the failure of less than 0.1% of the sets each year. The Western Electric Company has achieved a failure rate of less than 10 failures per 10^9 part hours for transistors used in the telephone plant. Therefore it is reasonable to expect a failure rate of 10 to 100 times this amount would be achievable for the parts in a specialized receiver where production is large enough to get the process under statistical control.

E. THE COST OF MAINTENANCE

From the above discussion we may use three levels of set failures for which to investigate the maintenance cost. These are approximately 4.6×10^4, 4.6×10^5 and 4.6×10^6 set failures per year.

On the basis of a normal working day, including holidays, sick leave etc., it is estimated that one service man could repair 7000 sets per year. We have then:

	Case 1	Case 2	Case 3
Failure rate/1000 hours	0.001%	0.01%	0.1%
No. repairmen	7	70	700
Cost at $12,000/man yr incl. overhead	$ 84,000	$ 840,000	$ 8,400,000
Parts cost at $1/set	46,100	461,000	4,610,000
Handling and mailing at $1.25/set	47,600	476,000	4,760,000
Total yearly repair cost	$177,700	$1,777,000	$17,770,000
Av. repair cost/set for 10 year life	$.0254	$.254	$2.54

It is clear that it is worth about $2.25 per set to reduce the part failure rate from that of Case 3 (0.1%/1000 hrs.) to that of Case 2 (0.01%/1000 hrs.). Likewise, it is only worth $0.22 per set to reduce it the next factor of 10. However, it is implicit that it is worth about $22 per set to reduce the part failure rate from 1% down to 0.1% per 1000 hours.

(The failure rate of 1% per 1000 hours is not shown in the table above as the results which would be obtained are obvious. However, subsequent discussion will consider 1% per 1000 hours failure rate primarily as it represents the rate presently attainable; see Section D above.)

F. THE VALUE AND COST OF REDUNDANCY

The probability that any one set will fail in t hours is given by $P_f = (1-e^{-Rt})$, where R is the set failure rate per hour. For the three cases of part failures rates of 1%, 0.1% and 0.01% per 1000 hours and eight critical parts, for a time of one year we arrive at a probability of failure of .502, .067, and .007, respectively.

If each person were provided with two sets, each with equal reliability, the probability of both failing is P_f^2 . A part failure rate of 0.43% per 1000 hours would be required for two sets to provide the same reliability as one set constructed of parts having a failure rate of 0.1% per 1000 hours. Since there would be twice as many sets under this condition, the average repair cost would be $2.20 per installation over 10 years. Hence, the breakeven cost for two sets constructed of 0.43% per 1000 hour parts would be $2.20 less than the cost of one set constructed of 0.1% per 1000 hour parts. Similarly, two sets constructed of parts failing at the rate of 0.125% per 1000 hours would provide the same reliability as one set constructed of parts failing at the rate of 0.01% per 1000 hours.

If the two sets were tuned to different stations, the value of redundancy lies in the lower probability of both stations being off the air because of technical trouble or damage, and the lower probability of no reception due to fading at nighttime if AM broadcast is used. Also, if one set failed the probability of the second set failing while the other was being repaired would be only 0.024 if four weeks were required for the repair and replacement cycle and if 0.43% per 1000 hour parts were used in its construction.

G. TRANSMITTER RELIABILITY

Transmitter availability, i.e., the fraction of the time a station is scheduled to be on the air and is radiating a satisfactory signal, is extremely high. Here again, economic considerations have been influential.

The high reliability and availability have been accomplished by good design, good maintenance practices, and the use of standby transmitters. Obviously, broadcast stations cannot operate without electrical power. In order to assure operation of some stations under post attack conditions, a program is under way to equip them with both emergency power and fallout protection.

Beyond the hazards of electrical power failure and fallout the most vulnerable item of broadcast equipment is the antenna, which for some AM stations is over 1000 feet high. Since antennas are built to withstand abnormally high winds, they can be expected to survive a 10 MT explosion at a distance of 10 to 15 miles.

H. SABOTAGE AND SUSCEPTIBILITY TO FALSE TRIGGERING

As already stated, sabotage is not considered to be of major significance in a warning system if the capability to detect and identify such acts is provided. Except for some outdoor warning devices, a warning system based on radio transmission would have few unattended items of equipment; hence sabotage would be more difficult. Conceivably a concerted effort could be made to destroy a large number of transmitting antennas. However, such an art would result in an increased military alert, making the net result of questionable value to the enemy.

I. THE QUALITY OF THE WARNING

The use of radio provides an inherent capability of broadcasting both an alerting signal and the warning message over the same medium. The alerting signal can be synthesized of any combination of tones or sounds which are found to be best for the purpose. Since the warning message would follow immediately after an alerting signal, it is self-validating. With proper system design, warning could be disseminated either nationwide from a central point or from lower organizational levels to areas within their jurisdiction (in either case with virtually no delay).

J. NON-TECHNICAL ASPECTS

The transcript of the House Subcommittee on Government Operations, covering civil defense, gives the impression that committee members were questioning why radio cannot be used for attack warning. Satisfactory consideration has not been given to the design of a satisfactory home receiver and of a comprehensive radio warning system. Sec. 1 of the Communications Act of 1934, which created the FCC, states in part regarding its purpose, "For the purpose of regulating interstate and foreign commerce in communications by wire and radio so as to make available, so far as possible, to all the people of the United States a rapid, efficient, nationwide, and worldwide wire and radio communication service with adequate facilities at reasonable charges, for the purpose of the national defense, for the purpose of promoting safety of life and property through the use of wire and radio communications, and for the purpose of securing a more effective execution of this policy by centralizing authority...."

Sec. 4 Par. O states, "For the purpose of obtaining maximum effectiveness from the use of radio and wire communications in connection with safety of life and property, the commission shall investigate and study all phases of the problem and the best methods of obtaining the cooperation and coordination of these systems."[1]

Sec. 303 provides that as public convenience, interest, or necessity require, the commission shall study new uses for radio, provide for experimental uses of frequencies, and generally encourage the larger and more effective use of radio in the public interest; and have authority to establish areas or zones to be served by any station.

The provisions of the Communications Act of 1934, as amended to 1960, appear to include not only ample authority for the use of radio for civil defense warning purposes but also for the designation of certain selected stations to broadcast the necessary signals and messages.

There are no problems concerning rates or charges, since this service would be provided by the broadcasters in the public interest as they now broadcast traffic information and Presidential pronouncements.

The most significant problems appear to be concerned with the warning receiver. Should such a receiver be separate or a part of an entertainment receiver? If a separate set, should it be furnished by the government? If not, how should it be manufactured and distributed?

The factors pertaining to the design of a particular system to utilize radio and the selection of stations to provide the best coverage are too complex to be dealt with in this report.

K. COST

One cost item in the establishment of a radio warning distribution system is the signal generating and switching equipment required to automatically pre-empt the transmitter input and generate the appropriate control signal to activate the warning receiver. The cost of such equipment would

1. Federal Communications Commission, The Communications Act of 1934 with Amendments and Index Thereto, 13 September 1960, pages 1, 10, 36.

range between $500 and $2000 per installation and if as many as 1000 stations were used to cover the U.S., at most 2 million dollars would be required for station equipment. The major cost item owing to the very large number required would be the special warning receiver. The cost of such a receiver specifically designed for the purposes established here would range between $15 and $25.

In addition to these costs there is another item which is common to all systems. This is the signal network required to link the National Warning Center to the local warning centers and the tie lines linking the local centers to the alert and warning transmitters, in this case the radio stations.

L. SUMMARY AND CONCLUSIONS

To summarize, the characteristics of electromagnetic radiation are such that FM radio and TV transmissions cover only a "line of sight" radius around the transmitter which is proportional to the square root of the antenna height. The range of an average TV or FM station in the U.S. would be about 25 miles with the extremes being about 10 miles for low antenna heights to over 100 miles for those few stations situated on high mountains.

On the other hand, AM radio is capable of traveling much greater distances although the coverage which exists during the daytime and the nighttime is considerably different. During the daytime only groundwave coverage exists, while during the nighttime both groundwave and skywave coverage exists. This results in reduced primary coverage and usable skywave coverage several hundred miles away from powerful clear channel transmitters. Radio waves provide the only means of reaching people in transit as well as the only practical means of reaching a large portion of the population with a voice message. The broadcast industry provides a large resource in transmitters which could be utilized for warning purposes at very small cost.

In contrast to power line alerting systems, a radio warning system can combine both the alerting signal and the warning message. However, to do so requires a special receiver which can be activated by a sufficiently unique signal to insure the desired operation without false alarm triggering. The coverage of radio systems is substantially independent of population growth or density.

In addition, such special receivers powered by a trickle charged battery would continue to function even during commercial power outages.

Where outdoor warning devices are called for, the radio set activating signal can also be utilized to activate those devices. If outdoor loudspeakers are required, the same alerting signal and warning message can be disseminated over the speaker system. This would be particularly useful in large stores, factories, and schools which have existing paging or sound systems.

As pointed out earlier in the discussion, true system cost is composed of many subsystem costs and can be materially affected by reliability and maintenance cost. By utilizing existing transmitting facilities and network ties of the broadcast industry, an investment which could easily run to several billion dollars is avoided. All that would have to be added are the necessary ties to local warning centers, together with the switching and signal generating equipment at each selected station. To insure an adequate level of survivability of radio warning system, redundancy would have to be provided through station selection, redundant or hardened network ties, and station emergency power and fallout protection. However, since both American Telephone and Telegraph and the Defense Communication Agency are taking steps to insure land line communication survivability, the benefits of these expensive protective measures may be available at little or no direct cost to OCD.

The cost of the switching and signal generating equipment which would be required of each radio station would range between $500 and $2000. If we assume as many as 1000 stations to cover the U.S. with the redundancy required, at most 2 million dollars would be required for special station equipment. As special civil defense warning receivers are required, their cost will probably range between $15 and $25.

In addition, the radio warning system can be employed for testing and training without compromising the alerting signal by "crying wolf." Finally, the use of some form of radio broadcast is the only medium in which a system can be devised which meets all of the requirements set forth in Chapter Five.

V. MISCELLANEOUS WARNING DEVICES

A. INTRODUCTION

The power line, wire line, and broadcast systems have been detailed and evaluated in previous sections in terms of effectiveness in meeting warning system requirements. None of these systems achieves total coverage of all elements of the public with an alerting signal and voice warning message, since they are basically indoor systems. Some additional tie-ins to other devices are required to reach the outdoor urban, suburban, and rural elements of the population.

This section describes and evaluates pyrotechnic outdoor warning devices and outdoor sound systems in regard to their capabilities to supplement an indoor warning system and to provide the alerting signal and voice warning message to the out-of-doors population. These are the people who are not immediately adjacent to a house, factory or commercial establishment, and hence, who could not hear an indoor device, such as a NEAR, radio or telephone receiver. These people would be engaged in working or travelling in a range of environments from prospecting or trail riding to walking on a busy city street.

B. PYROTECHNIC OUTDOOR WARNING DEVICE

1. General

a. Description

The role of pyrotechnics as an alerting device is to attract attention in a dramatic manner by either visual or audible means, by either day or night. A pyrotechnic system includes a propulsion system, a projectile to carry alerting devices, the alerting devices themselves, and a means of safely disposing of the projectile. The propulsion system would be activated and ignited by an alert activation signal and would fire a projectile in a desired trajectory for alerting a limited or extended area. The projectile would carry alerting devices producing sounds by explosions, whistles, sirens, or other devices and/or visual effects by smoke, reflected sunlight, flares, or similar means. Upon expiration, the projectile would be destroyed by an explosion or allowed to return to earth by parachute or some similar device so as not to become a hazard.

b. Evaluation

As an outdoor warning device, a pyrotechnic system is capable of being initiated by an alert activation signal from either the national or local warning center, and it could employ an alerting sound and/or visual effects singular in its meaning. However, the resemblance of sound and/or visual effects that might be employed for alerting to fireworks displays, actual attack explosions, sounds of police, fire or ambulance sirens, factory or train whistles, etc. could compromise the effectiveness of its attention getting role. The resemblance of effects could even cause an immediate response of resorting to duck and cover, when instructions via a voice message would indicate time available for better protective measures to be taken.

Due to the time lag between the alert and the availability of a voice warning message over another medium and receiver, this device would have possibilities as an outdoor alerting device only in rural areas where time is less critical and where means of delivering a nearly simultaneous alerting signal and voice warning message are non-existent.

2. Rocket Power, Inc. - Pyrotechnic Outside Warning System[1]

a. Description

Under a present research investigation being conducted for OCD by Rocket Power, Inc., the pyrotechnic outside warning system is developing rapidly as vehicles, propulsion systems, warning devices, and recovery components are being integrated and tested. The vehicle chosen by Rocket Power is a 2.25 inch outside diameter aluminum alloy tubing casing with an .083 inch wall thickness. Fin stabilizing was selected over cone and spin methods. The propulsion unit being used is a conventional rocket motor with a solid propellant fuel. In order to produce audible and visual alertings, a flare, smoke, an explosive charge, and a whistle are incorporated as the payload. Parachute recovery of the vehicle has been selected to overcome the dangers associated with the falling vehicle and possible fires from the flare. The testing program is underway to perfect the integration of all the system components and to develop comprehensive cost estimates for an operational system. The testing and evaluation phase of the Pyrotechnic Outside Warning System is to follow.

Preliminary cost estimates, subject to change upon completion of the study, were $700 for a cluster of rockets, including all the launch equipment necessary for the rockets to be activated by an alert activation signal, similar to that provided by NEAR.

b. Evaluation

A comprehensive evaluation must wait until the project is completed, but the evaluation of the general pyrotechnic system given should be applicable.

C. OUTDOOR SOUND SYSTEMS

1. Acoustics of Local Warning Devices

The transmission of an acoustical warning involves: (a) source, (b) intervening media, and (c) competing sounds or background.

a. Source

Data on intervening media and competing sounds set certain re-

1. Rocket Power, Inc., Pyrotechnic Outside Warning System, Progress Report No. 2, August 15, 1962.

quirements for the source and therefore must be detailed before a critique of outdoor sound systems can be made. Hence, local warning devices presently being used will be detailed and evaluated in a following section. Future warning devices will be either outgrowths of present ones through modification, improvement and/or redesign, or entirely new technical innovations based upon results of research studies underway. Some of the current studies to investigate the design, operation, and effectiveness of various sound systems are being conducted by Bolt, Beranek and Newman, Inc.,[1] by the Michigan State University,[2] and by the Defense Systems Department of the General Electric Company.[3]

The study by Bolt, Beranek and Newman is concerned with message material and content, intelligibility considerations relating to the choice of speech material and choice of talkers, and psychological and sociological factors relevant to the choice of message content and formulation. They have also evaluated available experimental data on the performance of loudspeaker systems outdoors and are planning further investigations on the propagation of audible sound, including the speech signal in urban areas. The study by Michigan State University is concerned with the characteristics of optimum audio warning signals and means of eliciting proper population response. The study by General Electric is concerned with recent technological advances and their possible application to the design of improved devices and/or systems. These studies will aid in determining the qualities of the source, either alerting devices or voice message transmitters, that will assure maximum effectiveness in alerting the public and disseminating the required information.

1. Bolt, Beranek and Newman, Inc., Investigation of the Design and Operation of Sound Systems for Civil Defense, Quarterly Progress Report No. 2, July-September 1962.

2. Michigan State University, Response of Population to Optimum Warning Signal, Monthly Progress Reports, 1962.

3. B. G. Mitchell, General Electric Company, Improved Outdoor Warning Devices, Monthly Progress Report, Defense Systems Department. No date given.

b. Intervening Media

The expected level of the desired signal at the receiver depends not only on the strength and directional properties of the source, but also on the reflecting, refracting, diffracting, scattering, and absorbing properties of both the intervening atmosphere and the intervening terrain and structures. From the technical paper, Air Raid Warning in the Missile Era, by the Johns Hopkins University, the following broad estimates of overall effects are detailed:

Literature review of effects of sound propagation due to (a) ground absorption, (b) humidity, fog, and rain, (c) temperature refraction and wind refraction, and (d) air turbulence resulted in the conclusion

> "that in the frequency range below 1000 cps and other distances of less than a mile from the source, air turbulence is the principal cause of attenuation, and ground absorption can also be of importance. Molecular absorption is shown to be under 1 dB per 1000 ft.
>
> The refraction of sound waves due to temperature differences in the atmosphere with altitude can cause the sound to bend upward so as to completely miss remote points, effectively producing sound shadows beyond certain distances. This temperature refraction by itself can be computed to be generally negligible as long as the source is reasonably elevated."[1]

Shadow effects produced by wind-refraction phenomena are a serious problem.

> "When effects of wind and temperature gradients combine additively...wind refraction alone is of negligible concern for steadily sounding single-frequency sources that are well distributed in space, since the loss in sound intensity reaching an observer from some directions is compensated by that arriving from other directions. However, such compensation is not to be anticipated in a system in which the sources rotate or the signals vary in frequency.

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1. Theodore Wang, et al., Air Raid Warning in the Missile Era, Operations Research Office, John Hopkins University, July 1960, pp.25-26.

Some sound is absorbed by grass, foliage, and relatively porous surfaces; sound is reflected from pavements, structures, and other hard surfaces.

Obstructions contribute to the production of sound shadow; on the other hand, diffraction and scattering processes serve to compensate somewhat for these shadow effects. Reported values of intensity loss in shadow areas of large obstacles run from 15 to 25 dB.

The most important of the sound-attenuating factors -- air turbulence -- is the most difficult to evaluate quantitatively. Wiener, et al.[1] examined air turbulence along with other factors at some length and indicate no obvious relation between the frequency of the presumably associated fluctuations in wind velocity. However, they report several cases of 5 dB variations under generally stable atmospheric conditions."[2]

Sound transmission in cities is under study by Bolt, Beranek and Newman, Inc. The following excerpts are taken from the quarterly progress report No. 2, July-September 1962.

"The temperature profile in urban areas is approximately isothermal under most conditions. The wind velocity profile thus becomes the determining factor in possible shadow zone formation. The wind velocity profile in city streets was estimated to follow the 0.1 power law.

The discussion of eddy and wake flow patterns...begs the conclusion that the best location for a sound source would be over the middle of the street.... It is probable that a source location over the curb or outside edge of the sidewalk would escape most of the turbulence caused by the buildings."[3]

Sound propagation characteristics at street level and from elevated sources have not been completed.

1. F. M. Wiener, et al., "Field Testing," Capabilities and Limitations of Long Range Public Address Equipment, Report 466, Bolt, Beranek, and Newman, Inc., Cambridge, Mass., 1 June 1957.
2. Theodore Wang, et al., Air Raid Warning in the Missile Era, op. cit., pp. 25-26.
3. Bolt, Beranek, and Newman, Inc., Investigation of the Design and Operation of Sound Systems for Civil Defense, op. cit., pp. 10-11.

c. Competing Sounds

Background sounds in a particular area of a particular city are related to the specific functions of that area. Extremes might be indicated as a residential area, in the early morning hours when there is little or no activity, and a manufacturing area, adjacent to an airport during a jet aircraft take-off. Knowledge of background levels of each area is necessary to evaluate potential warning audibility in comparing the expected sound level of the desired warning with that of the competing background noise.

2. Present Sound Systems

Outdoor sound producers can be classified as (a) sirens, (b) whistles, horns, or bells, and (c) loudspeakers.

a. Sirens

In a field study of existing outdoor warning systems, W. Sattler[1] describes the outdoor sound producing devices found in 18 warning systems. The electrically driven siren is the most commonly used device for outdoor attack warning. One type produces sound as radial vanes on the inside of the motor driven rotor causes air to be drawn in. The flowing air is then chopped when ports spaced around the periphery of the rotor match corresponding holes in the stator to produce the varying pitch as the motor changes speed. This type of siren is useful in applications where ratings of from 2 to 40 horsepower are sufficient. The corresponding sound output ratings at 100 feet are 100 to 130 dB (minimum) respectively for the two extremes.

Another type, the Federal Model 1000 "Thunderbolt" manufactured by the Federal Sign and Signal Company of Chicago, uses a motor to rotate the horn and two additional separate motors to drive a blower and chopper assembly. By doing this, the air flow and the sound amplitude do not vary with the pitch of the sound as in the first type.

Gasoline engine driven sirens are also in common use. This type of siren can produce a sound pressure level of 135 dB at 100 feet, and can start and operate without commercial electrical power up to the limits of its fuel supply. The Chrysler and Biersach and Niedermeyer sirens of this type use an integral blower and chopper and therefore produce a siren sound as soon as the engine reaches idling speed. However, in the gasoline engine driven Federal

1. W. Sattler, Development of Procedures for Non-Alert Testing of Outdoor Attack Warning Systems, AC Spark Plug Division, General Motors Corporation, 22 October 1962.

Model 2000, the blower and chopper are again separate units. The blower is driven by the gasoline engine and the chopper is driven by an electric motor, which receives its power from a storage battery. During the cranking interval the chopper motor is prevented from running. If the signal circuit is still closed when the engine succeeds in starting, the chopper motor is automatically energized and siren sound is produced. A list of sirens certified as meeting OCD specifications is found in Annex 5-A of OCD Manual 25-1, Federal Contributions for Civil Defense Equipment.[1] The size and sound output rating in decibels, the manufacturer, and identity by make and model are included.

b. Whistles, Horns, Bells

Horns are frequently used in small systems or as fill-in for large areas in the larger systems. They are rated at sound output levels of from 100 to 120 dB minimum at 100 feet. The ability of horns to be started and stopped instantly is a characteristic possessed by no other warning device. In the case of a horn operated by compressed air, a turn-on delay may be noticed if the distance between the central valve and horn is appreciable. A list of horns certified as meeting OCD specifications is also found in the Federal Contributions for Civil Defense Equipment manual.[2]

Whistles and bells are less frequently used. These devices have been used where the whistles and bells have become an integral part of the environment of the community. In these cases, a factory air or industrial electric whistle or a carillon is looked upon as the community warning device. The rating at sound output levels can be as high for whistles and the carillon, where loudspeakers are used, as for horns and sirens. These devices are not considered as OCD approved devices for general installation.

c. Loudspeakers

Loudspeakers now in use for outdoor warning are weatherproof units rated up to 75 watts and are nearly always grouped in clusters for omni-directional coverage. In addition to the loudspeaker cluster, an alarm site consists of either a transistorized, weatherproof power amplifier or a vacuum tube power amplifier that must be suitably housed a limited distance from the speakers. Both types of power amplifiers can be operated

1. Office of Civil Defense Management, Federal Contributions for Civil Defense Equipment, Administrative Manual 25-1, July 1959 and Change 1, 30 September 1960.
2. Loc. cit.

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1. Office of Civil Defense Management, Federal Contributions for Civil Defense Equipment, Administrative Manual 25-1, July 1959 and Change 1, 30 September 1960.
2. Loc. cit.

from storage batteries; the length of transmission periods is limited only by the capacity of the batteries. The batteries are recharged by a battery charger connected to commercial power. During stand-by periods, some amplifiers, depending on type and manufacturer, are completely de-energized while others idle at reduced power to extend component life. In either case, the amplifiers must be switched from standby to operate by remote control from the activation point. The two public action signals, "alert" and "take cover," are initiated at the control console by electronic tone generating circuits, disc recordings, or tape recordings.

An example of an outdoor sound system making use of microphones, amplifiers and loudspeakers as a means of an alerting signal and warning message dissemination is the "Big Voice" warning system of Altec Lansing Corporation installed in Salina, Kansas. The microphone of the system picks up voice messages and a generator supplies the appropriate alerting signals at the Civil Defense Headquarters. Signals or verbal instructions are transmitted via rented telephone "tie-lines" to the remote speaker locations, either to individual locations or simultaneously to all. Each speaker location is powered by a separate amplifier. The system is also capable of transmitting radio broadcasts. The cost of this installation was stated to be somewhat less than $1.00 per resident in this community of 45,000 population.

d. Siren Modifications

1) The Stanford Research Institute conducted a study for OCD to determine the feasibility of modifying a warning siren for the production of intelligible speech. The following information taken from the Summary Report of the study summarizes the design and construction of a prototype device and conclusions reached by that project.

"In the modulated airstream loudspeaker, which forms the speaking portion of the assembly, a flow of compressed air is controlled by an electrical speech signal. Smaller units of this Stanford Airstream Modulator (SAM) had been constructed previously. In the present work three larger speaker units were constructed and combined in an assembly with a Federal Model-1000 Thunderbolt Siren. In the siren, a separate air compressor (blower) supplies air to a chopper that alternately passes and interrupts the air flow, producing the siren sound. The airstream modulator was designed to use the same compressed air supply, which was switched from the siren to the modulator and vice versa. The control mechanism for the siren was used with as few modifications as possible in the design of the siren-loudspeaker combination."[1]

"The development and testing of the siren-loudspeaker demonstrated that such a device will work and that it can be constructed as an addition to an existing siren. There are limitations inherent in the use of the device, the most serious of which is the short voice-coil life that is experienced at maximum sound-output levels...Improved circuit isolation through the rotator slip rings should be sought, and the resistance of the exposed portions to extremes of climatic environment should be investigated."[2]

Using a recorded speech input, an average sound pressure level of 117 dB was achieved on the horn axis at a distance of 100 ft. At a distance of 675 ft. (limited by terrain) observers reported that the sound was loud, clear, and intelligible.[3]

2) An air modulator loudspeaker has recently been built by James B. Lansing Sound Inc. for use in acoustic environmental testing work. This unit is capable of 1 kw of acoustic output with an inlet pressure of 30 psi. The output, for a constant input to the modulator, is uniform within $\pm$ 1 dB up to 3000 cps in contrast with the Stanford Research Institute air modulator (SAM) which has an output characteristic that drops at the rate of 12 dB per octave above 500 cps.

For a conventional loudspeaker to achieve constant output over a given frequency region its diaphragm (or voice coil) must move with constant velocity for a given input over the frequency range. A modulated airstream unit, however, requires that a constant modulator or valve opening be achieved for the given input over the frequency range. To achieve such a characteristic requires that the air valve be stiffness controlled up to the highest frequency of interest. It is interesting to note that for a given voice coil and air-gap density the SRI design approach requires the same voice coil amplifier power for full output as a stiffness controlled unit at its resonant frequency. The stiffness controlled unit frequency response does not require any shaping of its voice coil amplifier characteristic.

1. James S. Arnold, and Amos Picker, The Modification of a Warning Siren to a Modulated Airstream Loudspeaker, Summary Report, Stanford Research Institute, 30 June 1961, p. 1.
2. Ibid., p. 5.
3. James S. Arnold, and Amos Picker, The Modification of a Warning Siren to a Modulated Airstream Loudspeaker, Abstract of the Final Technical Report, Stanford Research Institute, 30 June 1961.

The James B. Lansing unit could be made to produce about 200 watts output for a 5 psi inlet pressure which would produce adequate audibility under average conditions around a circle of 1 to 2 miles radius.

3. Evaluation

a. Sirens, Horns, Whistles, and Bells

These sound producing devices are available in many varieties of size, cost, sound output, and ruggedness of construction. Industrial sirens, horns, whistles, and bells can be used indoors to provide an alerting signal where the work activity noise level precludes voice recognition or intelligibility. Such an alerting signal would have to be singular in its meaning and be made very effective by an internal training program highlighting protective actions to be taken. However, the major use of these devices is to provide an alerting signal to that portion of the population that is out-of-doors. They are capable of having a singular meaning and could provide excellent coverage to the outdoor element in the urban-suburban environment. However, the capability of alerting the indoor or vehicular borne public is only incidental.

Unmodified sirens, horns, whistles, and bells are not capable of disseminating voice instructions. Hence the time delay would be great (in some cases excessive) between recognition of a hazardous situation and knowledge of what it is and what is to be done. When this time delay cannot be tolerated, these devices are inappropriate. The present devices do not have a unique signal, bear too close a resemblance to other uses of the same attention-getting devices, and have been tested too frequently. Hence their ability to alert has been compromised.

In summary, the use of sirens, horns, whistles, and bells provides only marginal alerting capability and little or no warning information.

b. Loudspeakers

Loudspeakers are capable of disseminating a unique alerting signal and voice warning message in any order or combination. Since both can come from the same device, the alerting signal and the voice warning message can be closely associated in time. Testing of loudspeakers can be accomplished without compromising the alerting signal. These devices can be used indoors as well as outdoors provided the competing background noises do not preclude voice intelligibility. Loudspeakers are not effective as warning devices for most vehicular traffic because of existent background noise. Urban-suburban areas could be well covered; however, the sparseness of the rural population would preclude their use in those areas. Excessive environmental interferences, such as topography, could also make use of loudspeakers excessive in cost.

c. Siren Modifications

The combination of a siren and a loudspeaker as a modification of the present Thunderbolt siren is an attempt to make use of a previous investment at a moderate additional cost. The addition of the voice warning message capability to the siren is greatly needed. The time delay between receipt of the alerting signal and the voice warning message could be eliminated. However, the drawbacks of alerting signal compromise detailed in a previous section would still exist. The coverage patterns of the siren signal and of verbal intelligibility would not coincide. In order to get verbal intelligibility excess alerting capability would be present.

If sirens can be modified to increase their attention-attracting effectiveness they would be of great value, provided the cost for the modification was moderate. No cost estimates for this modification work are available.

Another modification of Thunderbolt or other sirens having separate blower and chopper assemblies producing at least 6 psi air pressure, would be to delete the siren portion of the device and make use of the air supply for a modulated airstream loudspeaker. A unit such as the one manufactured by James B. Lansing Sound, Inc. could be used without major developmental costs. The following cost estimate would be applicable for modifications of existing Thunderbolt sirens: driver (in quantities of 100 or more) $600, horn $150, amplifier $200, and installation costs $250, totalling approximately $1200.

D. SUMMARY

Devices used in the civil defense warning system must be capable of attracting the attention of the public to the imminence of a hazard, of informing them of the nature of the hazard, and of instructing them on protective measures to be taken. Outdoor warning devices are necessary to meet the needs of that portion of the public that is out-of-doors. Alerting devices such as pyrotechnics, sirens, whistles, horns, and bells are capable of attracting attention only. Present alerting devices have been compromised to such an extent that their effectiveness in attracting attention is low. Loudspeaker systems are capable of attracting attention and immediately providing clear-language information concerning the nature of the hazard and necessary instructions on protective actions. Modifications to present sirens to provide a loudspeaker capability have been studied and may be the answer for meeting clear-language requirements. The results of studies underway will provide direction and impetus for future improvements and innovations in warning devices.

CHAPTER EIGHT

COMPARATIVE EVALUATION OF WARNING SYSTEMS

I. INTRODUCTION

Three possible approaches (power line, wire line, and broadcast) for providing the essential public alerting signal and warning message elements of an effective warning system have been individually described in Chapter Seven. In the comparative evaluations that follow, critiques of the individual systems are used as the basis for developing conclusions on the relative effectiveness of these systems in meeting the warning system requirements. Cost and other nontechnical considerations are also evaluated and conclusions are presented in a summary chart for ease of comparison.

II. MEETING THE REQUIREMENTS

A. QUALITY OF THE WARNING

1. General

Several of the operational requirements for a civil defense warning system are concerned with the quality of the warning itself. Warning must contain all the information necessary to carry out prescribed activities; it must be clearly recognizable, distinctive and unambiguous; it must elicit public confidence; it must be timely; it must be composed of an alerting, attention getting signal followed immediately by an information giving message.

These requirements dictate a message system with an overriding need for flexibility and adaptability. This need stems from the wide variety and combinations of environments which could exist, resulting from the hazards of nuclear war, chemical or biological attack, natural disaster, and changing levels of protection afforded to the public. Variation in hazards or levels of protection means variation in the desired response to warning. Also, variations in warning time due to discrepancies in threat detection, the evaluation and dissemination of information, and distances from targets may mean that some segments of the population have time to seek good protection while others will only be able to duck and cover.

The discussions justifying these requirements in previous sections pointed out the need for both an alerting signal and a voice warning message. The transmission of the voice warning message should be inherent in the warning system that provides the original alerting signal. Independent action on the part of the recipient ought not to be required to validate the warning. The alerting signal must not be separated from the voice warning message if positive protective response by a high percentage of individuals is to be assured within the very brief alloted period following detection of the first elements of an attack or natural disaster.

The NEAR system utilizes a signal which activates an indoor buzzer device. The desired response to this signal may be to turn on the radio for additional information or seek shelter. For NEAR to be effective, it is necessary that the public be pre-conditioned as to the appropriate response to the indoor alarm or that NEAR must be coupled with some means of disseminating a voice warning message. This message must provide all the necessary information required to carry out the prescribed activities.

a. Comparison

The broadcast medium has been suggested as a means of transmitting this voice message. The NEAR alerting signal would mean "turn on your radio", before or after reaching the shelter. NEAR cannot be considered as meeting this warning system requirement in itself, but only in conjunction with another medium.

The broadcast and telephone systems are capable of disseminating the alerting signal and voice message over the same receiver. Studies performed in the past indicate various methods are available for providing an alerting signal as part of a radio, TV, or telephone receiver. Broadcast equipment that can provide the voice message to the public in the present and future is currently operational. No breakthroughs in the state of the art need be made. However, development of a highly reliable alerting device either separate from or coupled to a radio or TV receiver needs to be undertaken. Further research on a telephone system designed to meet warning system requirements is also indicated as being necessary, primarily due to the wide divergence of the cost estimates obtained.

In summary, NEAR plus radio and/or TV can meet the requirements for an alerting signal and voice warning message, but a time delay must presently be expected between the alert and the information. Since radio and/or TV should be considered part of the overall warning system, money spent to include an alerting device within a radio or TV receiver would optimize the warning system in meeting these requirements. Additionally, a broadcast system can provide the greatest degree of flexibility and adaptability since radio receivers can be power or battery operated and can be portable. A telephone system could also optimize the warning system, but it would lack the flexibility and adaptability of the radio receivers.

B. COVERAGE

1. General

A fact which must be considered in relation to the requirement that no segment of the population should be excluded from the warning system, is that 12 to 25 percent of the population is in transit, mostly in automobiles, during any period of the day.[1] In addition to the transient population the coverage requirement means that people at home or at work, indoors or outdoors, and in urban areas and in sparsely settled rural areas must be warned.

2. Comparison

Of the three basic warning media, power line systems and telephone systems are inherently indoor alerting or warning systems. While they may be used to reach people outdoors with the addition of auxiliary devices such as loud speakers or public address systems, they are incapable of reaching people in automobiles, busses, trains, or airplanes. On the other hand, electromagnetic radiation utilized by AM radio, FM radio, and television broadcasting is the only medium that can reach all categories of people, indoors, outdoors, and transient.

While the range of FM and TV transmitters is limited to essentially line of sight distance between transmitting and receiving antennas, the medium frequencies of AM radio hug the ground so that their daytime range is limited only by station power and noise conditions at the receiver. At night, a skywave is reflected from the ionosphere with the result that powerful clear channel stations can be heard for several hundred miles.

In 1961 the continental U.S. was served by more than 3,700 AM stations, 800 FM stations, and 650 TV stations. The AM stations give daytime coverage to all populated areas of the U.S., and only portions of the western mountains and desert regions are not covered. At night usable ground wave or skywave signals exist over the entire U.S. Five states (Montana, Wyoming, the Dakotas, and Vermont) have no FM stations, but do have TV coverage in their populated areas. At the end of 1961 89%

1. See Chapter Seven for information on the number of persons in transit or engaged in different activities.

of the 52.4 million households in the continental U.S. had one or more TV sets.[1] Data given in Spot Radio Rates and Data indicate that there are 49.7 million households in the U.S. which have radios, or approximately 94% of the households in the U.S. can be reached by AM radio.[2]

Data obtained by Armour Research Foundation in 1956 indicated that only 75% of U.S. homes and 49% of farms had telephone service.[3] This figure is no doubt higher today since telephone companies are growing much faster than the population, as evidenced by the following figures.

While there were about 77 million telephones[4] in the United States at the end of 1961, as many as 55 million may have been in residences, since in 1960 of 65 million phones belonging to the Class A companies 46.6 million or 72% were in residences.[5] Since extension phones are included in this count the number of households covered is not precisely known. However, it is likely that the penetration of the telephone is approaching that of TV and radio. Without doubt the coverage of the 7.4 million[6] business and industrial establishments is complete. Even so, the coverage obtainable for individuals is again limited to those who are within the range of the telephone bell or other outdoor warning devices.

The study of power line warning systems, contained in Chapter Seven, indicates that while 90% of the people in a given time zone may be reached during the normal sleeping hours of that zone, and while on the average a maximum of 75% of the population could be reached by an indoor device like NEAR, during certain periods of the day this figure could drop to 50 or 60%.

It is apparent that potentially the greatest number of people can be reached by means of radio waves, most likely by AM radio or some combination of radio and TV. The optimal choice must be determined by a study of both the daytime and nighttime coverage of each area based on the station coverage maps and is beyond the scope of this study.

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1. Department of Commerce, Bureau of Census (1962), Statistical Abstract of the United States, pp. 44, 522.
2. Op. cit.
3. Armour Research Foundation, op. cit.
4. Statistical Abstract, p. 514
5. Ibid., p. 516
6. Ibid., p. 535

C. SURVIVABILITY

1. General

Survivable communications are required to connect the National Warning Center through intermediate points to the local warning centers. This survivable network is needed to activate any warning system, be it power line, radio, wire line, or any combination thereof. The difference in survivability among the systems lies primarily in the local warning area. The requirement to warn of attack effects from the local level will necessitate a high degree of survivability of the system.

In some cases an outage on the high voltage lines required to activate the NEAR system could prevent a large segment of the population from receiving the activation signal and, therefore, the subsequent voice message. However, overlap or multiple feeder line capability can be provided to lessen the chances that the loss of one feeder system would jeopardize warning for any appreciable segment of the nation.

2. Comparison

In the local area environment, NEAR and the telephone system are vulnerable to the extent that power lines, substations, cables, wires, and central offices are vulnerable. However, the loss of 60 cycle power also means the loss of the NEAR capability, since 60 cycle power is the basis for generating the alert activation signal. Telephone companies, however, have emergency power available and could call upon this supply for alerting signal and warning message distribution.

In radio and TV broadcasting, survivability of communication facilities can be somewhat higher, depending upon antenna location and emergency power provisions. If the transmitter station survives, or one in the neighborhood survives, the ability to disseminate the alert and voice message can be maintained through the use of emergency power even though commercial power is destroyed. Similarly the ability to receive can be maintained by use of battery powered devices. Therefore, a potential higher reliability is ensured through this media despite infrequent failures attributable to battery failure.

By utilizing broadcast of one type or another, overlap coverage can be provided in many instances. If one transmitting station is lost, the area can be covered by another station on the same or a different frequency. Receivers must be designed to accommodate any transmitting redundancy designed into the system.

For these reasons, the broadcast system for alert activation and warning message dissemination would be more survivable than the other two systems.

It must be emphasized that information and instructions must be available to the public even though a nuclear detonation has provided the only alerting. Clear language basic attack data, as well as information on attack effects, must be provided to the public to avoid confusion, anxiety, and panic. This may have to be done even at the risk of disclosing intelligence data to agents of the attacker. Broadcast facilities must be made survivable to provide this information.

D. RELIABILITY

1. General

The warning system must be dependable and reliable. It must not be susceptible to false alarm. The warning generated must be convincing or subject to verification or authentication.

Reliability is essentially a function of system and component design as well as quality of component parts. If a portion of the system is subject to sudden failure, alternate routes or alternate means (system redundancy) may be introduced to back up the unreliable portion. By suitably high quality and sufficient redundancy, reliability can be developed to any desired level in any of the power line, broadcast or wire line systems considered.

2. Comparison

Since a broadcast receiver is of necessity more complex than a NEAR receiver, the cost of achieving comparable reliability between the systems is higher. Reliability becomes a critical factor in warning receivers because of their continuous operation and the large number of sets involved. The radio and TV sets which will be required for receiving a voice message in the NEAR system will have a satisfactory reliability owing to their normal usage in this regard.

During natural phenomena or disasters, radio communications are usually the best means available for transmission and receipt of information primarily due to the reliability of the transmission medium. Sabotage is not considered a significant factor in evaluating any of these systems. However, the addition of a warning mission to any of them would make that system a more likely target for sabotage.

Probability of false alarm is negligible in any of the three systems provided proper design and parameter selection are made. By utilizing broadcast or telephone systems for both alert and voice message dissemination, false alarms occasioned by accident or misunderstanding can be corrected with only minimum delay.

E. READINESS

1. General

The warning system must be a full-period system with the means for generating and disseminating a warning in a state of constant readiness.

2. Comparison

The NEAR and telephone systems have reached such a level of automatic control that little or no attention is required for 24 hour operation. On the other hand, only half the nation's radio stations are licensed for 24 hour operation. Nevertheless, this half provides excellent coverage of the most populous areas.

Again emphasis must be placed on the necessity of coupling NEAR's alerting signal with a voice message. Both require a full-time system, and if radio is to provide the voice message, the readiness requirement must necessarily be extended to broadcasting systems.

All three systems require back-up or overlaps in coverage to ensure against outages and shut downs. The telephone and NEAR systems cannot rely on overlap coverage, and the cost of back-up facilities solely for warning purposes would be prohibitive. Broadcasting stations may have available stand-by transmitters or provide overlap coverage, so that any of several stations could serve any particular area.

F. TIME DELAY

1. General

It is essential that the warning be given with as little time delay as possible. The time required to disseminate the public warning and to provide time to permit the system to achieve designed levels of protection is in part determined by the design of the system.

2. Comparison

Assuming that a survivable alert activation network from the National Warning Center to the local warning centers is used for activating the desired warning system, the difference in disseminating time in any of the systems lies at the local level. If system requirements are met, all elements of the population will be alerted and given voice instructions. There would be little or no difference in time in activation of the alerting signal in the NEAR system and in the radio system. The telephone system would require a slightly longer time if sequential activation is used. Radio and telephone systems could immediately follow the alerting signal with voice instructions over the same device. NEAR would alert the recipients, but voice instructions would be received only upon finding a radio or TV receiver and turning it on. In cases of surprise attack or disasters without warning, this time delay in many cases will be excessive and the effectiveness of the warning system in securing immediate response would be degraded.

G. TRAINING AND EDUCATION

1. General

Training and education are essential elements preceding, accompanying and following the introduction of any of these three methods of disseminating the alert signal and voice message to the public and to organizational elements. A continuous training and education effort to keep the public aware of the current response to the alerting signal will be required. Practice in the desired response would be desirable, but any means of overcoming public apathy would be helpful. Voice messages, which carry more information, are inherently more convincing, and are easily interpreted by the public, should require less educational effort.

2. Comparison

The radio or TV media require but a small amount of preconditioning on the part of the public, since the radio and TV receivers are in everyday use and instructions would be needed only to point out any difference in operating procedures occasioned by the inclusion of an alerting device. The voice message would be designed to be self explanatory. Telephone system design could require the same level of training and education as the radio system.

The NEAR system requires an extensive public relations and education effort to precede and accompany introduction of the receiver. A continuous training and education effort to keep the public aware of the current response to the alerting signal would be required. The radio and telephone systems would require little or no training for the warning system to attract the public's attention and then to instruct them what to do to protect themselves.

III. COST

There are at least nine categories of costs to be considered in evaluating overall costs of a civil defense warning system. These categories are:

- Signal generating subsystem cost
- Signal distribution subsystem cost
- Control or activating signal distribution network cost
- Individual warning receiver cost
- Receiver installation cost
- System operating cost
- Maintenance cost
- System expansion cost
- Administrative cost

A. SIGNAL GENERATOR

Realistic or precise cost analysis requires a well developed system design. The information available on civil defense warning systems permits only a general order of magnitude estimate of the cost involved.

Estimates for the 240 cycle signal NEAR generator equipment range from $3.00 to $4.70 per meter.[1] These estimates appear to be for a minimal system, allowing no back-up equipment to provide for signal coverage during normal maintenance operation. In addition the 255 cycle generating equipment is recognized to be more costly, but no estimates are available as to how much more; however, a figure of $4.00 per meter more is not unlikely.

The utilization of existing telephones involves essentially an added service by an existing utility. Performance of this service would require extensive modification of its central office facilities. A wide range of cost estimates was encountered for making these modifications. OCD contractors who performed the field trials made estimates ranging from $1.80 to $4.35 per phone to modify existing central office equipments.[2] The Bell Telephone Laboratories is quoted as estimating from $40 to $50 per phone for a similar conversion.[3] The average plant investment per telephone in the U.S. is approximately $350 and from 25 to 50% of this is in

1. See Chapter Seven for development of these cost data.
2. Armour Research Foundation, op. cit.
3. Unofficial estimate made to the Office of Civil Defense.

the telephone exchange.[1] If we assume that the modification required to provide the warning signal represents from 10 to 25% of the cost of the exchange, a cost range of $9 to $44 emerges.

Representative of telephone systems which are separate from existing telephones but which may utilize local telephone company lines to reach subscribers are (1) the Bell and Lights system which costs about $15 per installation plus a $5 to $7.50 monthly service charge and (2) the Teleglobe system which costs about $5000 per control center and about $3 per month per subscriber.[2]

B. SIGNAL DISTRIBUTION

By using existing radio facilities the cost of both a signal generating and distribution system is avoided. With a power line system the existing power distribution network is utilized but rather high cost signal generators must be provided. In addition, in this system, other coordinated means must be employed to provide the necessary voice message. Telephone systems generally would use existing wire facilities for distributing warning. However, a separate warning system might require additional wire facilities since many residential areas have no existing spare lines.

C. CONTROL AND ACTIVATION NETWORK

The required signal and voice tie lines between the local warning centers and the signal generators or distributing centers are substantially the same for all systems except that for the power line system essentially a dual network is required, one to the NEAR signal generators and one to the radio stations for the voice message.

D. RECEIVERS

NEAR receivers have been procured in lots of 200,000 at a cost of $10.00 each which represents one of the few relatively well established costs available.[3] This is the factory cost, however, and additional costs must be incurred for distribution of the receivers. These additional costs could easily raise the price to the consumer to $15.00.

The use of existing telephones would require no additional receivers, since individual loudspeaker units could be added to existing telephones. These units would cost about $5.00 each if produced in large quantities. Separate telephone service costs include the necessary receiver as part of the monthly service charge.

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1. Developed from the Statistical Abstract, op. cit.
2. Ira Kamen, op. cit.
3. Department of Defense, News Release #1142-62, op. cit.

The cost of a special radio receiver to be controller by some characteristic signals transmitted by a radio station is the major cost item in such a system. Philco has proposed to build special broadcast receivers for $14.00 each. An SDC estimate of the cost for a sufficiently reliable receiver which would be under positive control of the warning system is from $15 to $20 each, in quantity production. If the necessary feature were added to new entertainment receivers the cost incurred for this feature would be approximately $5 to $10. Recent Congressional action requiring that all TV sets manufactured after June 1963 be capable of receiving the UHF channels could be a precedent for requiring a capability to receive a civil defense warning message.

E. OTHER COSTS

Among other cost items for any system requiring a receiver unit in the house is an installation cost which would average about $3.50 per installation.

With the exception of a separate telephone system, operation and maintenance costs for a warning system should be small since these functions would be performed by existing personnel.

In the case of a radio station the additional equipment is insignificant, but for a power line or existing telephone system whose maintenance would require additional personnel, service rates would be affected. There would be no problem for a separate telephone service offered for a regular charge.

As pointed out in the discussion of the radio and power systems, the cost of maintenance of home receivers is directly dependent on their reliability, and if the sets were inadequate, could result in the establishment of a new repair industry. This is a controllable factor and is common to all systems.

Power line systems are essentially comprised of current generators creating a certain minimum voltage across the impedance existing at the point where each receiver is connected. Therefore, a system of this type is extremely sensitive to changes in load. Hence, every time a new subdivision is opened or a new industrial plant connected, the NEAR generator system would have to be re-evaluated and modified. Since the usage of electric power is doubling approximately every eight years,[1] we can at least expect the cost of NEAR generators to follow the same pattern. Of all the signal distribution systems, only radio is substantially independent of population

1. Edison Electric Institute, Statistical Year Book, op. cit.

growth or shift and at most would require the addition of tie lines to new radio stations. Obviously, new homes would require new receivers in any system.

No determination has yet been made as to how the costs which would accrue to a utility in providing a warning service can be recovered by it. This problem appears to be minimized for the separate telephone service or for the radio system.

It appears that the first cost of a system like NEAR will be about $15 per installation. In 1961 there were slightly more than 60 million ultimate customers of electric utilities including Alaska and Hawaii[1] (52.6 million residential or domestic, 7.4 million commercial and industrial). According to the growth rate of electrical power customers (the total doubles every 27 years), this number can be expected to reach about 70 million by 1970. On this basis we can expect an initial investment of about $960 million which would expand to about $1.75 billion by 1971, including about $12.5 million per year system maintenance cost and 10% replacement cost of receivers. At this rate, to be equal, the average ten year cost for any other system could be at least $20 per installation. Thus, if the telephone plant could be converted for a cost of $20 per subscriber, it would give somewhat less coverage but would provide the required voice message capability. At $20 per receiver the cost of radio would be slightly less than the cost of NEAR over a 10 year period, since other costs are minor. For example, the cost of signal generating equipment would be less than $2 million, and even if it were necessary to subsidize some stations for the cost of a stand-by operator during the night hours (say 400 out of the total of 1900 full time stations at $6000 per year), this cost would be only $2.4 million per year. This amount is about the same as that of the annual engineering cost required to handle expansion problems for the NEAR system.

IV. OTHER CONSIDERATIONS

In the implementation of public warning devices on the scale conceived (i.e., in every household and business establishment), certain problems are encountered in the administrative, economic, legal, and public relations aspects of the program. Radio and TV sets are sold commercially to the public so they can receive entertainment, news, and educational programs broadcast by stations in their area. Telephones are installed under contract by the telephone companies to subscribers for person to person, place to place and various combination communications. Electric power is provided by utility companies under contract to a subscriber for the operation of any or all devices, machines, etc. in the subscriber's location. However, no precedent has yet been set for selling an alerting or warning device to a subscriber.

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1. Statistical Abstract, op. cit., p. 535

If the subscriber is to pay for this device through direct purchase or routine billing, he must be convinced of his need for such a device, be willing to pay the price set, and be convinced of the necessity of keeping it in operational condition. The problems involved in meeting these three conditions are innumerable. If the decision to acquire a receiver is left to the subscriber, it will be impossible to obtain the coverage required. However, if the device were an integral part of either a radio or TV set purchased or of a telephone or electric service contract, the acquisition of the device could be painless and maintenance could be handled in a routine manner.

If a telephone system warning receiver were included in telephone service contracts as part of the normal installation for a subscriber, special attention would be required for providing warning coverage where telephone coverage is not on a family basis. Normal telephone company business office and maintenance service would take care of most administrative and maintenance details. Legal problems again would be minimal, since the current Bell and Light warning system is operationally a part of the telephone service offered for special subscribers.

Electric service contracts could also include a warning receiver as part of the normal power installation. However, the fact that the receiver could be out of order and power still be provided would not motivate the subscriber to get immediate maintenance service. However, if the TV set is inoperative or the telephone out of order, family pressures encourage immediate maintenance service. An additional consideration is the fact that electrical utilities are not called on the failure of an electrical appliance or device. Calls for service of this type are made to electricians and not the utility itself. Thus, installations and maintenance of the receiver by the electric utility company would not normally be a routine matter, but would require special arrangements.

Administrative arrangements for billing, etc. could be routine. No precedent has been set for use of electric power for warning, so more legal problems are present in implementing the NEAR system than in the other two systems. In fact, the NEAR system presents problems of installation, maintenance, public relations, and legal liabilities that are far greater than those of either of the other two systems.

The public relations program necessary for gaining the public acceptance of household warning devices is worthy of discussion. During periods of crisis, when the public's interest in their own survival is heightened, the demand for an individual household warning device will be high and price and aesthetic aspects might be somewhat overlooked. However, in peacetime or on return to normalcy, the warning devices must become an integral part of the household furnishings and way of life to gain true acceptability. The inclusion of the device into the design of a radio or TV receiver would provide a continuous sale, in peacetime or crisis. The telephone system device also provides continuous availability. A power line device or a special broadcast receiver, as separate plug-in devices, will need to gain this acceptability and will require a harder selling job than the devices located in broadcast or telephone receivers.

One additional problem with power line systems is that of liability for a false alarm. As was indicated earlier, the probability of a false alarm on a system utilizing a signal only is greater than over a voice dissemination system.

Public utilities may be reluctant to accept the use of a signalling device if adequate legal safeguards are not provided against liability for false alarms and subsequent accidents.

V. SUMMARY

Seven basic conclusions may be derived from the evaluations considered within the report and summarized in Figure 7. These conclusions are:

1. All systems analyzed could be made capable of reaching the indoor and outdoor populace. However, the radio system is the most feasible for reaching the 10 to 25% transient population.

2. Current power line systems (e.g., NEAR) are incapable of transmitting a voice message requiring validation of the warning by other means, and incapable of being tested without compromise.

3. The radio and telephone systems have the greatest possibility of fast, unified alert and warning.

4. The radio, telephone, and power line systems are decreasingly survivable in that order. Power line systems are less survivable because they are dependent on 60 cycle power both at the signal generator and at the receiver.

5. The radio system is the only system not requiring change or expansion to meet population changes or growth.

6. The legal and implementation problems of a power line system and the system using existing telephone lines and instruments are greater than the private wire telephone system and the radio system.

7. Analysis indicates that ten year costs of utilizing individual or private wire systems are prohibitively expensive. Power line systems, radio systems, and systems using existing telephone lines and instruments are progressively less costly in that order.

VOICE MESSAGE	NONE	GOOD	VERY GOOD	EXCELLENT
VALIDITY OF WARNING	REQUIRES VALIDATION	SELF VALIDATING	SELF VALIDATING	SELF VALIDATING
ABILITY TO TEST WITHOUT COMPROMISE	POOR	VERY GOOD	GOOD	GOOD
GROWTH POTENTIAL	GENERATOR SYSTEM REQUIRES CHANGE WITH GROWTH OF POWER SYSTEM AND POPULATION	PLANT MUST EXPAND WITH POPULATION	PLANT MUST EXPAND WITH POPULATION	TRANSMITTER SYSTEM PRACTICALLY INDE-PENDENT OF POPULATION GROWTH
IMPLEMENTATION PROBLEMS				
LEGAL	MANY	SOME	NONE DISCERNIBLE	NONE DISCERNIBLE
RATE CHARGES	UNRESOLVED	UNRESOLVED	NONE	NONE
RECEIVER DISTRIBUTION & INSTALLATION	UNRESOLVED	NONE	UNRESOLVED	UNRESOLVED
PUBLIC ACCEPTANCE OF RECEIVER	UNKNOWN	EXCELLENT	UNKNOWN	UNKNOWN
COST: INITIAL & RECURRENT				
NUMBER OF RECEIVERS, BEGINNING AND END OF PERIOD	60-70 MILLION	50-60 MILLION[1]	60-70 MILLION	60-70 MILLION
SIGNAL GENERATORS	$4/METER $240 MILLION	$20/SUBSCRIBER 1.0 BILLION	INCLUDED IN[2] SUBSCRIPTION COST	$2 MILLION
SIGNAL DISTRIBUTION FACILITIES	EXISTING POWER LINE	EXISTING TELEPHONE LINES	LEASE FROM COMMON CARRIER	FREE SPACE
SYSTEM ENGINEERING	$3.0 MILLION/YR	INSIGNIFICANT	INCLUDED IN SUBSCRIPTION COST	INSIGNIFICANT
SYSTEM MAINTENANCE	$2.4 MILLION/YR	$10 MILLION/YR	INCLUDED IN SUBSCRIPTION COST	INSIGNIFICANT
RECEIVER COST (MANUFACTURE & DISTRIBUTION)	$15 EACH $900 MILLION	NO ADDITIONAL CHARGE	INCLUDED IN SUBSCRIPTION COST	$20 EACH 1.2 BILLION
RECEIVER INSTALLATION	$210 MILLION	NONE REQUIRED	INCLUDED IN[3] SUBSCRIPTION COST	$210 MILLION
RECEIVER MAINTENANCE	$4.75 MILLION/YR	NO ADDITIONAL CHARGE	INCLUDED IN SUBSCRIPTION COST	$1.7 MILLION/YR
ADMINISTRATION	UNRESOLVED	UNRESOLVED	INCLUDED IN SUBSCRIPTION COST	INSIGNIFICANT
OTHER COSTS	NONE	NONE	NONE	$2.0 MILLION/YR (NIGHT OPERATORS)
10 YEAR COST[4]	$1.98 BILLION [5]	$1.31 BILLION	$23.4 BILLION[6]	$1.68 Billion

1. BASED ON ESTIMATED NUMBER OF TELEPHONE SUBSCRIBERS
2. $30 MILLION
3. $210 MILLION
4. SEE APPENDIX D FOR DERIVATION OF 10 YEAR COST
5. IN ADDITION TO THE LISTED CHARGES, THE NEAR SYSTEM MUST ALSO SUPPORT AN ADDITIONAL VOICE NETWORK TO TRANSMIT THE WARNING MESSAGE FROM LOCAL WARNING CENTERS TO ONE OR MORE LOCAL RADIO STATIONS
6. COST BASED ON $36/YR SUBSCRIBER CHARGE

* TESTING AND TRAINING ISSUES ARE CONSIDERED GENERICALLY RATHER THAN FOR SPECIFIC SYSTEMS.

Figu

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REQUIREMENTS AND COSTS *	TYPES OF WARNING SYSTEMS: POWER LINE SYSTEM, e.g. , NEAR	TELEPHONE SYSTEM USING EXISTING LINES AND INSTRUMENTS	PRIVATE WIRE TELEPHONE SYSTEM USING SPECIAL PURPOSE RECEIVER BY SUBSCRIPTION e.g. , TELEGLOBE	RADIO SYSTEM
POPULATION COVERAGE INDOOR	VERY GOOD	GOOD	VERY GOOD	VERY GOOD
OUTDOOR (WITH APPROPRIATE AUXILIARIES)	GOOD	GOOD	GOOD	GOOD
TRANSIENT (IN VEHICLES)	NONE	NONE	NONE	GOOD
RELIABILITY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
SURVIVABILITY	FAIR	GOOD	GOOD	GOOD
SABOTAGE	NOT CONSIDERED A UNIQUE PROBLEM			
FALSE ALARM PROBABILITY	LOW	LOW	LOW	LOW
QUALITY OF WARNING				
UNIQUENESS OF SIGNAL	GOOD	FAIR	VERY GOOD	EXCELLENT
ABILITY TO DISSEMINATE VOICE MESSAGE	NONE	GOOD	VERY GOOD	EXCELLENT
VALIDITY OF WARNING	REQUIRES VALIDATION	SELF VALIDATING	SELF VALIDATING	SELF VALIDATING
ABILITY TO TEST WITHOUT COMPROMISE	POOR	VERY GOOD	GOOD	GOOD
GROWTH POTENTIAL	GENERATOR SYSTEM REQUIRES CHANGE WITH GROWTH OF POWER SYSTEM AND POPULATION	PLANT MUST EXPAND WITH POPULATION	PLANT MUST EXPAND WITH POPULATION	TRANSMITTER SYSTEM PRACTICALLY INDEPENDENT OF POPULATION GROWTH
IMPLEMENTATION PROBLEMS				
LEGAL	MANY	SOME	NONE DISCERNIBLE	NONE DISCERNIBLE
RATE CHARGES	UNRESOLVED	UNRESOLVED	NONE	NONE
RECEIVER DISTRIBUTION & INSTALLATION	UNRESOLVED	NONE	UNRESOLVED	UNRESOLVED
PUBLIC ACCEPTANCE OF RECEIVER	UNKNOWN	EXCELLENT	UNKNOWN	UNKNOWN
COST: INITIAL & RECURRENT				
NUMBER OF RECEIVERS, BEGINNING AND END OF PERIOD	60-70 MILLION	50-60 MILLION[1]	60-70 MILLION	60-70 MILLION
SIGNAL GENERATORS	$4/METER $240 MILLION	$20/SUBSCRIBER 1.0 BILLION	INCLUDED IN[2] SUBSCRIPTION COST	$2 MILLION
SIGNAL DISTRIBUTION FACILITIES	EXISTING POWER LINE	EXISTING TELEPHONE LINES	LEASE FROM COMMON CARRIER	FREE SPACE
SYSTEM ENGINEERING	$3.0 MILLION/YR	INSIGNIFICANT	INCLUDED IN SUBSCRIPTION COST	INSIGNIFICANT
SYSTEM MAINTENANCE	$2.4 MILLION/YR	$10 MILLION/YR	[illegible]	

Figure 7. Comparative Evaluation of Warning Systems

CHAPTER NINE

ANALYSIS OF THE ATTACK WARNING SYSTEM

I. INTRODUCTION

The purpose of this chapter is to consider the present Attack Warning System (AWS). The chapter will define and evaluate the present capabilities of the system in light of the performance requirements set forth earlier and indicate where inadequacies exist. Modifications of an immediate nature which are intended to improve system effectiveness and which will provide the system with a minimum operational capability will be discussed in Chapter Ten.

Appendix A, the Description of the Civil Defense Warning System, contains detailed information pertinent to Attack Warning System operation. Appendix B, the Warning System Environment, describes the environment within and around which the warning system operates. Both appendices and the system requirements outlined in Chapter Five are utilized in the analysis of the current system. Data for this analysis have been obtained from observation of system operation, facility visits, discussions with experienced personnel, and analyses of data obtained through various exercise programs.

II. SYNOPSIS OF OPERATION

A. ORGANIZATION

The Attack Warning System consists of four organizational levels - national, area or regional, state, and local. These levels are connected through a full period voice wire line network. The network subscribers are: the National Warning Center at Colorado Springs; OCD attack warning centers at NORAD regional facilities; and some 500 Federal and state warning points located in major population centers and Federal facilities throughout the U.S.

B. RESPONSIBILITIES

Warning responsibilities are jointly vested in Federal, state and local governments. These responsibilities were stated in Annex 13 of the National Plan as follows:

> "The Federal government is responsible for establishing and maintaining a national warning system, for declaring and disseminating warnings to State governments and, by special arrangements, directly to political subdivision, and for assisting State and local governments in warning the people.

State and local governments are responsible for establishing and maintaining warning systems, for disseminating warnings and other emergency information throughout their political jurisdictions, and for prescribing the action to be taken by the respective governments and the public upon receipt of warning." [1]

C. WARNING SYSTEMS IN USE

The National Warning System (NAWAS) utilizes telephone circuits to disseminate the warning messages from a National Warning Center and OCD to the state and local points which monitor the full period warning circuit 24 hours a day.

The initiation of the attack warning is from the National Warning Center in Colorado Springs, Colorado. A voice warning message is disseminated without relay or intervention to the warning points within the states. These warning points relay and further disseminate the warning to some 5,000 local warning points by various methods. Subsequently the local warning points activate devices which provide alerting signals to the general public.

State and local warning systems vary. Primarily they consist of public service radio networks whereby the state warning point, often the highway patrol headquarters, will relay warning on to its substations (some of which may already be on the NAWAS network as warning points). At these locations, additional radio networks or the telephone are used to disseminate the warning to the local warning points. Local warning is provided primarily by the siren and, in a few cases, outdoor voice warning systems.

D. DISSEMINATION PROCESS

The dissemination process from the National Warning Center to the warning points on the full period wire network takes approximately one minute, depending upon warning message length. The warning consists of an announcement stating the following: 1) declaration of air raid warning, 2) appropriate statement concerning the cause, 3) statement to stand by for warning times, and 4) an acknowledgement. Once initiated, the warning flow is intended to be, and normally is, automatic to the warning point level. Interventions to the dissemination process are possible at attack warning center level if, for example, appropriate switching

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1. Office of Civil and Defense Mobilization, The National Plan for Civil Defense and Defense Mobilization; Annex 13, Warning, September 1959, p.2.

actions have not been taken to interconnect the warning circuits. A description of the means by which warning circuits are interconnected may be found in the Description of the Civil Defense Warning System (Appendix A). Intervention is also possible at state level by another switch action. At the state level, interruption of the warning flow must be deliberate, as the switches concerned are spring loaded and the warning circuit within the state is normally connected to the area warning circuit.

E. SUMMARY OF OPERATION

After certain NORAD declarations about the Air Defense situation have been made, the OCD attack warning officer, located in the NORAD Combat Operations Center at Colorado Springs, would call for a connection of the warning circuit. To accomplish this he would use the control circuit to call all OCD attack warning centers. After the warning circuit has been connected he would disseminate the attack warning message to the warning points on the network. These warning points, located in all major metropolitan and industrial areas, would either activate local warning devices (only 28% had this capability in 1961)[1] or further disseminate the warning message to local warning points in the area.

As an example, assume that the warning point for a state is a state highway patrol headquarters in a major city. Upon receipt of the warning over the Federal portion of the system (NAWAS), the highway patrol would further disseminate the warning over the state public service radio network to other cities and points within the state. Upon receipt of the warning from the highway patrol, the local points would either activate local alerting devices or further disseminate the warning to the facilities where controls for public alerting devices are located. The method of relay is by voice over radio or telephone lines, or by signalling system such as Bell and Light. The Bell and Light system is activated at the warning point with an appropriate code after receipt of the voice warning message over NAWAS and the receiver of the Bell and Light signal would activate the sirens.

III. ANALYSIS OF THE SYSTEM

A. GENERAL

Any system may be composed of many elements or sub-systems. The component parts of the system are interrelated through disciplines or procedures; these are the means by which the sub-systems function together. The elements of the Attack Warning System are the Federal,

1. Office of Civil and Defense Mobilization, Annual Statistical Report, Battle Creek, Michigan, June 30, 1961, p. 76.

state and local parts of the system. The physical components are NAWAS (consisting of voice wire lines); radio (which is generally the means to disseminate warning within the states); and telephones, sirens, and public address systems at the local levels. The three sub-systems in the AWS are directly controlled and administered by the political subdivision within which each falls. Consequently, rather than interact in a normal fashion, they often tend to isolate themselves along geopolitical boundaries, thus allowing only a minimum of interaction and coordination among them. NAWAS, the Federal portion of the AWS, acts as the operational interface between the systems as it extends from the national to the local level.

B. ORGANIZATION

The Attack Warning System (AWS) lacks a cohesive, coordinated organization. At all levels there is need for establishment and standardization of appropriate and timely procedures. The total system is not well trained nor supported to provide more than a minimum degree of capability or effectiveness in its role of providing warning to the public. At best, the system as it exists can provide only an alerting signal and not the necessary warning information needed to attain suitable protective measures. Of the three sub-systems making up the overall attack warning system, the Federal portion (NAWAS) comes the closest to fulfilling some of the basic requirements for a warning system. It has organization and basic procedures, and is a full period system operational 24 hours a day. A distinct capability of NAWAS is that it provides voice warning, if not to the general public, at least to organizational elements at state and local levels. Another is that it provides instantaneous warning, that is, once circuit connections are made, the warning message flows unhindered and without interruption directly to the local level.

C. OPERATIONS AND PROCEDURES

1. NAWAS

NAWAS, as indicated earlier, extends into the states and the cities within the states. However, Federal control and establishment of rigid operational standards and procedures does not extend into the states. For example, state warning points are provided with spring-loaded foot disconnect switches allowing the state warning point to disconnect the state portion of NAWAS from the Federal circuit. This is not necessarily a bad feature, but does require standardization and rigid procedures to ensure continuous capability and effective operation.

The Attack Warning System is extremely vulnerable to either sabotage or to a direct attack and provides little assurance of its capability to provide post impact warning or warning of attack effects. Intervention points within the system are capable of modifying and even stopping the flow of the warning message.

The procedures for the declaration of the initial Air Raid Warning are not clear cut and as well defined as they could be. Procedures written in operational manuals are often descriptive and informative, but not explicitly directive in nature. The decision to warn the civilian population is dependent upon certain decisions which are made by the NORAD military command. The same factors do not necessarily apply in warning military and civilian organizations and the military/civilian interface is not clear in relation to those factors affecting the decision to warn.

The Attack Warning System does not provide means for disseminating hard copy warning messages. By observation of exercises, it was noted that warning messages, as they are received in OCD attack warning centers or state operational headquarters, must often be copied by hand for a permanent record. This practice significantly curtails the operation of the warning center. Operations personnel must talk slowly, manually record, often repeat messages, clarify verbal misinterpretations, and, in general, expend a significant quantity of time in the passage and receipting of warning information passed on NAWAS.

2. State and Local Systems

Warning systems within the states include all feasible means for further distributing the warning. In general, these systems require from 1 minute to 10 minutes or more to disseminate the warning to local warning points. There is little or no standardization of procedures or methods, and local circumstances often dictate the means and methods for passing warning more than do operational requirements.

The local warning system generally consists of sirens. Sirens provide the two public action signals and are activated normally at a central location upon the receipt of air raid warning information. This information can be supplied directly by NAWAS if the NAWAS point and the siren control point are the same. Otherwise, these facilities are provided warning via telephone, public service radio, or the Bell and Light signalling device. Upon receipt of warning, the local point will either immediately activate the sirens or, if procedures so state, will receive local approval to activate the siren. Once this approval has been obtained, sirens may be activated in the local community. Siren coverage varies from zero in some cities to 100% in others. In locales which have had training and appropriate public conditioning, sirens may provide adequate alerting. For areas which have not had any conditioning or have been subjected to compromising or false alarm situations by sirens, the sirens do not even provide a sufficient alerting capability.

In far too many cases the procedures found at the local warning point level indicate that the only appropriate response upon receipt of either a voice warning message or a signalling alert from another level, is to substantiate or validate the signal from either the sending source or another source. The activation of the local alerting devices is too often entirely dependent upon the approval of a local authority. An example of this was found in a major metropolitan warning point jointly run by city and county authorities. At this facility, approval to activate alerting devices must be obtained from two separate local authorities even though the warning message was received directly from NAWAS and the activation controls were physically in the same room. It is obvious what this type of situation at the local level means in terms of providing timely warning to the general public particularly in the critically short warning time periods.

D. CAPABILITY LEVELS

The level of capability of the systems varies considerably. Generally, the Federal level utilizing NAWAS maintains a minimum operational capability at all times to provide voice warning to lower organizational levels. The system is vulnerable to sabotage or attack damage, however, and does not assume any aspects of a distributed network.

It is interesting to note that throughout the Federal portion of the system a great deal of dependence is placed upon the voice warning that NAWAS provides. The validity of signalling systems is often questioned; however, the NAWAS voice warning is never questioned as to its intent, specific meaning or validity such as are the signalling systems in existence today. Signalling systems presently in use are not valid sources of warning information for the public. These systems are oftentimes subject to false alarms, and do not supply the necessary quantity of information or provide validation of their specific intent.

E. PUBLIC ACTIONS

According to the National Plan, states have the prerogative of specifying the actions to be taken upon the receipt of warning. In some areas, although the national Air Raid Warning has been passed to cities within the states, the cities are unable to take any action until the state has verified and authenticated this warning, assessed the degree of imminence, and determined the appropriate public action signal to be utilized within the state.

The general public is expected to take appropriate actions upon hearing one of the two public action signals by a siren. Yet, in those situations wherein local warning points are given warning by a signalling device (e.g., Bell and Light), rarely will any action be taken until there is a verification of the meaning of the signal. The NAWAS portion of the Attack Warning System since its inception has recognized the need and the usefulness of providing voice warning. NAWAS would not be nearly as effective a tool for the dissemination of a national alert and warning if it utilized only coded signals.

CHAPTER TEN

IMPLEMENTATION

I. SCOPE OF THE IMPLEMENTATION TASK

A. PURPOSE

The goal of the DOD-OCD warning program must be the fulfillment of the basic warning requirements established in Chapter Five of this report. These basic requirements were considered again in Chapter Six in light of a practical and feasible operational capability to perform the system mission and system characteristics, and operational and communication requirements were specified. These characteristics and requirements form the foundation upon which implementation plans may be constructed. The steps in the development of these implementation plans are as follows:

1. Providing a firm basis and support for a long range warning program.

2. Providing effective conditioning and training of the public.

3. Development and installation of a feasible warning system geared to meet the requirements of the late 60's and early 70's.

Implementation is concerned with the evolution and time phasing of modifications, improvements, and innovations to the warning system so as to achieve effective system operation. The implementation program must be both reasonable and practical. It must consider any benefits obtainable through the utilization of elements of the present system. It must also consider the relative costs of various approaches, and if need be, temper overall program goals in light of other civil defense requirements of the time period (e.g., the shelter program).

B. LONG RANGE PLANS

The first basic requirement is the establishment of a long range program for warning. This program must be as long-term and well-defined as is the shelter program. These programs are coordinate in that the existence of one does little good without the existence of the other. Shelter, as a level of protective measures, is an objective of the warning program. Presently there is more capability for warning than for shelter, and as the capability of the nation in providing shelter increases, so, too, should the capability of the warning system increase to provide effective warning.

The types and levels of protective measure that can be taken are closely associated with the length of warning time provided. Without warning, little advantage can be taken of protective measures. During time periods when the shelter program is degraded, an adequate, large scale warning system becomes even more important to provide the public time for shelter improvisations prior to the attack. As shelters increase in quantity and proximity to the public, it is possible that growth of the warning system may level off. This must not occur before the system can provide the public with at least the minimum time required to effectively utilize available shelter space.

It is not reasonable to assume that an effective and reliable attack warning system for the nation can be developed on the basis of the overall civil defense posture of the past 10 to 15 years. If the governmental responsibility to provide warning to the general public is a valid concept, then a more adequate long range program should be developed. If the concept is not valid and little or nothing can be done toward a new system, then the existing system should be extended, modified, and maintained in the best manner possible.

The requirements developed in this study outline the ultimate and proximate goals for the DOC-OCD warning program for the next ten years. Rather than operate on a year-to-year basis, with an occasional added impetus each time an international crisis develops, a stable program should be established resulting in a systematic and logical progression toward the defined goals.

An all-important element in this first step toward an implementation program is the realization that for the foreseeable future a warning system capable of providing attack warning and warning of attack effects to the general public is a necessity.

C. CONDITIONING THE PUBLIC

Public conditioning is another basic step in achieving a successful warning system. Warning without reaction on the part of the recipient is not warning at all. Public confusion and apathy must be eliminated from the overall program. Education, training, and a comprehensive conditioning of the public to the necessity and benefits of an effective warning program are vitally necessary.

Warning programs and shelter programs must be developed hand in hand with public education and training. Public apathy, often mentioned in connection with the civil defense program, may not be as important as is public confusion and lack of awareness and understanding of what is really required. For these reasons, education of the public is required as an ongoing activity throughout the entire life of the civil defense program.

II. IMPLEMENTATION PLANS

A. GENERAL

A specific plan for the evolution of the civil defense warning system is dependent on a number of factors which are unknown at this time. Among these are the following:

1. The annual budget level which will be available for this purpose.

2. The results of present and future research studies which will influence the system configuration.

The principal purpose in this study was to determine warning requirements. Recommendations have been made as to those feasible systems which would satisfy the requirements. The Implementation plan, in dealing with only feasible systems, must be careful in the degree of detail it attempts to set forth. In addition, any implementation plan must be evolutionary rather than revolutionary. For these reasons, the plan which follows is divided into three phases.

<u>Phase 1</u> is concerned with immediate changes, essentially organizational and procedural, which will make most effective use of existing facilities and in addition is concerned with the initiation of plans and studies to carry out the complete program.

<u>Phase 2</u> outlines the steps to be taken to achieve an interim improved system capability.

<u>Phase 3</u> sets forth the steps to be taken to achieve all of the requirements set forth in this report.

Further research and development work required for ultimate system design is outlined as a part of Chapter Thirteen.

B. PHASE 1 - IMMEDIATE MODIFICATIONS AND IMPROVEMENTS

1. <u>Introduction</u>

In Phase 1 modifications would be made to the present Attack Warning System to obtain a minimum essential capability to provide warning. Plans and studies should be started which will lead ultimately to a system which satisfies the requirements set forth in this document. Even though initiated in Phase 1, some of the investigations discussed below are applicable to and should therefore be actually completed in Phases 2 or 3.

2. Organizational and Procedural Modifications

Organization of the warning system to attain the specified requirements must start early and be constantly directed toward the program goal. Concurrently with organizational changes, changes in operational procedures will be required. Some of these procedures, although considered immediate, will perhaps carry over to later phases.

a. Establish Organization Structure

Certain basic organizational levels are obvious from the operational requirements. These are a National Warning Center, intermediate centers, and local warning centers.

1) The National Warning Center

The level presently most capable of performing its designed function is the National Warning Center. This facility should gradually increase its operational functions for overall system control for nuclear attack warning, providing means by which voice warning may be disseminated directly to the public, coordination and direct interaction with the military, as well as analytic and liaison activities required after attack on the nation.

The NORAD COC is the focal point for the National Warning System as well as for North American Aerospace Defense. As such, this facility would be a target for maximum enemy effort intended to destroy its command and control capabilities. As indicated in the operational requirements, an alternate national civil defense warning center is required to assume command and control responsibility in case the COC is destroyed.

The Washington Area Control Point, by reason of its physical location, is a logical choice for an alternate center. Here it would have access to attack and attack effects data which will form an important part in post attack warning; be close to other relocated governmental command and control operations; and be located where the interchange of information could be mutually beneficial. The Washington Area Control Point is near the facility that is the focal point for damage assessment information and which has a computer available for processing this data. The Washington Area Control Point is in a survivable location with survivable communications and is presently staffed for local warning functions. A transition to operational capability as an alternate National Warning Center would involve minimal capital outlay. If it is deemed infeasible to utilize the Washington Area Control Point for an alternate National Warning Center, the existing NORAD ALCOP should be designated and utilized for that purpose.

2) Local Warning Centers

The second essential organization level is the local warning center level, which may comprise a city or a county or even a group of counties. If at all possible, the local warning level should not be tied to a political entity, thus allowing greater freedom of action and minimizing local political control.

The local level is required to perform supplementary and amplifying warning tasks in the initial attack warning phase and to supply the basic data for attack effects evaluation and warning. Of the 403 civilian warning points reported in the OCDM Annual Statistical Report published in June, 1961, 310 were located in state police or city police departments, 42 in city fire departments, 36 in sheriffs' offices, and only 8 in state civil defense offices.[1] Civil defense, like air defense, must be a 24 hour a day operation.

Local warning centers having the capabilities detailed in previous sections do not presently exist. A number of warning points do exist which are terminals of the NAWAS circuit and which are manned 24 hours a day. Some of these points have the ability to activate warning devices directly and some have extensive ties to local civil defense organizations, local governmental offices, local radiation detection and monitoring facilities, state civil defense organizations, and other local warning points. Where such warning points exist, they need only implement changes to bring the local warning center into existence. Other communities or areas may have to inaugurate such centers. A local civil defense emergency operating center (EOC) would be the best facility, since it would be survivable and coincide with civil defense operations. If this is not possible, Fire department facilities capable of providing its occupants with fallout shelter protection would be an

1. Office of Civil and Defense Mobilization, Annual Statistical Report, Battle Creek, Michigan, June 30, 1962, p. 76

alternative. Some advantages accruing from such an installation are:

a. A 24 hour operation and coverage.
b. Trained men oriented for emergencies.
c. Established fire circuits and communications that could be easily expanded to send or receive information from many areas.
d. Vital concern for attack effects data related to fire operations.
e. Time available for training in warning procedures as well as radiation assessment; that is, firemen are not constantly as busy as are policemen.
f. Involvement of the public spirited persons already in volunteer fire companies.

3) Intermediate Levels

Although the national and local warning center levels are the only two having a specific decision-making responsibility, there are requirements for intermediate organizational levels in the warning system structure. Intermediate levels must encompass all activities not covered by the national or local warning centers.

The functions of an intermediate level are more difficult to isolate and specify than are local and national functions since the intermediate level does not normally have critical decision-making responsibilities. The responsibilities of intermediate centers include many functions also performed by the Federal, regional, and state facilities. Therefore, state and Federal activities, in some cases, could be housed in joint use facilities, thus reducing costs. Six of the intermediate centers should be located proximate to existing NORAD regional facilities for area military-civilian liaison activities. Survivability should be a consideration. Within a group of several states where geographic and environmental conditions are similar, a single intermediate center may be sufficient to coordinate activities and summarize information collected at lower levels.

Intermediate centers capable of fulfilling the operational functions as they are described in this report do not exist. A few states have an operational civil defense headquarters geared for emergency operations, but many of the functions are either provided by OCD regional offices or attack warning centers, or are not being performed at all.

Certain of the intermediate centers, normally those proximate to NORAD regional facilities, may be used as key centers. In addition to performing all the functions of an intermediate center, they would interact directly with the NORAD regional facilities, and could, if required, function in a limited capacity for a National Warning Center. To provide necessary civil-military interactions and to provide liaison between the NORAD regions and the key intermediate centers, a contingent of Federal personnel should be located at these centers.

b. Implement Appropriate Organization Manning

Attack warning centers as they exist today must be manned to provide a minimum operational capability immediately. There is no reason to believe that the quantity of information to be handled or the volume of work load for certain warning centers will be significantly less than for others. System exercises have demonstrated the need for a staff of no less than two fully qualified operators at each facility. These are required in order to adequately cope with the pre-attack and attack situations and to handle the quantity of information and interactions required with the military and NAWAS units. In the event of a no notice strike on the U.S. during other than normal duty hours, the present civil defense warning system would not be able to handle the transfer of information required at the area level. The optimum is full warning center manning (sufficient for 24 hours a day, 365 days a year), and the required absolute minimum is sufficient personnel to provide two persons on duty at all times during periods of increased readiness.

c. Revise Warning System Operational Procedures

The operational procedures presently outlined in the Federal Operations Manual and State and Local Procedures (Appendix 1 to Annex 13) should be reviewed for adequacy in light of the current and projected threat, and revised as necessary. Specific items to be considered are:

1) Responsibilities and authorities of warning center personnel.
2) Message reporting procedures and formats.
3) Use of pre-recorded messages for dissemination to the public.
4) Development of warning checklists and standard operating procedures.

5) Standardization of aids and maps at all levels of the system.

In addition, procedures should be specified for the collection, assessment, and reporting of information concerning biological and chemical agents, as well as radiological hazards to the warning organization and to the public.

d. Establish Alert Conditions for Civil Defense

The establishment of a Defense Readiness Condition (DEFCON), as utilized in the NORAD structure, is an action taken to bring the Air Defense system to a desired readiness posture to meet possible contingencies. DEFCONs provide a means whereby the military may increase readiness by using standardized check lists. The checklists provide commanders at all levels with guidance as to what activities must be expanded and which ones must be curtailed based upon the situation at hand.

The Federal portion of the Attack Warning System has thus far utilized military DEFCONs to the extent that they are passed to the OCD regional facilities. At a certain level in the DEFCONs, governors and state civil defense organizations should be notified. However, the military and OCD regions could have been on an increased alert for hours or days, and the states and their civil defense organizations might be totally unaware of this situation.

The need for alert conditions (ALCONs) at the Federal, state and local level is apparent. States presently have no standardized means whereby they may gradually increase their alert status; therefore, the need for ALCONs, separate from the military DEFCONs at Federal facilities, appears to be warranted. System exercises have indicated that military DEFCONs do not always meet the needs of OCD personnel. It is important that any system of ALCONs developed for civil defense usage be standardized and universal in its application. Using one system for Federal purposes and another for the states, or separate systems for each state will not work. The system must be standardized and applicable for all levels. Future system exercises, by providing realistic situations in a real time environment, will assist greatly in determining the specific scope and level of civil defense alert conditions.

e. Maintain Civilian Control

Military forces have the mission of protecting the population of our country against enemy attack. Detection systems have been implemented to give notice to the military forces so that they can react to an enemy attack and protect our population. Military actions are designed to accomplish their mission under emergency conditions. Civil defense functions of warning as well as those associated with recovery and rehabilitation are of interest to the military when there is a possibility of a conflicting situation which might compromise their mission. An organization capable of guiding the public in their activities, assisting them in helping themselves, and not making unnecessary demands on the military forces, is required. A subjective impression as an outgrowth of this study is that control of this organization must be in civilian hands if the opinions and needs of the population are to receive proper recognition. Civilian requirements cannot be relegated to a secondary role, as it is likely to be the case if they were added to the overall mission of the military forces.

Military operations require control of information regarding destruction received from enemy action, movements of friendly forces, and present environmental conditions. The civilian population needs warning and information about attack effects so that protective action can be taken to offset radioactive fallout and the spread of chemical and biological agents. There might be a definite conflict of interest in the release of this type of information where military censorship operates. Thus, it appears that civil defense public warning information should be handled by responsible civilians whose prime interest is the survival of the public.

f. Consolidate System Operational Functions

Warning and associated functions at OCD regional level and area attack warning centers should be combined to promote greater efficiency and effectiveness. The present location of administrative, logistical, and certain training and maintenance functions at regional level, while warning system operations are vested in area attack warning centers, does not promote the most effective operation of the system.

The warning function, and functions which must utilize the warning system, should be combined into a single operational unit. This organization, under the auspices of a single head, would provide a contingent of personnel to the NORAD regional facility for manning of the warning center. Functions within this operational organization would include the following:

1) Warning of attack, attack effects (CBR) as applicable, and natural disasters.
2) Communications
3) Damage assessment
4) Operational intelligence
5) Operations training
6) Emergency information
7) Inspections and evaluations

3. Communications and Facilities

Concurrently with the organizational and procedural modifications discussed above, the following improvements and modifications to communications and facilities must be implemented.

a. Provide Local Civil Defense Broadcast Capability

Since the effectiveness of warning is dependent upon the quantity of information it imparts, the coverage attained, and the response generated, the warning message must provide essential information in minimum time. To give the present system a capability to do this requires the utilization of the commercial radio broadcast system.

A method whereby a warning message could be provided to the public simultaneously with the normal alerting signals is to utilize certain of the 24 hour commercial radio broadcast facilities in the major urban and target areas as warning points on the Federal warning circuit (NAWAS). Commercial AM and FM radio broadcast stations alerted to CONELRAD by the AP or UPI teletype news service networks totaled 337 in the continental U.S. as of 1 January 1962.[1] These stations, all operating 24 hours a day, are located in 175 of the urban centers of the nation. Los Angeles and New York each have 12 such stations which operate 24 hours per day.

As the initial warning message is received, the NAWAS radio facilities would cease normal broadcasting, remain on frequency and utilize normal power to broadcast the initial warning announcement. This would provide the public local information

1. Federal Communications Commission, CONELRAD Manual for Broadcast Stations Licensed by the Federal Communications Commission, Annex K, 24 Hour Stations, FCC, Washington, January 1, 1962.

either from pre-recorded tapes or via a direct link with the local civil defense orgnization.

While the key radio stations on the NAWAS net will receive the warning message and relay appropriate messages to the public, all stations in the area should broadcast the same message. It is desirable, therefore, that some means be provided for achieving nearly simultaneous broadcasting of the same warning message by all stations in a given area.

The addition of commercial broadcast radio facilities to the NAWAS net provides advantages that would enhance attack warning system capabilities without introducing excessive additional costs. Prime among the advantages gained is the provision of voice warning messages to the public. A second advantage is the capability to provide both alerting signals and warning messages without any significant time lapses.

There are, of course, variations which could be applied to the use of broadcast facilities depending upon the local situation. In some areas the broadcast station or transmitter, if suitably protected and properly located, might provide facilities and equipment necessary for a local warning center. Civil defense organizations might use such facilities to activate local warning devices as well as provide warning messages. If this is not feasible, a line from the local warning center to the radio transmitting facilities might be installed. At this point, the way in which this is accomplished is not as important as the fact that it be accomplished. Obviously, costs, survivability of the facilities, and local situations will enter into the planning necessary to achieve this capability.

While this modification is not necessarily a costly item, or one which presents technical difficulties, it does have some hindrances. If broadcast station personnel issued the warnings as they were received, the station and employees would have to be granted some immunity from situations arising from false alarms. In this case, provision of the voice message by NAWAS ensures to a degree against false alarming. Another difficulty to be investigated is the procedural problem and situations under which one station could preempt another's broadcast capability for emergency use.

An example of the use of the broadcasting medium for dissemination of warning is the Canadian Emergency Broadcasting Plan. In Canada, the prerequisites to the use of the broadcasting system are as follows:

1) Only official announcements--warning and instructing the public--should be broadcasted.
2) These announcements and instructions must be broadcasted as quickly as possible after the Army has sounded the National Alert.
3) It must be possible to keep some, if not all, broadcasting stations in operation during the attack and post-attack phases, even though hydro power has been disrupted and fallout radiation intensities have reached a dangerous level.[1]

The principal features of the Emergency Broadcast Plan are as follows:

1) All radio and television broadcasting stations in Canada, with the exception of some northern stations, will have 24 hour per day connection to the Emergency Radio Network.
2) At Ottawa and in each province, a radio studio which has direct communication facilities with the Federal and provincial warning centers will be staffed 24 hours per day.
3) Existing CDC radio networks will operate 24 hours per day.
4) Emergency orders will permit the setting up of the Emergency Broadcasting Network in a matter of minutes.
5) All primary target areas will receive official warning and instructions by radio over local stations, many of which normally remain on the air 24 hours per day, or over radio stations which are maintained in the state-of-readiness to go on the air in a matter of seconds.
6) Radio transmitters which are considered "Key Stations" will be provided with emergency standby power facilities and modified to protect operating personnel during periods of high intensity fallout radiation.
7) Emergency broadcasting studios will be established.[2]

The principal features of the Canadian Emergency Broadcasting Plan appear appropriate for consideration for this country's use. A first step has already been taken in that a requirement has been levied by the Office of the President for the establishment of a nationwide radio and/or TV hookup within 5 minutes in the event of a national emergency to enable the President to

1. F. P. Johnson, "The Emergency Broadcasting Plan," Emergency Measures Organization (EMO) National Digest, Ottawa, June 1962, pp. 4-5
2. Ibid.

communicate directly with the public. This coincides with the Canadian plan for a nationwide hookup within 5 minutes or less for information from the "Federal Control Studio."[1]

b. Eliminate CONEIRAD Procedures But Retain Emergency Broadcast Capability.

The use of CONEIRAD to deny the enemy navigational aid is no longer a valid concept. What is valid, however, is the capability whereby radio stations can be utilized for broadcast of emergency information to the public. This capability should be maintained and expanded. However, those aspects that result in the use of reduced power transmitting equipment pretuned to only the frequencies of 640 or 1240 kilocycles should be eliminated.

Radio stations should use standard frequency and appropriate power so as to reach the largest segment of the population.

It is interesting to note that the CONEIRAD Manual for Broadcast Stations, in specifying actions to be taken, does allow for civil defense usage of the radio broadcast system at normal frequencies and power ratings for the dissemination of warning information. Broadcast stations alerted to CONEIRAD by the Associated Press (AP) or United Press International (UPI) teletype news networks may broadcast civil defense information, if requested by local civil defense authorities, as long as the total message does not exceed 1 minute. However, this procedure is not presently being utilized at local levels.

c. Establish Uniform Meaning for Signals

The Federal portion of the Attack Warning System (NAWAS) utilizes an alerting signal, followed by a voice warning message on the same medium. The persons to whom these messages are directed (at warning point level) are normally those preconditioned to emergency situations (fire, police, etc.) and who have at least a minimum of training and foreknowledge of what the warning system is for. As subsequently disseminated to the public however, warning is supposedly contained within either the wavering or steady tone of a siren, and the signals themselves supply the warning.

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1. The Emergency Broadcast Plan for the U.S. is outlined in more detail in Annex A (National Industry Advisory Committee Plan) of the CONEIRAD Manual for Broadcast Stations Licensed by the Federal Communications Commission (FCC 61-502), FCC Washington 25, D.C. This Annex was approved July 29, 1960.

In civil defense warning, the hazards to be warned about may not be in evidence and an alerting signal necessarily leaves a void to be filled by another medium. The signal brings one's attention to something, but does not in itself define the problem, or provide a minimum quantity of data about the situation it is heralding. As such, an alerting signal alone does not and cannot provide all of the information necessary for understanding the warning. More information is required, which may only be provided by voice warning messages.

The altering signal is vital, however, as a precursor to any warning message, particularly where the time element is critical. The signal must alert the recipient to the fact that a hazard does exist, and to seek additional information. The required data concerns the nature of the threat, its imminence, and appropriate protective measures which should be taken. The best medium to provide this data is the radio, and all alerting signals must then point the way to the radio. The singular meaning of the signal should be vigorously advertised. This should be done only after it becomes possible to provide the warning message at the same time or immediately following the alerting signal. The alerting signal should be as distinctive as it is possible to provide through a low cost modification or conversion of the existing sirens. If it is not possible to achieve near simultaneity of alerting devices and warning messages, then it is not feasible to change or modify the meaning attached to the device.

d. Establish Non-Alert Testing Capability

Warning device testing is another element for consideration. It is absolutely necessary that devices for disseminating the alert be tested as often as required to ensure a high degree of operational readiness. The siren system utilized presently for public alerting has been compromised through the various testing programs now in use. Further compromise of these devices through audible testing must be stopped.

It is equally important that the testing of future alerting systems not compromise the meaning of, or degrade the effectiveness of, the system. Non-Alert Testing of Outdoor Attack Warning System,[1] a report by the AC Spark Plug Division of the General Motors Corporation, had as its objective the development of

1. W. Sattler, Development of Procedures for Non-Alert Testing of Outdoor Attack Warning Systems, AC Spark Plug Division, General Motors Corporation, 22 October 1962.

procedures for operational readiness testing without compromising system effectiveness. This report describes various non-alert testing concepts and describes how they can be used in conjunction with existing warning systems.

e. Modify Interconnection of the Warning Circuit

The warning system must be capable of immediate operation. If the normal utilization will be for the National Warning Center (NWC) to disseminate tactical attack warning to all warning points simultaneously, then the National Warning Center must be provided with a capability to control the circuit. As it exists now, the NWC, prior to dissemination of warning, must use the control circuit to call up the warning circuit and switches must be thrown at other attack warning centers in order to interconnect the warning circuit. Failure of a circuit, switch, or human at any point would block the flow of the warning message. The interconnection capability for the warning circuit should be in the hands of the National Warning Center. Additional circuits to the 26th, 30th, and 32nd warning centers should be provided to the National Warning Center with individual selection of circuits as required, complete circuit control, and backup circuitry in the event of outages.

Providing this circuit interconnection capability to the National Warning Center does not preclude the use of the area circuits by the OCD attack warning centers in training exercises or during post impact periods. The capability and authority to connect or disconnect the circuit for any period of time must rest with the National Warning Center.

In the event of the destruction of a NORAD Regional facility, an alternate facility would immediately take over its functions. There is presently no provision at any of these NORAD Regional Alternate Command Posts (ALCOPs) for alternate civil defense warning centers. The ALCOPs should be provided with engineered communication facilities allowing relocated civil defense personnel to use the area warning circuit (NAWAS) from these locations.

f. Expand Radio Communication Capability

Presently being implemented in the Attack Warning System is a system whereby four of the attack warning centers are being provided with single side-band (SSB) radio equipments which will connect the warning center with the adjacent regional headquarters. These radio links provide the warning centers with an alternate means for dissemination of warning information in the event the NAWAS link between these facilities is disrupted. Regional facilities, upon receipt of the data on the SSB radio link, would then further disseminate the information on the NAWAS circuit. This program is important and should be expanded to include the operational civil defense headquarters of all the states within the area covered by the warning center. Although presently funded for the attack warning centers, additional funds will be required for the expansion to the state organizations.

g. Augment the NAWAS Extensions Program

Several states presently utilize the NAWAS extensions program for providing voice warning beyond the warning point to the local warning point level. This type of warning is essential since, as it is voice, it has built-in verification and provides a necessary quantity of warning information to the local civil defense organization. The NAWAS extensions surpass any signaling devices used for the same purpose. The NAWAS extensions program should be continued as necessary to replace present signaling systems, such as Bell and Light, wherever possible at local levels. This modification is intended to improve immediate system capability only. As implementation of an automatic system progresses, this program may be either used as backup, or phased out.

h. Provide Improved Alert Device Activiation

The controls for activating local alerting devices should, wherever possible, be located at the NAWAS warning point level. Several items justify this provision. Prime among these is time. Under a critically short warning time category there will not be enough time for the warning dissemination and relay process that is presently maintained in many areas. The delays caused by lack of internal procedures, manual relay, and further dissemination are too long, and the effectiveness of the system suffers as a result. Each warning point served by NAWAS should have, as part of the program installation, the siren activation controls and the <u>authority</u> for their activation in its area of responsibility. Further relay should be limited to those areas which are outside the coverage of the alerting devices.

i. Provide Warning System Teletype Capability

The attack warning system does not presently have a capability to rapidly pass and disseminate quantities of warning information in the form of hard copy messages. Subscribers on the NAWAS warning net must record information, either on tape or by manual shorthand or long hand methods. Observation of these methods for recording data, coupled with the quantity of information to be passed, points up the need for the use of teletype on the warning network. Facilities to be interconnected on the warning teletype net are as follows:

1) National Warning Center
2) OCD attack warning centers
3) OCD regional operations centers
4) State civil defense organizations
5) Major metropolitan civil defense organizations
6) Radio broadcast facilities which are on the NAWAS network.

The teletype network could be effectively used for the following purposes:

1) Dissemination of hard copy warning messages to civil defense organizations and key radio broadcast stations on the network.
2) Dissemination of attack reports, NUDET occurrences, and similar operational data.
3) Dissemination of emergency broadcast messages to civil defense organizations, or emergency broadcast messages cleared for dissemination to the general public. Applicable messages could be passed directly to radio stations on the net for broadcast to the public.
4) Coordination and liaison between various organizational levels.
5) Provision of a secondary means for warning dissemination and to verify initial warning messages.

To provide the greatest capability, the teletype network should utilize separate circuits from the existing NAWAS system, thus providing a backup for NAWAS. This would also allow unhindered use of that circuit for warning and other emergency data. If this cannot be achieved, the existing NAWAS warning circuit should be used for both voice and teletype purposes.

The use of NACOM I facilities for a teletype net should be investigated. OCD regional facilities are presently full time on this net, which is under the Defense Communications Agency (DCA), and state civil defense organizations are on the net on an engineered basis.[1] Warning centers and key NAWAS warning points could be added for little additional cost. <u>Warning</u>

1. OCDM, <u>1961 Annual Statistical Report</u>, <u>op</u>. <u>cit</u>., p. 85.

centers should be able to preempt other transmissions when circuits are required for warning.

C. PHASE 2 - INTERIM SYSTEM MODIFICATIONS

1. Introduction

Interim modifications to the warning system take on more of the aspects of the final system configuration. In some cases, they are extensions of work accomplished in Phase 1. In other cases, they involve greater capital outlay and must be undertaken only after some additional research has been completed. (See Chapter Thirteen.)

2. Organizational Modifications

a. Establish and Phase-in Additional Local Warning Centers

Additional local warning centers which are indicated as being necessary from the investigations of the organization structure begun in Phase 1 should be established and phased-in during this period. Provision must also be made for the adequate staffing and training of the personnel for these centers in order to ensure an effective operational capability.

b. Program and Locate the Desired Number of Intermediate Centers

In addition to their normal administrative, logistic support, and liaison function, these centers may function as backup alternate National Warning Centers. To accomplish this mission they must be provided with adequate physical facilities and a well trained staff.

3. Communications and Facilities

a. Where necessary, relocate state warning centers away from prime target areas.

b. Expand or modify the existing communication circuits between warning centers at the state level and above, as necessary, to provide adequate survivability.

c. Provide a capability for hard copy (teletype) warning message capability at the local warning centers. The existing voice warning circuit must also be retained. The TWX circuit should be engineered with a view to its retention in the final system to provide not only a hard copy warning message capability, but also for use as an administrative and logistic support circuit. The voice circuit can serve as a command control circuit for the final system. Survivability considerations must be observed in establishing these new circuits.

d. Provide tie lines between local warning centers and the radio stations selected by coverage studies to cover the local area; where necessary arrange for 24 hour stand-by capability at these stations. By providing tie lines from the local warning center to the selected radio stations, the requirement for locally oriented warning instructions, depending on the threat and time categories, is fulfilled in a way that will be easily adapted for use with the final automatic system. Since not all radio broadcast stations maintain a 24 hour schedule, arrangements will need to be made to maintain a capability to broadcast a warning message within 5 minutes.

e. Provide emergency power and fallout protection for all radio broadcast facilities found necessary for the dissemination of voice warning messages and/or other emergency communications. Station coverage, vulnerability, and redundancy should be considered. In some cases where transmitters can be remotely controlled, radio station personnel should be afforded fallout protection. Protection should also be provided where operations are located at the transmitter. Stand-by power at the transmitter and at studio locations necessary for remote control is required. A voice message capability must be maintained in any area subjected to damage short of total destruction.

f. Equip all existing sirens having separate air compressors with modulating air stream loudspeakers. This step would provide an alert signal and a voice warning message over the same outdoor device. This would enhance the usefulness of the sirens and give an improved warning capability at a moderate cost wherever sirens of the Thunderbolt type exist. Since from five to ten years will be required to complete the implementation of an indoor warning system, such outdoor devices could perform an important interim mission as well as being useful to cover people out-of-doors in the final system.

g. Establish a capability to disseminate warning over public address, paging or music distribution systems such as MUZAK which exist wherever large numbers of people normally gather. Such facilities would include schools, department stores, shopping centers, factories, etc. Such coverage can reach a significant fraction of the transient population.

D. PHASE 3 - ACHIEVING FULL SYSTEM CAPABILITY

1. Introduction

From one to three years after system implementation is started, the results of needed additional research will be known, development of a suitable warning receiver will have been completed, and necessary funding accomplished. Whenever any major subsystem is ready for implementation it should be started. For example, since approximately 70 million receivers will be required for an indoor warning system, seven years would be required to manufacture this quantity at the rate of ten million per year. It is therefore clear that the development of a warning system with complete indoor coverage will not likely be completed before 1970. Hence the interim capability and the phase-in of the final improvements must be planned and coordinated to achieve the greatest system effectiveness at all times.

2. Modifications to Communications and Facilities

a. Install the automatic warning system in accordance with plans and specifications which will have been developed under a study for this purpose. The automatic system will provide displays of threat and time categories in all warning centers and activate the alerting signal and warning message transmission. This network should be implemented as soon as possible. Even though an indoor warning capability may not exist for a number of years, the automatic warning facility will greatly increase the effectiveness of the overall warning system.

b. Integrate the warning and the attack effects activities into a single homogeneous working organization. An immediate modification recommended in Phase 1 was the integration of warning functions at the OCD regional and OCD attack warning center level. In Phase 3, particular emphasis should be placed on warning functions at intermediate centers and local warning centers.

At the local and intermediate levels personnel will be heavily concerned with the assessing and evaluating of attack effects data, determining the impact these effects will have on local areas, and warning the public of these hazards.

c. Plan and provide necessary communication links with appropriate military installations. Specification of direct communication links between intermediate centers and NORAD regional facilities will be required during this phase. This phase should also include the establishment of the primary communications network between the National Warning Center and intermediate centers; the secondary network between intermediate centers and local warning centers, and an effective warning distribution network between local warning centers and alerting and warning devices.

d. Implement the most feasible indoor warning system. Further research is required to determine the capabilities of several types of indoor warning devices to meet the operational requirements and performance characteristics set forth in this document. After evaluation of these research efforts, implementation of the most feasible of these systems can be initiated. As indicated above, the acquisition of these devices alone requires several years. Therefore, the research efforts should be initiated immediately and the implementation of the devices accomplished as soon as it is practical.

CHAPTER ELEVEN

SYSTEM TRAINING AND HUMAN FACTOR CONSIDERATIONS

I. INTRODUCTION

The development of training programs for a warning system capable of effective operation in the late 60's and early 70's is dependent upon several prior accomplishments.

First, there must be an approved, integrated, and evolving plan for the warning system. Second, until system specifications have been drawn and a detailed implementation plan outlined, there will be limitations on the degree of specificity that training plans may assume.

Simulation exercises, as a training device, generally appear applicable to most elements of the civil defense warning system. These exercises are designed to train personnel, analyze the system, improve procedures, incorporate innovations, and test equipments.

With ample specificity and firmly established goals, effective planning for a training program will be possible. A system training program such as that being developed under OCD Project 2213, Warning System Exercises, appears to offer the greatest potential for developing and maintaining efficient operational readiness under all contingencies, including the least desirable possibility that the current system remains static as well as the more desirable possibility that all budget requests for improvements are approved.

Comprehensive training program development is currently somewhat premature. Further research should allow development of a more comprehensive program based on identification of problems and suggestion of goals to pursue in formulation of training and testing to assure optimum operational readiness.

The warning process can be related to two problems:

1. Physical and technical - Hardware and procedures for detection of a threat and relaying a signal and message to maximum numbers of people with minimum delay.

2. Human - Perception, interpretation, and action after receipt of warning.

In civil defense planning generally, as well as warning, the magnitude of the first problem frequently obscures the importance of the human factors issue. Concern with human factors is a major emphasis in training. Human reactions have been studied in disaster and civil defense situations, notably by the National Academy of Sciences - National Research Council's Disaster Research Group.[1] Attempting to relate the findings of such disaster studies to plans for thermonuclear disaster, a former director of the Disaster Research Group found that human behavior affects planning in three critical ways:[2]

1. Reaction to the disaster when it occurs.

2. Reaction to plans during a time of crisis.

3. Reaction to plans under a current, normal situation, i.e., <u>now</u>.

Linking this specifically to the warning process, Williams suggests, "it does not matter how accurately danger is detected and how quickly and widely signals are transmitted, if people do not understand and act on the signals when they receive them."[3] Recommending full consideration of both primary and secondary warning, he feels that there is a possibility that "...warnings can be made more effective if we will (1) profit by mistakes of the past and (2) work, and practice hard enough to make them work better...."[4]

Differentiating between mere signals and warning, he defines them:

> "...as the transmission of messages to individuals, groups or populations which provide them with information about (1) the existence of danger and (2) what can be done to prevent, avoid or minimize danger....A state of alarm without a corresponding course of action to follow, at best leaves it up to the individual or group to design its own course of action (without, too often, enough information to do so) or at worst leads to crippling confusion or indecision....The information about <u>what</u> to do, must be possessed by the population before the <u>warning</u> signal arises. The warning signal in this case becomes a message which says, <u>now</u> is the time to do it. If this kind of signal is to work <u>it</u> means that those who receive it must already have been successfully instructed in recognizing the signal and in the course of action to take when they do receive it....It must leave no

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1. See the Disaster Study Series of the Disaster Research Group. Sixteen publications have been issued up to January, 1963, by the National Academy of Sciences-National Research Council Printing and Publishing Office.
2. H. B. Williams, <u>Human Behavior and Themonuclear Disaster</u>, Unpublished manuscript obtained from the Office of Civil Defense, August, 1961, p. 3.
3. <u>Ibid</u>., p. 27, <u>passim</u>.
4. <u>Ibid</u>., p. 30.

> room for ifs, ands or buts. If the signal can mean several different things, then the recipent requires still further information before he knows which one of these things he should do. In this way, the warning signal is an integral part of the whole emergency system; if the system does not contain clear plans which are to be followed, the usefulness and effectiveness of warning signals are seriously decreased."[1]

The above conclusions emphasize the need for prior training of both warning system personnel and the populace. The degree and kind of training must be related to practical problems and specific goals. Adequate operational readiness can be defined as the most important goal. To achieve it presumes prior and successful testing of equipment, training of NAWAS and related personnel in procedures, and indoctrination of civil defense officials and the public as to appropriate interpretation and reaction. Given accomplishment of these prerequisites, requirements for operational readiness can be determined, and a genuine capability planned, established, appraised, and improved with subsequent training and exercises.

This chapter will consider various problems in training civil defense officials, warning system personnel, and the populace. It will relate these tentatively to development of message format and to prior findings from disaster research and civil defense studies, and finally will suggest means for improving training immediately and in a long range effort.

II. PROBLEMS ASSOCIATED WITH TRAINING THE WARNING SYSTEM

It will facilitate the discussion to distinguish between organization or structural problems and substantative or functional problems.

A. ORGANIZATIONAL PROBLEMS

To counteract the potentially dangerous and frequently observed reluctance to issue warning on the part of responsible officials, organizational authority, command, and duty structures should be well-detailed and understood by both system personnel and the general populace. Policy must define expected performance under different contingencies and practice must develop and determine the level of ability to perform defined tasks. Unless persons with specific responsibilities within the system are convinced of the proper procedures, they are not likely to provide clear direction and/or to elicit appropriate reaction from the citizenry.

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1. *Ibid.*, pp. 31-32

The interfaces with NORAD elements, including the disaster control procedures of the Air Force, and the responsibilities, procedures, and prerogatives of the national, regional, state and local echelons of the civil defense organization must be defined. Recipients of warning at all levels must be given sufficient data in the warning message to allow understanding and eliminate doubt.

This will be a recurrent problem because training requirements will change for operational crews and the populace as changes in the warning system are implemented. Moreover, an explicit statement of responsibilities applies to at least three areas in maintaining operational readiness in both the military and non-military elements of the warning system. These areas are:

1. New Procedures and/or Personnel

Whenever new equipment or procedures are added to the system this incurs retraining requirements for existing personnel. If these changes apply to the public, they too must be informed.

2. Replacements and Backup

Attrition, illness, and prolonged duty periods during emergencies require replacement or backup personnel for NAWAS operations personnel. Practical considerations may indicate a need for certain military-OCD agreements in this second area.

3. Cross Training

Supplementary cross training of personnel in interfacing systems must be considered. This applies to the Canadian NSAWS,[1] NORAD Air Defense System, Civil Defense NAWAS System, and other systems such as the U.S. Hurricane Watch, or various fire fighting systems. Possible joint use of facilities, periodic transfer of personnel for brief working tours in other systems, and development of new training techniques would also offer benefits.

B. FUNCTIONAL PROBLEMS

Problems identified by authorities can provide an inventory of guidelines to be considered by civil defense officials, especially NAWAS personnel, in establishing and carrying out warning procedures. They also may provide a basis for development of a training course for planners. H. B. Williams and others identify such problem areas:[2]

1. NSAWS is the National Survival Attack Warning System.
2. Williams, Human Behavior and Thermonuclear Disaster, op. cit., p. 33, passim.

1. Wolf-Wolf

Officials may be reluctant to transmit warning because they lack the information to provide a complete description of the danger and an estimate of when it will actually strike. They may fear criticism should the disaster not occur. Although more study of this problem is required, some results indicate that the likelihood of criticism is distorted and exaggerated. Also, "upsetting" people is not necessarily evil; some apprehension is probably desirable to encourage preparation for emergency action. Officials should be concerned about disseminating unrealistic information regarding an undefined threat, but must be willing to transmit information vital to the populace's ability to protect itself in time of emergency. Further risks can be diminished by prior public training and education, so that the public may simultaneously learn more about the probable dangers, types of warning, and "be given a more realistic understanding of the problem of the official who has to decide when to issue warnings and when not to issue them."[1] This allows a realistic participation in one of the critical issues of civil defense.

2. Panic Stereotypes

Panic normally occurs only under specific conditions. Popular opinion seems to feel that confusion or uncertainty alone may engender maladaptative behavior. Research indicates that this is extremely unlikely and that training can reduce the danger to a minimum.[2]

3. Relay

Delays in transmission frequently result from uncertainty as to source and content of the message. If message source and content are established in advance through training, the delays, uncertainty, and need for confirmation can be significantly reduced in relay of messages.

4. Coverage

Only dynamic exercises under simulated but realistic conditions can appraise the extent and problems of coverage. How many people receive what aspects of the message, how quickly, depends upon the involvement of at least samples of the population.

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1. Ibid, p. 35.
2. E. L. Quarantelli, "Nature and Conditions of Panic," American Journal of Sociology, LX (November 1954), pp. 267-75.

5. Message Ambiguity

People give different interpretations of information conveyed by a warning message depending upon prior experience, environment, and cultural context. Message formats must be designed to minimize these differences in interpretation.

6. Confirmation

Previous studies do not reveal specifically whether or not adequate conditioning or training will obviate the public's need for corroboration of the alert. Whether appropriate training in recognition of signals and actions will ever be enough is not established. All the human factors involved probably have not been identified and even those that have, have not been sufficiently explored. The kinds of compliance by different age groups, the social chain of communication and who in a society functions as gate-keepers or opinion leaders are examples of factors that may be of paramount importance in receptivity of the populace to the message and the extent of protective actions.[1]

7. Interpretation and Action

Each person defines his situation according to experience and expectations. Protective actions can be said to be based on an individual cost/effectiveness, one which defines for that person the consequences of different acts he might take in relation to shelter, family, flight, role conflict, and other variables.[2] One study has indicated that role conflict, feelings of inadequacy, and apprehensions are related to the degree of preparation. A person's meaningful tasks should be assigned according to a master plan that considers desires, opportunities, needs, and abilities of entire families.

Williams reiterates that:

> "... People define threatening situations in terms of the strength of the threat, time available, and the cost and effectiveness of taking protective action--as they subjectively understand these things. What are the chances that the danger will actually occur to them, and

1. M. L. DeFleur and O. N. Larsen, The Flow of Information: An Experiment in Mass Communication, Harper and Brothers, New York, 1958, expecially pp. 229-31 and 270-71
2. P. G. Nordlie and R. D. Popper, Social Phenomena in a Post-Nuclear Attack Situation, Human Sciences Research, Inc., Champion Press, Arlington, August 1961

if it does how great a loss are they likely to suffer? How great is the risk? How long will it be until the danger materializes, how long before they must make a final decision, how much time to make good their escape, if that becomes necessary, and what can one do about it anyway? What countermeasures are available and how effective are they likely to be against the danger? And what will it cost to take the available countermeasures in terms of time, money, effort, separation from loved ones, anticipated ridicule if one is wrong, and in other ways?...If warning information is ambiguous or unspecific, if it leaves open a variety of interpretations and a variety of actions, people are likely to choose the more optimistic of the available interpretations, choose the less costly of the available actions, or delay still further in reaching a decision."[1]

8. Chronology

The following should be studied to identify consistency and gaps in information, and establish some form of logical continuity within a regular pattern. "Inputs come from several different sources - official warning systems, quasi-expert sources, non-expert official sources, informal social sources, and physical cues - and each needs to be tracked down and analyzed"...in relation to different "target audiences" through comparison processes designed to examine different frames of references.[2]

9. Feedback

At some point feedback to the warning source is necessary. This will enable determination of the numbers likely to survive and can serve as one element of possible damage assessment because population can be considered one form of remaining resource. Little research has been done in this area.[3]

1. Williams, op. cit., Human Behavior and Thermonuclear Disaster, pp. 38-39. Also Williams, op. cit., Communications, pp. 162-170. Four variables are presented in definition of threatening situations: the degree or strength of threat, time, cost of protective or avoidance actions and effectiveness of available countermeasures.
2. Ellemers, op. cit., Studies in Holland, Vol. 4, p. 13.
3. Williams, op. cit., Communications, pp. 174-5.

10. Subsequent Messages

How much overlap, repetition, and information should be included in subsequent messages should be investigated. Few data are available on this aspect, but the Orson Welles "War of the Worlds" broadcast has revealed the importance of factors such as the point in which one tunes in during a broadcast or the relevance of educational achievement or training.[1]

11. Other Analyses

C. E. Fritz has explored the question of how to make people respond quickly and effectively to attack warning in a different fashion. He has developed three propositions:

a. "Warning can be effective only when there is a system of organization, designed to implement appropriate responses to a warning message."[2]

This includes consideration of initial education and training in signal recognition, development of appropriate action and response, and follow-up to ensure correct response. Individual motivation for appropriate response must be triggered by an appropriate confirmation of prior training and message content. Message characteristics should be clarity, uniqueness and lack of ambiguity. The stimulus should invoke pre-rehearsed actions appropriate to the situation and the nature of danger. It also should be instantly accepted. Disaster studies have shown that ambiguity in the message will consistently prompt refutation, or at least delay by further information-seeking or cue-confirming behavior.

b. "A warning signal of attack should never be associated or identified with a test situation or with other kinds of emergency signals.... The signal must be so clear-cut and unambiguous that it is always, unequivocally, identified as 'the real thing'.... Ideally we want to call 'wolf' only when actual danger is present. For this reason, I seriously doubt whether the present siren system of warning can be salvaged as an effective attack warning system. At the very least, it

1. H. Cantril, The Invasion from Mars: A Study in the Psychology of Panic, Princeton University Press, 1940.
2. C. E. Fritz, "Some Implications from Disaster Research for a National Shelter Program" in G. W. Baker, J. H. Roher, and M. J. Nearman, Symposium on Human Problems in the Utilization of Fallout Shelters, Disaster Study 12, Publication 800 of Disaster Research Group-National Academy of Sciences, Washington D.C., 1960, pp. 145-46.

will require strong reinforcement with other distinctive, informative signals."[1]

This second proposition offers strong argument in favor of immediate amplifying data on the warning, a requirement which can most effectively be met by the flexibility inherent in voice transmission with complete coverage. Fritz adds that warning in the missile era makes simultaneous national transmission necessary to preclude local delay or interpretation.

c. "If the choice is between no warning at all and a warning time that is likely to be insufficient for people to complete the recommended or fastest protective acts, the best choice may be no warning at all."[1]

Research indicates severe emotional reactions during impact with greater proportions of casualties attributed to inadequate warnings. However,

..."This, of course, is an extremely difficult choice to make. It assumes a perfection in knowledge about elapsed time between warning and attack, the likely targets and the length of time required to take protective action, which may not in fact exist. It should be remembered however, that, in a nuclear attack, the detonation of bombs will provide millions of people at some distance from the target area sufficient time to take shelter, provided that they can identify the signs of attack and have the protective structures reasonably at hand. In more remote areas, people may even have sufficient time to erect shelters hastily or to reinforce existing structures against the radiation hazard before fallout reaches them.[1]

It should be noted that little research has been done on this problem of translocation or figuratively being caught in mid-stream. More adequate information is needed before firm conclusions can be drawn.

Still another approach to the possible psychological effects of warning was developed by I. L. Janis.[2] He examines low, moderate, and high degrees of threat as relayed by an observable stimulus

1. Ibid.
2. I. L. Janis, "Psychological Effects of Warnings," in G. W. Baker and D. W. Chapman, ed., Man and Society in Disaster, Basic Books Inc., New York, 1962.

such as siren or radio. Then he observes the level of reflected fear in reaction as mild, moderate, or strong. His paradigm then covers needs for vigilance or reassurance and attitudes towards vulnerability. He relates these to certain behavioral consequences including emotional tension, optimism, pessimism, denial, and necessity for blanket or discrete reassurance. Each of these consequences can be examined through training exercises designed to discover implications and evaluate performance.

III. MESSAGE FORMAT

Many of the problems identified in warning have implications for the training program, and may be linked in some way to message format. Further research should be carried on immediately to determine a group of message formats consistent with the intent of the message originators. Such study also should examine the response and reaction of potential addressees. Certainly this is likely to vary with prior experience, normal times, conditions of increased international tension, crisis, and limited war, to cite only a few examples. Message format should be flexible, but designed to include essential elements under whatever conditions may arise. Among these should be:

1. Designation/confirmation of source.
2. Designation of addressee.
3. Designation of area.
4. Time - related to message length, duration, repetition, chronology, and updated information.
5. Identification of the degree of hazard.
6. Identification of appropriate protective measures.
7. Provision of required amplifying information.
8. Designation of priority for different organizational echelons.
9. Statement of procedures and prerogatives, identifying decision sources.
10. Identification of uncertainties.
11. Establishment of appropriate termination procedures.
12. Provision for testing and training modes.

IV. PRIOR RESEARCH

In addition to regular publications covering the psychological, sociological and cultural context of warning and disaster, there are many specific surveys which focus on disasters generally, as well as civil defense exercises and false alerts in particular. Additional guidelines for planners can be gleaned from these. Work has been done on behavior in crisis situations including:

1. Disaster and extreme situations.
2. Brainwashing and sensory deprivation.
3. Internment, concentration camps and prisons.
4. Role conflict.
5. General theory of panic, stress, and conflict situations.
6. Rumor.
7. Game theory and interaction.
8. Behavior under general conditions of stress and threat.[1]

In addition, these phenomena have been studied under laboratory conditions and through experimental attempts to arouse crisis behavior. Sixteen reports by the National Academy of Sciences-National Research Council in the Disaster Study Series have been published. Most include extensive bibliographies and many offer insights particularly valuable to civil defense.[2] "An Inventory of Field Studies on Human Behavior in Disasters" includes one appendix providing details on thirteen studies of civil defense exercises and false alerts.[3] To attempt to comprehensively survey these materials is beyond the scope of this contract, but certain salient findings will be covered.

Disaster can be defined as "...a basic disruption of the social context within which individuals and groups function, or a radical departure from the pattern

1. R. C. Brictson, FN-5995 "Behavior in Crisis Situations - A Bibliography," System Development Corporation, November 1961, and FN-6788 "Behavior Under Conditions of Stress and Threat - A Bibliography," System Development Corporation, 3 August 1962.
2. See Disaster Research Group Studies, op. cit.
3. Disaster Research Group, "An Inventory of Field Studies on Human Behavior in Disasters," National Academy of Sciences, Washington D.C., August 15, 1959.

of normal expectations."[1] This 'expectations of the individual' is a recurrent theme in disaster research and a well-established one in both psychology and sociology. Any analysis of warning should profit from use of this concept.

Fritz has surveyed the problems of disaster warning[2] and cites the hypersensitivity of recipients who have had recent experience, the reluctance of agents to issue warning until they are certain that a danger will materialize, the difficulty in securing public acceptance of warning messages, and the oversimplification frequently observed in conceiving warning as a direct stimulus-response kind of communication. He suggests that

> "...in an untrained population the outcome of this complex process may be or may not result in the public responses intended by the warning agent.
>
> An effective disaster warning system requires a realistic recognition of these social and personal responses to information about danger. The agency issuing the warning must not only transmit messages about the existence of danger but must also supply people with information about what can be done to avoid or reduce the danger.... The problem of warning, in other words, must be viewed as a total process of communication and organization in which people are informed about the danger, told what to do about the danger, and supervised so that their actions conform to the required protective measures. When the responsible authorities view the problem in this way, warning can be effective...."[3]

This opinion is reinforced by a Department of Defense study of Hurricane Carla.[4]

Four other studies offer comments on the effectiveness of signals, reactions of people, and ways of improving the system based on social science research. The first two are related to warning specifically and the third to human behavior in the thermonuclear disaster.[5] The fourth offers guidelines to be considered in the establishment of message format and in development of a training program. These guidelines are:

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1. Disaster Research Group, H. D. Beach, R. A. Lucas (Eds.), "An Introduction to Methodological Problems of Field Studies in Disasters," Committee on Disaster Studies, Report 8, Publication 465, National Academy of Sciences, Washington D.C., 1956, pp. 1-2.
2. Fritz, op. cit., "Disasters," pp. 663-8.
3. Ibid. p. 667.
4. M. E. Treadwell, Hurricane Carla: September 3-14, 1961, U.S. Government Printing Office, Washington D.C., 1961.
5. William A. Scott, "Public Reaction to a Surprise Civil Defense Alert in Oakland, California," Survey Research Center, University of Michigan, Ann Arbor, 1955; also see Williams, Human Behavior and Thermonuclear Disaster, op. cit.; and DeFleur and Larsen, The Flow of Information, op. cit.

1. People define situations according to their own perceptions of the signals and objective reality - the interpretation of warning is independent of the ultimate validity of that signal.

2. Interpretation of and compliance with warning depend in part on the observed reactions of others in the environment, including age, sex and occupational reference groups.

3. Interpretation depends on the degree and kind of previous experience with emergencies or disasters.

4. Interpretation depends in part on the response of officials who are interrogated as to validity, corroboration, or refutation.

5. Interpretation varies with the individual in relation to the primary group he is associated with when he receives the message.

6. The higher an individual's social status, the more likely he is to question validity of a warning message.

7. Persons who belong to large or complex organizations are likely to interpret the message as valid.

8. Response varies with the types of social category membership of warning recipients.

9. Logical or rational behavior is not necessarily an outcome of correct interpretation.

10. Retrospective interpretation of the meaning is based upon a person's prior experience and judgment as to the outcome of response to the signal.[1]

V. TRAINING PLANS

Based on the previous discussion of problems, message format, and prior research, training plans should evolve according to immediate improvements in the warning system, interim changes, and long range goals. Examples of effective warning in disaster studies:

1. R. W. Mack, and G. W. Baker The Occasion Instant: The Structure of Social Responses to Unanticipated Air-raid Warnings, Disaster study 15, Publication 945, Disaster Research Group, National Academy of Sciences, Washington D.C., 1961, p. 45, passim.

"...indicate one or both of two factors; 1) a population which has experienced the danger, knows the signs or has learned to believe the authorities, knows what to do and when to do it, or has thought about a potential danger (like a dam that could burst) and figured out what to do if it ever occurred; 2) planning and organization."[1]

Although the evidence is not conclusive, research on a Washington D.C. false alert in 1958 suggests that training can make a significant difference.[2] Three things should be considered in training: The idea of practice of the action in association with the signal; the importance of trained leadership; and practicing the emergency procedure all the way through.[3]

Operational exercises on a simulated basis, such as a system training program, can accomplish these objectives for the warning system. Benefits can be predicted for civil defense officials, including NAWAS personnel, and the populace. Our emphasis will be on officials because involvement of citizenry at large requires prior executive or legislative decision. If basic information regarding the warning process has been promulgated by brochures or mass media such as radio or television, then the populace will be receptive to messages disseminated in time of emergency or during training exercises. Moreover, such a system training program can immediately improve capabilities as well as provide a flexible method for training during any period of transition prefacing a longer range system change designed to meet requirements for the late 60's and early 70's.

A. DEVELOPMENT OF EXERCISING CAPABILITIES

1. Need for Exercising

An interplay of men, plans and equipment is required to perform the civil defense mission, any unproved, static "paper program" being an unreasonable and unnecessary risk. Until some method of training and analysis that exercises operational capabilities on a real-time basis is developed, the effectiveness and potentiality of any system is based on speculation. We must provide dynamic exercise capabilities to optimize job proficiency, to facilitate incorporation of plans, to test equipment reliability, and to assess operational readiness.

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1. Williams, _op. cit._, _Human Behavior_, p. 46; also see R. A. Clifford, _The Rio Grande Flood: A Comparative Study of Border Communities in Disaster_, Disaster Study 7, Publication 458, National Academy of Sciences, Washington D.C., 1956 and E. R. Danzig, P. W. Thayer and L. R. Galanter, _The Effects of a Threatening Rumor on a Disaster-Stricken Community_, Disaster Study 10, Publication 517, National Academy of Sciences, Washington D.C., 1958.
2. Williams, _op. cit._, _Human Behavior_, p. 42.
3. _Ibid._, p. 47.

Determination of effective response to threat, demonstration of the utility of various plans, and measurement of system reliability are contingent upon operational exercises as developed through some form of system training program.

Exercise capabilities are indispensable tools in planning, management, implementation, and maintenance of proficiency in any operational system. Without such vehicles of analysis, system management observations depend on paper work and conjectures. With various simulation models, system exercises can provide exposure to many contingencies and allow incorporation of a realistic, updated threat with measures to contend with it. Such exercises facilitate keeping technologically abreast and teach system response under realistic conditions. Accurate information displaces misinformation, experience replaces hearsay through actual performance.

Simulation models, which may incorporate operational units of the actual system, serve for system exercises. Normally the models are devised for analysis or training. Purely analytical models focus on problem-solving or design considerations and frequently exclude human operators. Training models invariably include human decision makers and may be used for indoctrination or establishment and evaluation of performance levels.

2. Potentialities of System Training Program

A System Training Program (STP) offers a hybrid model, especially suited to programs which must continue to evolve under the ongoing stress of operational responsibilities. Indeed, training missions designed as operational readiness inspections have demonstrated the effectiveness of such programs in military environments. They can provide the same service for civil defense.

The following principles derived from STP appear applicable to an OCD program:

a. Man-machine systems learn, improve, and evolve with the personnel subsystem as a result of cumulative exercise experience.

b. Functionally complete units, as comprehensive in scope as possible, should be trained both for individual and system-interaction proficiency.

c. The actual environment should be realistically simulated to ensure effective motivation of participants and to facilitate transfer of learning to the operational performance.

d. Exercise objectives and complexity should vary to develop flexibility in coping with various contingencies under different situations.

e. Knowledge of system performance during missions, distributed as rapidly as possible, provides feedback that strengthens capability as well as morale.

3. General Development of Training Programs

Development of any programs for OCD-DOD should stress innovations and analytical ability as well as training, because an in-house Training and Education (T&E) unit exists. The need for civil defense training is, however, widely recognized. A recent House of Representatives report, New Civil Defense Program, states,

> "an informed public is essential to an effective civil defense program. Millions of pieces of printed matter have been distributed ...a great deal of this information is out of date, unrealistic, or partial in its coverage. The public is more confused than it is informed...responsible civil defense authorities should endeavor, to the greatest extent possible, to translate technical information into practical instruction."[1]

Similarly, the Sonoma County, California, prototype plan for civil defense reported that all participants in a civil defense responsibility must be designated, informed, trained, and drilled to develop appropriate procedures.[2] Adequate preparations for civil defense are difficult to expedite under ordinary circumstances, the effect being that we have had little recent experience of simulated threat, therefore have little knowledge of actual threat.

Training programs designated to prepare people for the conditions of self defense must compete with pressing work-a-day problems of concern with the family and securing status or recognition. The problems of an uncertain future are not given due consideration. Apathy and disbelief are more frequent responses than participation and preparation.

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1. New Civil Defense Program, op. cit., pp. 64-65.
2. Sonoma County, California, Training Plan for Civil Defense, No date, p. 12.

"In preparedness programs the critical need is for training people to act in an organized, concerted fashion at a broad community or national level. This cannot be accomplished simply by providing people with knowledge about appropriate techniques of individual or family survival. It requires a basic understanding of how each person's behavior fits into a general, coordinated kind of action, and this in turn, requires frequent rehearsal of the behavior within the setting for which the general plan is designed.

In this type of system planning the leadership in the social system must take major responsibility for initiating the preparedness program. To the extent that the preparedness program requires public participation, the leadership must specify the realistic nature of future danger, the means for dealing effectively with the danger, and the concrete steps needed to secure the required state of preparation. Means for facilitating public compliance with the requirements of the plan must also be incorporated in the program of preparation...so that preparedness for disaster becomes an accepted part of the normal pattern of social life...a socially approved and rewarding form of behavior under usual conditions of social functioning, rather than an individual sacrifice which competes with the achievement of the normal objectives in the society."[1]

To reiterate, an operational exercising capability appears to be an appropriate vehicle for development of an effective civil defense program. Such exercises will:

a. Provide a comprehensive method for development, appraisal, and modification of civil defense at all levels of government.

b. Facilitate a system evaluation and analysis of current or planned procedures via mission results.

c. Furnish recommendations for improving civil defense programs and activities for subsequent exercises.

Additional benefits include formation of practical goals, improvement of work habits, assimilation of new methods, and learning general principles in a logical context. Specification of attainable mission objectives allows crews to resolve inadequacies in the system. Attempts are made to maximize learning and avoid traumatic situations

1. C. E. Fritz, "Disaster," op. cit., p. 663.

or frustrations which might impair performance. Knowledge of results from actual practice increases the meaningfulness, habituation of response, timing of effort, and positive transfer of new training to operational procedures. Through many exercises, components are interwoven into a total system that performs optimally with both accuracy and speed.

B. METHODS

Any system requiring training represents a unique situation and civil defense is no exception. Various organizations are involved and many plans for training should be integrated into a total effort. Decisions regarding selection of who shall be trained, when, to what extent, and with what objectives must precede analysis of how training results will influence subsequent plans. The NAWAS system is of primary concern, and next in importance are the OCD regional centers, then the state, county, and community agencies, and the populace in that order.

Orderly, positive, meaningful training presupposes sound direction, and should exercise an optimum amount of the total system. Immediate involvement begins the chain of events that, by adequately spaced learning, should lead cumulatively to proficiency. Objectives must be devised to exercise existing plans and to raise questions reflecting those plans. Simulation models and exercise configurations should be developed for experimentation in keeping with an overall program. (See Figure 8.) In the early stages only the hierarchy of responsible officials should be exercised, until their proficiency warrants expansion to other levels. Gradual increase of participation should involve more officials and, at length, the citizenry in wide-scale operational exercises. However, the populace concurrently can be prepared for involvement by use of mass media public information programs.

Performance may be measured by various criteria, but personnel, procedures, and equipment most clearly come into perspective through the evaluation of whether the system accomplished its mission. After definition of acceptable performance levels and the essential elements to be observed in missions, the range of responses may be ordered to establish degrees of operational readiness or proficiency levels. These dynamic tests of the STP type offer:

1. Economic feasibility.

2. Remedial efforts designed for specific objectives.

3. Varieties of realistic situations otherwise unavailable.

4. Relatively valid estimates of system's adequacy.

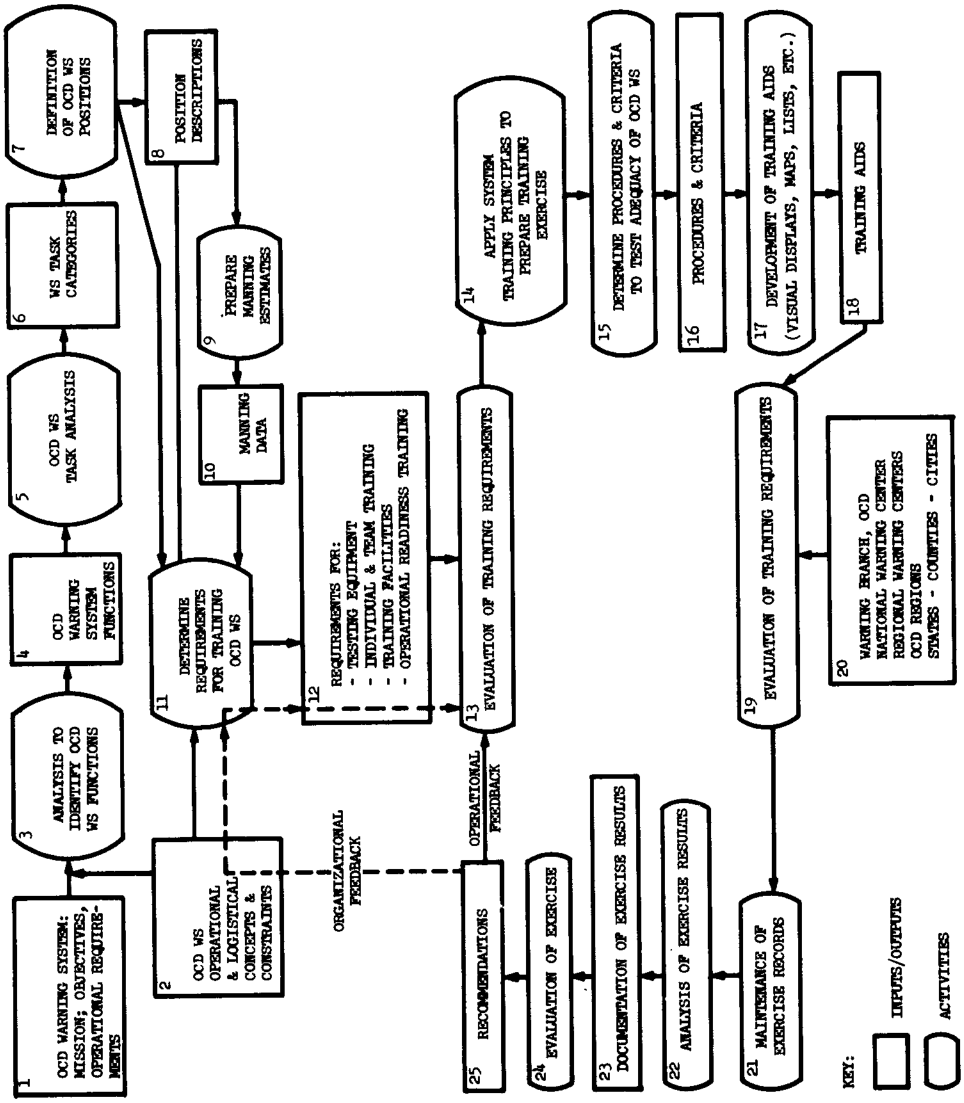

Figure 8. Warning System Training Program Plan

5. General acceptability to personnel performing the mission.

6. Establishment of standards.

7. Experience with new procedures, techniques, and equipments.

8. Opportunity to detect, trouble-shoot, repair, and replace faulty elements.

9. Operational familiarity with outages and backup systems.

Other measures of performance, although useful, do not offer the broad advantages of operational exercises. Paper-and-pencil tests of various types and programmed learning tests can be used to assess and increase personnel knowledge. Special rating crews can observe daily activities and make subjective judgments as to adequacy. Total system performance is unquestionably related to subsystem activities of human beings or equipment. But the most effective study and meaningful measures depend upon simulation techniques, which are the least expensive, most revealing devices for training, feedback, design, and planning.

The warning-communications system should be appraised under all defense conditions (DEFCONS) and types of damage, as well as under varying transitions between conditions. Message content, accuracy, priority, and speed of dissemination vary in the normal state and under the conditions of increased tension, attack-imminent, immediate-impact, post-impact, and long-range recovery. Placement of personnel, priorities of effort, suspension of normal activities, lack of preparations, conflict of roles, concern with family whereabouts or survival, and updated estimates of threat or subsequent impact are other concerns. For example, estimates vary regarding the import and extent of the role conflict which will ensue when from one-half to two-thirds of the total number of families in the United States are uncertain of the safety and whereabouts of all members.[1] The effectiveness of personnel may be reduced when apprehensions over family welfare have not been resolved.

Civil defense should be exercised down through the local level, not only for warning, but for all phases of civil defense. One problem here is that central authority for civil defense is ambiguous; therefore coordination is lacking. The operational role of OEP also is not fully understood by officials at all government echelons. The Federal OCD office, having no authority over the states, can only advise and suggest measures to be taken. Likewise, the state has no authority over local governments, and can given only information and guidance. On the local

1. S. B. Withy, Fourth Survey of Public Knowledge and Attitudes Concerning Civil Defense, Survey Research Center, University of Michigan, 1954.

level, jealousy guarded prerogative and overlapping responsibility are the chief hindrances to a well-organized civil defense warning system. Generally, the paradox of local autonomy and federal direction requires resolution through adequate definition and practice.

The Federal part of the warning system needs further training. The attack warning personnel should be brought closer to NORAD, and should consider themselves as part of the larger team of air defense and civil defense. A normal test of the warning system suggests that the speed of dissemination is fast enough, but if communication outages occur, that speed will drop significantly. Exercising is needed to stress the system and to enable personnel to improvise according to their current situations. There is increasing awareness of the variables involved, but unlike some military systems, there has been dangerously little experience with operational exercise on a real-time basis with simulated missions. At both national and local levels, relatively little has been done to train for circumstances which require the occupation of alternative or backup facilities. These may not be in appropriate locations and sufficient communications for their effective utilization may not exist.

Evaluation of the present OCD training program indicates that an operational exercising capability or System Training Program can probe dynamic aspects of the system. With such a capability, organizational interfaces could be defined and operational proficiency determined. OPAL exercises do not constitute the type of real-time, dynamic, and practical exercises that are required.

Target priorities and damage scripts do not appear firmly linked to discernible exercises objectives. With the entry of DOD into civil defense, interaction with military units might facilitate realistic assessment. Interfaces with military organizations, utilization of public media for training purposes, extension of CONELRAD, backup communication networks, time-dated reports, increased encouragement of and requirement for participation, widely disseminated feedback reports, encouragement of mass media coverage, and possible inclusion of training needs in a state governor's conference agenda would improve subsequent exercises. The exercises should be held more frequently, with more specific objectives, should allow the possibility of more than a single strike, and should give immediate feedback on a national level when possible. Since NORAD is involved, the possibility of exercises with Canadian units should be considered, as well as OCD participation in the NORAD yearly exercise, Division STP runs, and Operation Sky Shield.

Finally, a System Training Program can provide important data on the functional problems related to warning which were outlined earlier in this chapter. Such information could be useful in training the current system or in comparing the effectiveness of different systems in coping with human factors issues. For example, for power line, wire line and electromagnetic systems, data could be gathered on the following problems: wolf-wolf, panic stereotypes, relay, coverage, message ambiguity, confirmation, interpretation and action, chronology, feedback, and subsequent messages.

CHAPTER TWELVE

COMPONENT AND SYSTEM TESTING

I. THE NEED FOR TESTING

The warning system requires that warning of an event of very low probability of occurrence be disseminated with a very high probability of success. These probability extremes create problems and complexities in testing. Just as an insurance company must ensure its ability to pay in case a claim arises, the warning system must also ensure its ability to pay off. There are many similarities between the warning system and a missile system such as Polaris or Minute Man; they must be constantly ready to perform a mission it is hoped will never be needed. To ensure that readiness, elaborate subsystem testing must be a routine and periodic activity.

In addition to these extremes of probability, testing of the warning system is also complicated by the human factor. If, in testing the system, the alarm is repeatedly sounded without people participating in the drill, it rapidly ceases to have meaning as an alarm. This cry wolf effect is one of the principal causes of the ineffectiveness of the present siren system. On the other hand, appropriate testing of an alert signal coupled with proper information and education can enhance the system's effectiveness.

II. THE FREQUENCY AND TECHNIQUES OF TESTING

A. PURPOSE

One purpose of testing is to detect failed or marginal components; another is to evaluate system capability. Since most devices are less than perfectly reliable, testing is needed periodically to isolate unsatisfactory components and eliminate them.

Components in the warning system must survive stresses which exist during its ready or standby condition and those which are imposed by the testing itself. In the extreme, components could actually be worn out by elaborate testing.

B. DETERMINATION OF FREQUENCY

The frequency of testing required for the civil defense warning system and its components may be determined by:

1. The failure rate of each component of the subsystem under standby conditions.

2. The required probability of operation of the subsystem.

3. The statistical probability distribution function (e.g., Poissin, Gaussian, Wiebull) that describes the reliability behavior of the component.

There are, of course, many factors influencing the reliability of a component. For instance, seasonal variations in weather may affect the performance and reliability. Some components may be vulnerable to hot, humid weather and others to extreme cold weather. If such seasonal variations are known, testing schedules may be adjusted accordingly.

With this knowledge, the annual frequency of testing of various components may be computed and the results used to establish testing policies. For example, suppose that the desired probability of operation of a civil defense receiver is set at 99% of the installed receivers. These receivers have a failure rate of .114% per 1000 hours, or, since there are 8760 hours per year, on the average an annual failure rate of 1% may be expected. On this basis, the receivers should be tested at least once a year. Suppose, however, that the failure rate was established on a small sample quantity and is not a very exact number. The available statistics imply from the standard error of the probability of operation (delivered from the selected distribution function) that the probability is .95 that the failure rate is less than .23% per 1000 hours. Therefore, to be 95% sure that not more than 1% of the receivers have failed, the testing rate is set at least once every six months.

Where a very large number of devices are involved (e.g., an estimated 60 or 70 million CD receivers), and where the components are to be repaired rather than replaced, the distribution of work in the repair shop should be considered. The work may be spread out by testing the whole system more often to pick up failures as they occur, or by testing a fraction of the system at appropriate intervals, e.g., 1/6 of the system every month.

C. TESTING TECHNIQUES

Although many system components can be adequately tested individually, others can only be tested partially, and some can be tested only by executing the intended function of the system or subsystem.

For instance, the timer in a NEAR receiver or in a pyrotechnic device (as in ammunition) can only be tested by trying to get the timer to operate.

For a test to be meaningful, success or failure of the test attempt must be made known to those performing it. In the case of civil defense receivers it may be impractical for a testor to observe personally whether all receivers are operating successfully and the testing system may have to depend upon the individual householder to report failures of the device. To elicit this cooperation, elaborate preparations and indoctrination of the public will be required.

On the other hand, signal generators and communication systems are quantitatively few enough to be tested thoroughly by qualified personnel. Components of these systems can be easily tested both individually and as parts of subsystems. Some of the testing activities which may be undertaken for each of the major systems considered in this report (power line, wire line, and broadcast) are presented in the next section.

III. CONSIDERATIONS FOR TESTING

A. POWER LINE SYSTEMS

For a power line system such as NEAR there are five major subsystems to test.

1. The signal activation network which extends from the warning center headquarters to the signal generators.

2. The phase control or synchronizing network which may be combined with the activation network.

3. The signal generators and line coupling capacitors.

4. The signal distribution network.

5. The individual warning receivers.

As the signal activation and phase control networks would probably utilize land lines provided by the local telephone company, standardized procedures which have been established for testing such circuits should be used for those purposes.

The signal distribution network is the ordinary power distribution system and is tested continuously by its normal usage. However, problems of signal strength and phase control do arise and must be checked.

NEAR signal generators require very high voltages in their operation. Also, the state of the art in silicon control rectifiers has not yet advanced sufficiently to insure the high degree of reliability required for their use in these generators. Additionally, signal generators will be normally installed in outdoor switch yards exposed to extremes of environment. The performance of semiconductor devices is critically dependent upon surface conditions of the semiconductor and particularly to moisture intrusion or inclusion. Hence, frequent testing of the generators may be expected. Also, since the NEAR receiver contains a timer which requires the signal to be on for at least 10 seconds before the buzzer is activated, it is possible to test the generator without sounding an alert.

Receiver testing is complicated by the cry wolf problem. Partial tests may avoid this problem, but the effectiveness of complete tests will require considerable cooperation and sophisticated observation on the part of the public to detect and report malfunctioning devices. Testing of the timing and relay mechanisms is important in that the vibrating reed electromagnet is subjected continuously to a 120 volt, 60 cycle stress and relay contacts may become corroded or the clock lubricant could harden. These would either preclude or degrade the alerting signal. The clock and buzzer may be tested separately by supplying manual bypass switches on the receiver. An indicating device in parallel with the clock would make it possible to indicate the successful operation of the vibrating reed relay during the brief tests of the signal generator. However, complete system tests require the cooperation of the public, and an extensive educational program would be required to elicit the necessary response.

B. TELEPHONE SYSTEMS

The type of system used will determine the problems of testing a telephone warning system. If the existing telephone system is utilized, most of the equipment is employed in normal usage and may be considered as being called continuously self tested. Equipment not in normal usage will be in the control office and may be checked by the routine maintenance procedures of the regular central office maintenance staff.

If a separate telephone warning system is used, the same problems arise as those that exist for any other system employing individual warning receivers. Principally, ways must be devised of monitoring the performance of individual receivers during a test. The problem is eased somewhat by the continuity of the phone lines and the connecting devices which can be checked from the central office.

The basic problem in testing receivers is in imparting knowledge of the test to those in attendance at <u>inoperative</u> receivers. Telephone systems, as broadcast systems, have the advantage of employing voice messages. Recipients may be reassured that this is a test. If the receiver is inoperative, the recipient will be neither falsely alerted nor reassured. Like the Two Black Crows vaudeville routine: "I'll meet you on the corner of First and Main. If you get there first, make a mark on the lamppost. If I get there first, I'll rub it off," an announcement to the effect that "if you don't hear this civil defense announcement, take your receiver to the nearest repair station" will not suffice. Media other than the warning system must be used to elicit cooperation and ensure adequate test results.

C. BROADCAST SYSTEMS

Many similiarities exist between testing broadcast systems and testing special telephone systems. The signal activation network and signal generator can be individually tested by the normal central office maintenance personnel, but the individual receivers must be tested by transmitting the activating signal followed by the test voice message. Recipient cooperation must be elicited in identifying inoperative and marginal receivers and in getting these repaired or replaced.

Partial tests of broadcast receivers may be made by equipping them with a push button to bypass the audio activating relay, permitting the normal station program to be heard. However, although this tests part of the receiver, it does not test the activating signal demodulator and vibrating reed relay. Occasional tests of these elements will be necessary.

Other tests must be made of broadcast systems to ensure message coverage under various conditions. This is, of course, as much a system operation evaluation as a component test. It involves checking for the existence of blind spots and screening as well as extent of coverage and signal strength under varying atmospheric conditions in order to assess broadcast system performance.

CHAPTER THIRTEEN

AREAS FOR FURTHER RESEARCH

I. INTRODUCTION

The constraints of time, manpower and the required focus imposed by the contract objectives necessarily limited the warning requirements study to the establishment of basic requirements, performance characteristics, and a general survey of feasible warning systems. However, numerous areas requiring further research were uncovered in the course of the study either as necessary expansions of this effort or as studies tangential to it. These areas include technical studies required prior to system selection, and studies of a more general nature dealing with operational and organizational functions. These are discussed generally throughout this document and several efforts are detailed in Chapter Ten Implementation. Other areas for further research are expanded on here.

II. UTILIZATION OF RADIO FOR WARNING

In order to determine the effectiveness and cost of a radio based civil defense warning system, it is necessary to carry out two coordinated studies. One of these is to examine in detail the coverage of the populated areas of the United States which can be obtained by means of the three media: AM radio, FM radio, and TV. For AM radio, both daytime and nighttime coverage should be considered, utilizing only full time stations.

The second study is to develop and field test a civil defense warning receiver. One such device, which is set forth in an SDC invention disclosure, uses a frequency modulated subcarrier in the upper part of the audible frequency range. This device, and others, require further investigation, development, and testing.

An optional third study is laboratory research exploring the comparative effectiveness of an array of coded signals and voice messages. Such an effort would serve as a pilot study, screening less effective methods or messages as a prerequisite for more elaborate field tests.

III. UTILIZATION OF TELEPHONES FOR WARNING

A study should be made of the cost required to convert present telephone central offices so as to be capable of disseminating a distinctive alerting ring (i.e., a different cadence from the normal ring) and a warning message when a receiver is picked up. The first phase of this study should be aimed at determining its competitiveness to NEAR on a 10 year cost basis. Only if competitiveness is indicated should a more detailed Phase 2 development, testing, and costing be performed. The primary concern about the cost of telephone warning systems results from the very wide divergence of cost estimates made previously for this type of warning system.

IV. IMPLEMENTATION OF AN AUTOMATIC WARNING SYSTEM

Plans and specifications should be developed for the specific circuits and equipments required to implement the operational requirements established in Chapter Six of this report. Chapter Ten provides the outline to be followed in the implementation of this capability and discusses, in some detail, some of the research efforts required.

V. USE OF MILITARY SERVICES

The organization and administration of the warning system should be examined to determine interfaces with the military and the impact of various potential utilizations of military forces, in conjunction with civilians, in the warning system. Army units, reserve forces, and State National Guard forces should be looked at to determine what capability these units have to maintain and/or operate the system. The operation of other systems (e.g., Canadian) should be analyzed to determine areas of potential applicability to the United States. Other complex issues such as capability, training, and maintenance should also be considered in this study.

VI. THE DECISION TO WARN

The Warning Requirements Study has recognized the importance which the decision to warn has in the process of warning. This study, in its determination of operational requirements, has specified levels of decision making but did not address itself directly to the problem of decision making itself, particularly at the national level. Additional study is required to determine the general and specific relationships that OCD attack warning personnel have with the NORAD Command Control Structure. The specific factors that influence the making of the national decision to warn the general population should be determined. Who makes these decisions, under what conditions, and utilizing what kind and types of data, must be determined. Could this type of decision making be more effectively maintained in an environment which differs from that of OCD? As indicated in Chapter Ten, it appears that warning of civilians is a civilian function but the civilian-military interface is not clearly defined and until it is, only a subjective answer may be supplied to these questions.

VII. ALERT CONDITIONS

As indicated in Chapter Ten, there is a need for the establishment of a schedule of alert conditions for use by civil defense. These would provide the means by which civil defense organizations (Federal, state, and local) may be alerted to changing defense readiness postures, and which will provide helpful, meaningful guides for these organizations in their planning activities. These alert conditions must be standarized and appropriate for use at all levels of the system. This is primarily a design and development effort, as the need has been fairly clearly established. Military defense readiness conditions (DEFCONS), although in some cases helpful, are not always applicable for they were not designed for civil defense usage.

VIII. INFORMATION PROCESSING

Attack Warning Centers, OCD Regional Offices, and State Civil Defense Headquarters, in many cases, have common requirements for the storage, processing, and retrieval of information. Intelligence data, incident data, resource data, and weather forecast data all play a significant part in the operation of these facilities and in the successful fulfillment of their mission both to warning and civil defense. In light of the organizational requirements set forth in this study, and in consideration of the over-all implementation tasks, these facilities should be analyzed to determine what assistance data processing would provide in their operation. Data base outlines could be provided as an outgrowth of this study, which assist in determining areas of mutual interest and concern and in identifying overlapping efforts.

A specific example is in the area of local attack effects warning. Warning of attack effects requires that several things be accomplished before the warning is issued. The first of these is the provision of means and methods whereby chemical, biological, and radiological attack hazards may be rapidly detected and evaluated. The implications of these hazards on the local community must be determined, and, finally, appropriate warning and information must be issued. Apart from the local considerations, data on damage, surviving resources, spread of chemical, biological and radiological agents, etc., must be collated and assessed at successively higher levels of the warning system. The question of how much data, in what format, and what should be done with it has not been resolved. Research is required to determine these requirements and information needs at each level.

IX. MESSAGE FORMAT - CONTENT

Based on factors adumbrated in Section III of Chapter Eleven, a comparative analysis of different message format-content types appears warranted. This study should include investigation of flexibility, coherence, redundancy, and channel capacity as well as information needs and requirements of both civil defense and governmental officials and the general populace.

X. HUMAN REACTIONS TO ALERT SIGNALS AND WARNING MESSAGES

The functional problems identified in Chapter Eleven offer broad guidelines for a study on human reactions to alert signals and warning messages which might be conducted concurrently with the format-content project suggested in Section IX above. As a unique area it includes issues such as interpretation and action, message ambiguity, chronology, feedback, panic stereotypes, relay and false alarm probabilities. Ultimately data on such issues should be related to training of both civil defense officials and the populace for each system considered.

APPENDIX A

DESCRIPTION OF THE CIVIL DEFENSE WARNING SYSTEM

I. INTRODUCTION

The purpose of this system description is to describe the civil defense warning system as it exists in the United States. This appendix, prepared in July, 1962, forms the basis for the analysis of the system which is reported in the body of this document.

The contents of this description have been derived primarily from published material pertinent to the operation of the existing civil defense warning system. Also, data obtained from staff visits to various centers and other agencies has, wherever possible, been incorporated into the document.

Section II of this system description deals with definitions, requirements, and the mission of the civil defense warning system. Section III is an overview which gives the history of the warning function, and describes the present role of the Department of Defense in the warning system. After a short summary which indicates the joint responsibility for warning shared by Federal, state and local governments, and the individual, Section IV deals specifically with the components and functions of the Attack Warning System at all levels. Section V describes CONELRAD indicating its changing nature, and Section VI describes the National Emergency Alarm Repeater (NEAR) and its current development. To aid in the utilization of the maps contained in Section IV, Section VII provides a facility listing of the National Warning System.

II. GENERAL

A. DEFINITION OF WARNING

The National Plan, Annex 13, Warning, defines warning as the "alerting of people to the threat of extraordinary danger and the related effects of disaster."[1] Warning about the following actions are included within the scope of the warning definition, but do not necessarily limit it.

1. Hostile aircraft and missiles
2. Invasion
3. Biological and chemical warfare agents
4. Radiological contamination
5. Clandestinely introduced weapons
6. Conflagration
7. Various natural disasters, which could include:[2]
    a. Flood
    b. Drought
    c. Fire
    d. Hurricane
    e. Earthquake
    f. Storm or other catastrophe resulting in damage, hardship, or suffering

Implicit within this definition are the responsibilities for governmental facilities to collect, evaluate, and disseminate necessary information. As amended one year later, in Appendix 1 to Annex 13, of the

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1. Office of Civil and Defense Mobilization. National Plan for Civil Defense and Defense Mobilization, Annex 13, Warning, September 1959, p. 1.
2. National Plan, Annex 40, Natural Disasters, April 1960, p. 1.

National Plan (September 1960), warning is stated in somewhat more specific terms: "Warning is the alerting of civil defense forces and the general public to the threat of extraordinary danger and the related effects of both enemy caused and natural disasters."[1]

B. WARNING SYSTEM REQUIREMENTS

The requirements from which the present civil defense warning system has evolved have not been explicitly stated in the National Plan as requirements. Implicitly, they are contained within Annex 13, Warning, as objectives which are to be realized for various civil defense warning functions.

The objectives form broad system requirements and the partial fulfillment of an objective may completely fulfill one or several specific operational or performance requirements. In the absence of the specific system requirements objectives of the system to fulfill the warning function as it was defined in the National Plan are included below:

> "To assure the availability of adequate means and methods for disseminating warning.
>
> To assure proper public recognition of and response to warning signals.
>
> To obtain prompt and accurate information on impending or existing attack and other dangers.
>
> To warn all concerned of attack and other dangers in time for proper protective actions."[2]

C. WARNING SYSTEM MISSION

The mission of the present civil defense warning system is not explicitly stated although Annex 13, Warning, of the National Plan states "the principles, responsibilities, requirements and broad courses of non-military action incident to this subject.'[3] These requirements

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1. Office of Civil and Defense Mobilization. Procedures for Warning Points, State and Local Warning Operations Manual, Appendix 1 to Annex 13 (NP-13-1), National Plan Appendix Series, p. 36.

2. National Plan, Annex 13, Warning, op. cit., p. 34.

3. Ibid., pp. iii.

have been stated in terms of broad functional objectives. The definition made in civil defense documentation of what constitutes warning, coupled with the objectives of warning, can only provide the implicit system mission.

The Federal Civil Defense Act of 1950, in outlining the responsibilities of the Director of the Federal Civil Defense Administration, speaks of the authorization delegated to the Director to "make appropriate provision...for dissemination of warnings of enemy attack to the civilian population." [1]

D. TYPES OF WARNING

As outlined in official publications, civil defense planning must be kept flexible so as to deal with all possible situations. Warning of hostile intentions or attack may come in three ways:

1. Strategic Warning

Strategic warning is knowledge of "indication of a possible attack in advance of its launching." With reference to strategic warning, the National Plan, Annex 1, Planning Basis, states:

> "It is possible that there might be strategic warning of an all out nuclear attack on the United States. Strategic warning may range from verified information of an enemy's intent to attack to an accumulation of many interconnected actions and reactions interpretable as indication of a potential enemy's probable intention to attack the United States. Despite the possible difficulty of recognizing strategic warning, there might well be evidence of such a high degree of probability of attack that it would appear only prudent to take certain steps in military, civil defense, economic, and political fields to greatly accelerate readiness measures."[2]

2. Tactical Warning

Tactical warning is defined as "warning by mechanical or electronic means to the effect that the enemy attack has been launched."[3] The National Plan, Annex 1, Planning Basis, issued in June of 1959, states:

1. Federal Civil Defense Act of 1950, Section C, 64 Stat.: CH 1228, 81st Congress 2nd Session, 12 January 1951, p. 1248.
2. National Plan, Annex 1, Planning, June 1959, p. 8.
3. Ibid., p. 9.

"It is assumed that for the next few years, during which weapons delivery systems for attack on the United States would consist mainly of manned aircraft, the probable maximum tactical warning for the nation as a whole would be about 3 hours. Thereafter when delivery systems would consist mainly of guided or ballistic missiles, maximum tactical warning of initial attack would be reduced to one-half hour for the nation as a whole."[1]

3. No Warning

There may be no strategic or tactical warning, i.e., the first detonation may be the first warning. An attack without warning may evolve from a breakdown in the acquisition and processing functions or from a failure or inadequacy in the means of detection. Specific situations which might tend to promote this probability will be dealt with in the discussion of threat. However, a "no warning" situation for everyone is difficult to conceive and while there may be no warning for certain targeted areas, warning may be provided for other areas, if means of dissemination or the warning information are readily available.

III. OVERVIEW

A. HISTORY OF WARNING FUNCTIONS

The responsibility for warning the civilian population has been assigned to a civilian agency since 1952. In July of that year, the newly formed Federal Civil Defense Administration assumed from the Air Force (Air Defense Command) the responsibility for dissemination of warnings of enemy attack to the civilian population. Under Title II of Public Law 920, the FCDA Administrator was authorized to..."make appropriate provision for necessary civil defense communications and for dissemination of warnings of enemy attacks to the civilian population."

Reorganization Plan No. 1 of 1958 consolidated the Federal Civil Defense Administration and the Office of Defense Mobilization into one agency, the Office of Defense and Civilian Mobilization. All functions heretofore carried out by these organizations were then transferred into the new agency housed within Executive Office of the President. The OCDM, as it became known, was in existence from July of 1958 until August 1961. During this period, the National Plan[2] was written.

1. Ibid., p. 8.
2. Office of Civil and Defense Mobilization. National Plan for Civil Defense and Defense Mobilization, October 1958.

This plan, its annexes and appendices state responsibilities, requirements, and actions which are required for the conduct of civil defense at all levels of government.

Several annexes and appendices of the National Plan appear to have had a significant effect upon the development of the existing warning system, in particular, Annex 1, Planning Basis; Annex 4, Authorities for Civil Defense and Defense Mobilization; Annex 13, Warning; and Annex 15, Communications. These annexes and others have been utilized in the preparation of this description.

B. ROLE OF THE DEPARTMENT OF DEFENSE

On July 20, 1961, Presidential Executive Order 10952 was issued which transferred the operating functions of civil defense from the OCDM to the Department of Defense. The functions of particular concern to the description are the following: "...All steps necessary to warn or alert Federal military and civilian authorities, state officials, and the civilian population; all functions pertaining to communications including a warning network, reporting on monitoring, instructions to shelters, and communications between shelters."[1]

The Secretary of Defense is also to "develop plans and operate systems to undertake a nationwide post attack assessment of the surviving resources including systems to monitor and report specific hazards resulting from the detonation or use of special weapons."[2]

At this time, it was also the stated intention of the Department of Defense to utilize the Defense Communications Agency as manager for civil defense communications.[3]

Effective 1 August 1961, the complete civil defense warning responsibility was vested in the Department of Defense. Secretary of Defense McNamara stated that the administration of the overall civil defense program within his department would be guided by four principles:

> "The civil defense effort must remain under civilian direction and control... It requires the closest and most sympathetic cooperation between the Federal civilian authorities and the state

1. Hearings Before a Subcommittee of the Committee on Government Operations, House of Representatives, Eighty Seventh Congress, First Session. Civil Defense 1961, Washington 1961, Appendix 3A, Executive Order 10952, p. 379.
2. Loc. cit.
3. Ibid. Letter from Roswell L. Gilpatric, Deputy Secretary of Defense, to Hon. R. Walter Riehlman, pp. 552-553.

and local governments.

In the age of thermonuclear war, civil defense must be integrated with all aspects of military defense against thermonuclear attack.

The civil defense functions of the Department must not be permitted to downgrade the military capabilities of our Armed Forces.

Whatever expenditures are undertaken for civil defense projects must be directed toward obtaining maximum protection for the lowest possible cost."[1]

1. Office of Civil Defense

An Office of Civil Defense (OCD) administered by the Assistant Secretary of Defense for Civil Defense has been established within the Department of Defense.

The responsibilities for warning as they were outlined in the National Plan (for the Federal government) will be found within this organization. These responsibilities deal with:

"a. Establishment and maintenance of a national warning system...

b. Declaration and dissemination of warnings to the state governments and by special arrangements, directly to political subdivisions...

c. Assisting the states and local governments in warning the people."[2]

The national warning system and the functions of declaration and dissemination of warning are the subjects of specific treatment in this description.

2. North American Air Defense Command (NORAD)

The agency which has the responsibility to declare various defense conditions and states of alert, and to disseminate warning information to military and selected civil agencies, is the North American Air Defense Command (NORAD). NORAD's mission is to defend the continental United States, Alaska, and Canada against air attack.[3] The responsibilities and procedures for NORAD dissemination of air

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1. Ibid., p. 5.
2. National Plan, Annex 13, Warning, op. cit., p. 2.
3. Headquarters, North American Air Defense Command. NORAD - Organization and Function, Ent AFB, Colorado, August 1961, p. iii.

defense warnings and defense readiness conditions are outlined in NORAD Regulation 55-12, Air Defense Warning System for North American Continent, dated 15 July 1961.[1]

The specific responsibility for NORAD dissemination of warning is as follows. "The United States Joint Chiefs of Staff and the Canadian Chiefs of Staff Committee have charged the Commander-in-Chief, North American Air Defense Command with the responsibility for disseminating air defense warnings and defense readiness conditions for the North American Continent. To discharge this responsibility, provisions are made for initial notification to be disseminated to a limited number of key points; key points, in turn, are responsible for further dissemination of this information (i.e., U.S. Army Headquarters to posts, camps and stations; U.S. Navy Districts to Naval air stations and bases; RCAF to COSC; Federal Aviation Agency Air Route Traffic Control Centers to designated Air Force and Air National Guard bases."[2]

The NORAD dissemination of warning is accomplished by two methods. Dissemination to military agencies and the FAA is done through a military warning system, and dissemination to the OCD is done by direct liaison with OCD representatives at NORAD headquarters and the various NORAD regions. The military warning system consists of a teletype Readiness and Warning network connecting NORAD Headquarters, NORAD regions and other key United States and Canadian agencies; and a NORAD Military Air Defense Warning network (MADW) which is a combination of teletype and phone circuits used to pass warnings, defense conditions, CONELRAD (control of electromagnetic radiation) messages, and NUDET (nuclear detonations) reports between FAA centers and NORAD regions and sectors.

NORAD responsibilities to the civilian attack warning system are specified in NORAD 55-23, Memorandum of Understanding Concerning the Civilian Attack Warning System Between OCDM and NORAD, dated 19 February 1959. These responsibilities are in part as follows:

> "Plan for the participation of OCDM in the defense of the United States, including Alaska, insofar as air defense warnings are concerned, and coordinate such planning with the OCDM Liaison Office at Headquarters NORAD and OCDM representatives at subordinate NORAD levels.

1. Headquarters, North American Air Defense Command; Headquarters, Continental Air Defense Command, Operations. Air Defense Warning System for North American Continent, NORAD/CONAD Regulation 55-12, Ent AFB, Colorado, 15 July 1961, Sec. 2, p. 1.
2. Loc. cit.

Display and evaluate the air defense situation in order to determine when and where an Air Defense Emergency and Military Air Defense Warnings are required, and specify the degree of such warnings.

Notify the OCDM National Warning Center and the OCDM Warning Officer on duty at Regional COC's whenever an Air Defense Emergency is declared or terminated, and whenever the degree of military warning is changed. Also, make available all information regarding implementation or termination of CONELRAD.

Provide information on implementation or termination of SCATER where available.

Provide tactical surveillance information as required by NORAD for the Air Defense Mission to the OCDM Warning Centers for their use in accomplishing the civil defense responsibilities.

Advise the NORAD OCDM Liaison Office and OCDM representatives at subordinate NORAD levels of any change in plans for SCATER, CONELRAD and other matters deemed to be related to civil defense.

Coordinate plans directly affecting civil defense with the OCDM Liaison Officer."[1]

IV. NATIONAL CIVILIAN ATTACK WARNING SYSTEM

A. GENERAL SUMMARY

In the United States, warning of attack is disseminated to the civilian population over the Attack Warning System (AWS). This system composed of Federal, state, and local elements provides for the dissemination of warning information from Federal warning centers colocated with military air defense headquarters, to the civilian population through an integrated if not totally coordinated effort. See Figure 1 for the flow of warning information through the system.

The agencies which share responsibility for the dissemination of civilian warning are the Federal, state, and local governments. Their

1. Headquarters, North American Air Defense Command, Operations. Memorandum of Understanding Concerning the Civilian Attack Warning System Between OCDM and NORAD, NORAD Regulation 55-23, Ent AFB, Colorado, 19 February 1959, pp. 1-2.

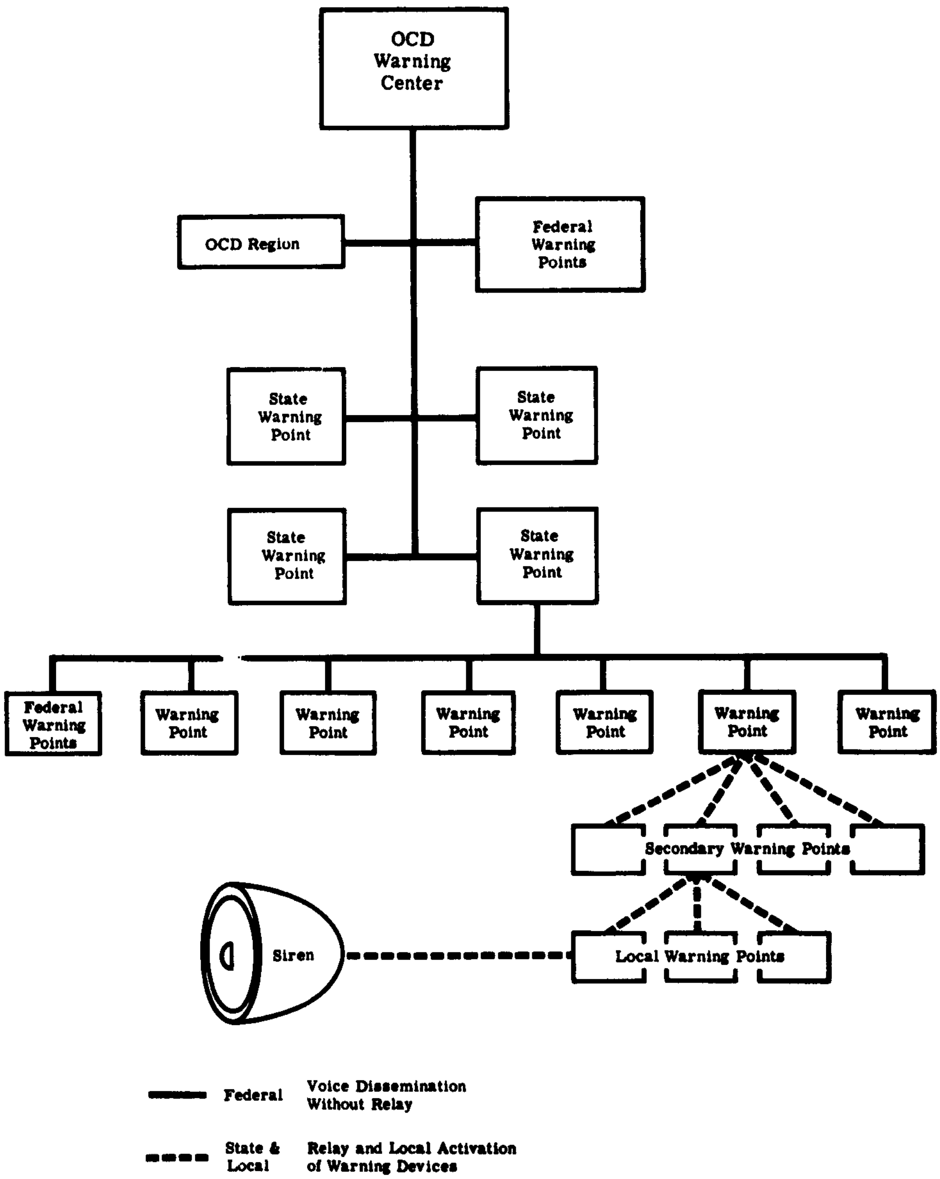


Figure 1. Civil Defense Warning Area

responsibilities deal with declaration and dissemination of air raid warnings, prescribing the actions to be taken upon receipt of warning, and the development of local warning procedures and understanding.

The Federal portion of the system consists of full period leased voice telephone circuits which interconnect OCD warning centers with Federal, state and local warning points. This portion is called the National Warning System (NAWAS).

State portions of the network include facilities and equipments needed to further distribute the warning to the local governments. These include public safety radio, bell and light, telephone, and teletype networks as primary means of communication. Local warning systems include telephone, bell and light, and radio systems to further relay the warning, and finally the actual warning devices utilized to disseminate the warning to the civilian population. The siren is the principle warning device utilized for alerting, and the warning signals employed by the local agencies after the receipt of an air raid warning message are as specified in the National Plan, the "alert" and/or the "take cover" signal. Warning time and the local civil defense planning determine the appropriate signal to be utilized. Means of warning transmission are shown in Figure 2.

B. FEDERAL PORTION

1. Responsibilities

The Federal government is responsible for the establishment and operation of the National Warning System (NAWAS), which is the Federal portion of the AWS. NAWAS is directed by the Warning Office, Communications and Warning, OCD. This office is responsible for the overall administration and supervision of the system. A liaison officer is assigned to NORAD Headquarters to ensure that there is a close working relationship between NORAD and OCD.

2. National Warning System (NAWAS)

NAWAS consists of two full period voice telephone circuits leased from the telephone companies, and allows for the dissemination of warning from the initiating source (usually the National Warning Center at Colorado Springs) simultaneously, and without relay to nearly 500 Federal and civilian warning points within the United States.

a. Components

One of the two full period voice telephone circuits is the

Process	Federal	State	Local
Full Period Leased telephone Circuits	P	P	P
Long Distance Toll Telephone	S	S	
Local Telephone			S
Teletype		S	
Bell and Light		S	S
HF/VHF Radio		P	
Siren			P
Public Address			S
Muzak — Type			S

P Primary Means

S Secondary Means

Primary and Secondary means are based on nationwide coverage. Individual states may vary, e.g., California and Pennsylvania use Bell and Light as Primary means.

Figure 2. Means of Warning Dissemination

NAWAS warning circuit. This circuit is designed to permit dissemination of warning simultaneously from a single source, normally the National Warning Center, or on an area basis from an OCD warning center. The NAWAS warning circuit interconnects the following points:[1]

1) National Warning Center - NORAD Headquarters, Colorado Springs, Colorado

2) OCD Warning Centers - At the six NORAD Regions

3) Warning Branch Headquarters

4) Canadian National Warning Center - Ottawa

5) (Classified Location)

6) OCD Regional Headquarters

7) Federal Warning Points

8) State Warning Points

9) Warning Points

The OCD Regions and regional boundaries are displayed on Map 1. OCD warning areas may be found on Map 2, which displays the NAWAS portion of the AWS. A complete listing of attack warning facilities is contained in Section VII of this Appendix.

The second of the two NAWAS full period telephone circuits is the control circuit. The control circuit interconnects the following locations:[2]

1) National Warning Center

2) OCD Regional Headquarters

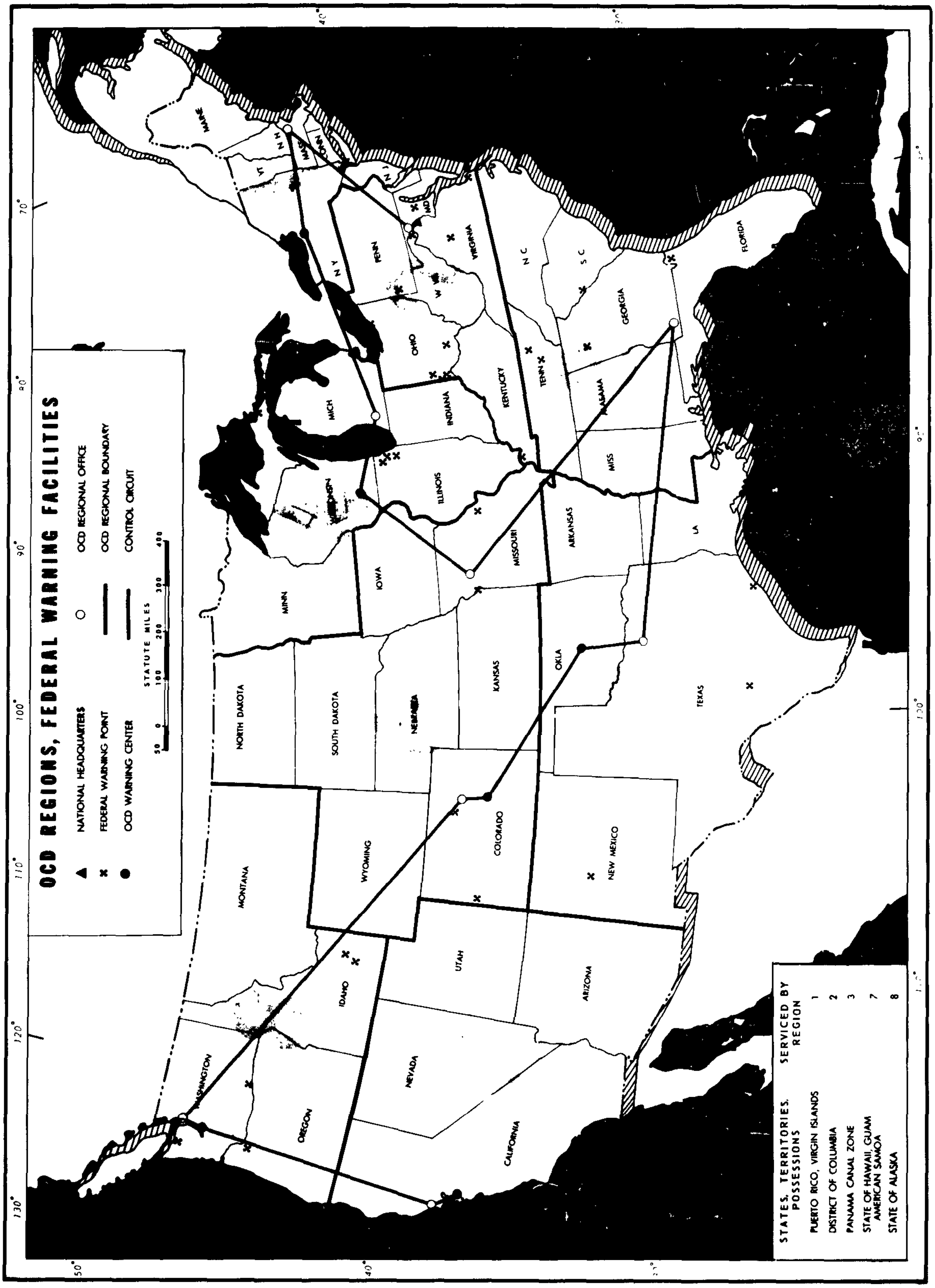
3) Warning Branch Headquarters

4) OCD Warning Centers - NORAD COC's at the six NORAD regions

5) (Classified Location)

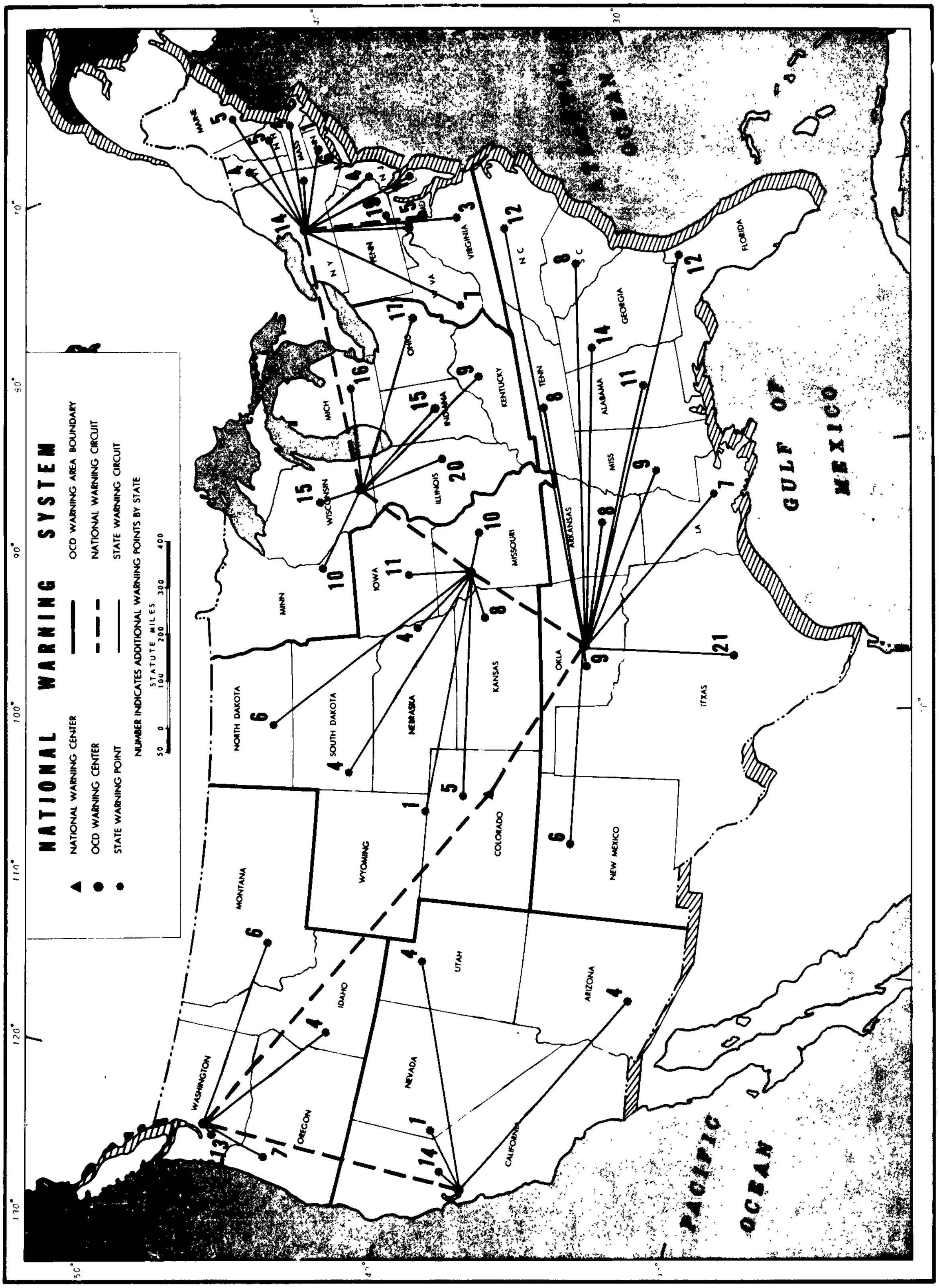
1. Office of Civil and Defense Mobilization Warning Office. OCDM Warning Center Procedures for Operation of the National Warning System, Federal Warning Operations Manual, November 1960, pp. 2-1, 2-2.
2. Ibid., pp.2-4

APPENDIX A



Map 1

APPENDIX A



Map 2

APPENDIX A

The NAWAS control circuit is normally utilized for the exchange of tactical information and for some administrative purposes. The passing of unclassified surveillance information between warning centers is accomplished on the control circuit. At certain locations, the control circuit may be interconnected with the warning circuit to provide a backup capability. However, the control circuit is normally not used for the dissemination of warning, as it does not connect the warning centers with the states or with the civilian warning points within a state.

The National Warning Center at NORAD Headquarters is the primary control point for NAWAS and, as such, provides notification to all facilities on the NAWAS warning net of an initial air raid warning. The OCD responsibility is both to declare and disseminate the civilian warning, and is dependent upon decisions of the Commander in Chief NORAD.

The National Warning Center, upon the receipt of any change in normal readiness at any of the NORAD facilities, advises the following:[1]

1) OCD Warning Centers

2) OCD Regions

3) Washington Area Control Point

4) Warning Branch Headquarters

Additional functions of the National Warning Center include: to disseminate CONELRAD and SCATER announcements; provide control and coordination for the other warning centers, and assume their warning functions if necessary; disseminate unclassified tactical surveillance information over the NAWAS control circuit; and to provide a cross-talk capability with other warning centers.[2]

The NAWAS warning circuit is normally divided into areas warning circuits. Three of the OCD warning centers, and the National Warning Center have the capability of interconnecting area warning circuits. Figure 3 indicates the warning centers which have this capability. Important to note is the fact

1. Ibid, p. 1-2.
2. Loc. cit.

APPENDIX A

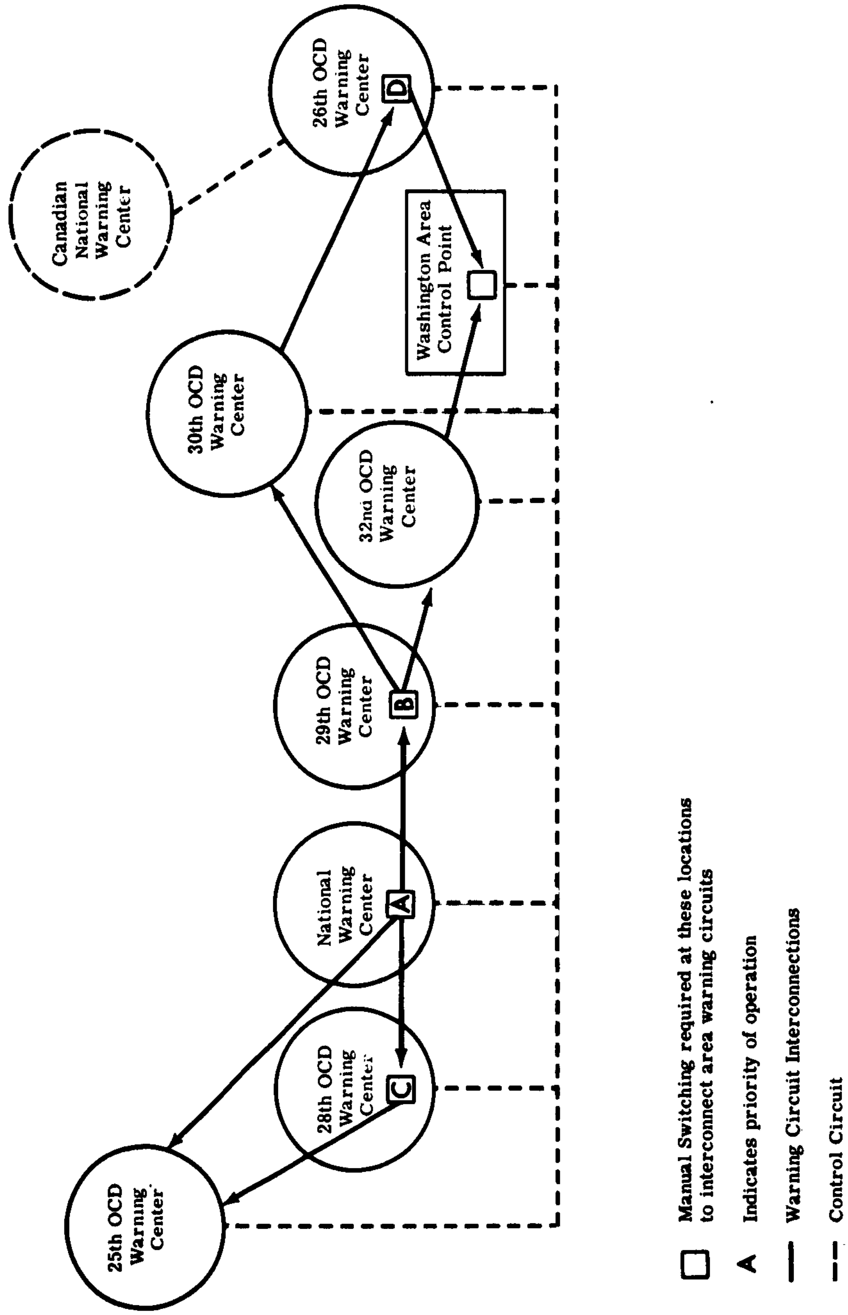


Figure 3. Federal Warning Network

that the OCD warning centers will normally be advised on the control circuit by the National Warning Center when they are to manually connect the area warning circuits. There is no master switch for connecting the warning circuits together, and in order for the warning to reach the 26th warning area on the warning circuit, two manual connections must be made. One of these is done at the 29th Warning Center to connect in the 30th, and the other by the 26th, which connects itself with the 30th. The 26th Warning Center also may connect in the Canadian Federal Warning Center at Ottawa. When the warning circuit is separated into area warning circuits the National Warning Center as the NAWAS control point functions as an attack information source for all the OCD warning centers and uses the control circuit for dissemination. The National Warning Center must at all times be capable of taking over the warning circuit.

b. Procedures

Staffs of OCD personnel have been assigned to warning centers within the NORAD Combat Operations Centers at NORAD Headquarters and at each of the NORAD Regions. Each of these OCD warning centers has the capability to initiate an air raid warning, either through the National Warning Center or through the other OCD warning centers. Space has been provided within the NORAD COC's for the OCD staffs, and their joint operating responsibilities are as outlined in NORAD Regulation 55-23, Memorandum of Understanding Concerning the Civilian Attack Warning System between OCDM (now OCD) and NORAD, dated 19 February 1959.

The staffs are on duty 24 hours a day at the National Warning Center Colorado Springs, and at the COC's of the 26th, 29th, and 28th NORAD Regions. At other regional centers, i.e., the 25th and 32nd and 30th, OCD manning is not presently sufficient to provide for 24 hour operation, but a manual switching capability to interconnect these OCD warning areas to the other fully manned warning centers is provided, thus maintaining a continuous capability for the dissemination of warning. Figure 3 displays the normal warning flow, the manual switching capability, and priorities for manning of the regional warning centers.

During normal operations, the NAWAS warning cirucit is separated into area warning circuits which are totally controlled by the OCD warning centers. See Map 2 for display of warning areas. The national warning center will request OCD warning centers over the control circuit to connect their warning circuit switches, which, as can be seen from Figure 3, will interconnect all area warning circuits allowing the National Center circuit control.

The OCD warning centers also have the capability of interconnecting the control circuit with the warning circuit. This is accomplished through the use of a grouping key and an associated signal lamp. The purpose of interconnecting the two circuits would be to disseminate warning information over the control circuit in an area where the warning circuit was inoperative. The grouping key would then serve to bridge a gap between two points. It is necessary that two locations operate the grouping key where there is a warning circuit outage. The National Warning Center would normally specify the locations which would operate the grouping key.

The OCD warning centers have many of the same responsibilities as does the National Center, i.e., providing circuit control, advising other centers of changes in defense conditions, and receipting and disseminating supplementary warning information after the declaration of the initial air raid warning by the National Warning Center.

The OCD warning centers supply supplemental information which includes the following:

"1) The Warning centers provide computation and dissemination of estimated warning times and other attack information to points within the warning area.

2) They exchange information of an unclassified nature with each other utilizing the control circuit.

3) They are the recipients of NUDET reports from the warning points. They also have available to them the military reports of nuclear detonations. OCD warning center personnel screen these reports and provide information to the OCD Regions and the operational headquarters via NAWAS.

4) Warning centers also receive reports of downed aircraft, nuclear accidents, natural disasters, etc., and provide a coordination/liaison function with the military and other responsible agencies.

5) If the circumstances require, OCD warning centers will take over the functions of the National Warning Center. If the National Warning Center at Colorado Springs is in-

activated, the following take-over priority is established:

a) 29th OCD Warning Center

b) 28th OCD Warning Center

c) 26th OCD Warning Center

d) Any other Warning Center."[1]

C. STATE AND LOCAL

1. Responsibilities

Like the Federal government, state governments and local governments also have the responsibility to establish warning systems and provide for the further dissemination of warning in their areas. The state and local governments, however, have an all important additional responsibility to prescribe the actions to be taken upon the receipt of warning.[2]

Annex 13 of the National Plan puts particular emphasis on the actions to be taken upon the receipt of warning, stressing that the actions to be taken are to be based upon local decisions predicated on state and local civil defense plans.

These actions will be based upon preplanned procedures which are normally outlined in state civil defense plans. As outlined in Annex 13, the actions may fall into one of two general categories: to evacuate or disperse, or to take shelter.

> "Target cities and other areas near assumed targets will, if time and conditions permit, execute plans for evacuation or dispersal to prepared reception areas.... If time and conditions do not permit evacuation, full advantage will be taken of existing shelter, and fallout protection will be improvised."[3]

Detailed responsibilities of the state and local governments are as outlined below.

> "a. Operate in conjunction with OCDM (OCD) Warning Points in accordance with Federal-state arrangements. (The criteria for the selection of the warning points will be discussed in a later part).

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1. Ibid., pp. 1-3, 1-4.
2. National Plan, Annex 13, Warning, op. cit., p. 2.
3. Ibid., p. 5.

b. Establish, maintain, and operate warning systems and devices, with financial and technical assistance from the Federal government.

c. Provide, in accordance with section 10.9 of FCC rules, for the dissemination of attack warning by those existing public safety communications system as needed.

d. Issue and publicize instructions for action to be taken by governmental agencies, industries and institutions and the public upon the receipt of warnings.

e. Develop a capability to transmit to OCDM (OCD) warning centers information concerning nuclear detonations, fallout, and chemical and biological hazards occurring in the area.

f. Conduct periodic tests and exercises to determine the operational capability of their portions of the Attack Warning System.

g. Conduct training courses for their warning personnel.

h. Develop plans for warning point personnel to use in determining the public action signal to be sounded when competent authority cannot be located within a specified time."[1]

2. State and Local Systems

The establishment of civilian warning points has gradually evolved from a total of 174 in 1953 to 449 by the 30th of June 1961.[2] Present plans are to bring the total to 500 by the end of FY 1962.[3] The establishment of Federal warning points on the NAWAS System has been a more recent program, and involves the locating of warning points at certain selected Federal facilities. The United States Coast Guard has 12 stations on the net. Also represented are the United States

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1. Ibid., p. 7.
2. Office of Civil and Defense Mobilization. Annual Statistical Report, Progress Report, Fiscal Year 1961, Battle Creek.
3. Warning point totals as of 1 April 1962 were 46 Federal and 464 warning points within states. Reference: Letter from Virginia A. Staggers, OCD, to W. R. Warren, System Development Corporation, 6 April 1962.

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Army; Atomic Energy Commission; General Services Administration; Department of Health, Education, and Welfare; Tennessee Valley Authority; and Bonneville Power Administration. Federal warning points numbered 46 as of 30 June 1961.[1] Annex 1 contains a facility listing of Federal and civilian warning points.

Warning points which are the normal terminus points for the NAWAS warning circuit, relay the warning messages on to secondary and local warning points within their area of responsibility. The dissemination of the warning message from the OCD warning centers to the 500 warning points on the NAWAS net in the United States, takes approximately 15 seconds.[2] Further dissemination of warning and acknowledgments over the state and local portion requires more time (averaging 7 minutes in a 1959 test) to reach the local warning points from which warning devices are activated.[3] Local procedures may call for further evaluation or authentication of the warning message as it is received. Thus, the average of 7 minutes represents the time required for warning to reach the local warning point, and does not necessarily indicate the time it reaches the people.

There were approximately 5000 secondary and local warning points within the United States as of 30 June 1961.[4] These points receive and disseminate warning messages in a variety of ways. NAWAS extensions are presently the fastest means of reception, involving no relaying of the original message.[5] (The NAWAS Extensions Program is covered in more detail later). Other methods are public safety radio systems, teletype nets, commercial telephone, and bell and light systems.

Warning is normally disseminated from the secondary warning point in a fan-out procedure, where each facility called in turn relays to other facilities, until local warning points have been notified and implement the alert utilizing local devices available, normally sirens. (See Figure 1.)

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1. Ibid., p. 73.
2. The warning message is instantaneous and simultaneous to all NAWAS subscribers; 15 seconds is normally required to deliver messages.
3. Office of Civil and Defense Mobilization, Statistical Services Division, Administrative Services Office. Summary Statistical Report on OCDM Warning Test of January 15, 1959, no date, p. 2.
4. Annual Statistical Report, op. cit., p. 82.
5. Ibid., p. 53.

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The criteria involved in the selection of a civilian warning point are found in Criteria for Warning Points, and are determined by target areas in the following order of priority:

a. Cities of 50,000 or more in population.

b. State capitals.

c. Cities of 25,000 - 50,000 population near designated military or government installations.

d. Cities of 10,000 - 25,000 population near designated military or government installations.

e. Cities of 20,000 - 50,000 or more in population.

f. Cities which do not meet above criteria but are recommended by State CD Directors and approved by Chief, Warning Branch.[1]

Warning points may also be selected on the basis of an area warning concept. For more sparsely populated portions of a state, a location which has the means available to further disseminate the warning may be selected for a warning point independent of the population or targeting criteria indicated above.

The actual warning point facility "must be manned 24 hours a day by personnel experienced in handling messages of an emergency nature."[2] Of the warning points established by 30 June 1961, 42 per cent were located in state police offices, 35 per cent at city police offices, with the remaining 23 per cent located in other local government facilities, primarily, city fire departments and sheriffs' offices.[3]

The warning point facility must be capable of having "immediate access to communication channels for further dissemination of the warning within a prescribed area of responsibility."[4] In Criteria for Warning Points, the ability to have two way communication is stressed but not considered mandatory.

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1. United States Government, Director Warning Office. Criteria For Warning Points, Office Memorandum, 1 April 1958, p. 1.
2. Loc. cit.
3. Annual Statistical Report, op. cit., p. 75.
4. Criteria For Warning Points, op. cit., p. 1.

The warning point should also be located outside of the assumed blast and thermal damage area. According to the Annual Statistical Report for 1961, the typical warning point is located 3.4 miles from a city and is manned either by state or city police.[1]

The last criteria for warning point facility selection is that the operators should be provided protection from fallout in order that warning functions will not be interrupted due to enemy action. Again, the Annual Statistical Report for 1961 states that no specific provision for shelter against blast or fallout has been provided for the personnel manning most warning points.[2]

The costs of warning point establishment is borne by the Federal government. This includes installation of equipment, maintenance, and recurring costs. The Federal government provides funds on a matching basis for the costs of civilian warning systems found below the warning points including the purchase of sirens. Since 1952 a total of 9,192 sirens have been purchased under the contributions plan.[3]

a. Components

The Federal portion of the Attack Warning System, i.e., NAWAS, provides for the dissemination of warning without relay from the National Warning Center and/or OCD centers through established state warning points, and terminating at warning points within the states. Further dissemination is then made to local warning points. Local warning points are facilities which receive the warning message and activate the public warning devices within their area of responsibility. Those warning points designated as state warning points have the same functions as warning points and in some cases local warning points, but in addition act as control facilities on the state portion of the NAWAS circuit.

All warning messages from the National and OCD warning centers pass through the state warning points, and these facilities have the capability of disconnecting warning points within the states from the area NAWAS circuit. A state warning point will, after a warning announcement, acknowledge to the area OCD warning center, and then by

1. Annual Statistical Report, op. cit., p. 75.
2. Loc. cit.
3. Ibid., p. 83.

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depressing a non-locking foot-operated switch, disconnect the remainder of the state warning circuit and gather receipt of message acknowledgements from the remainder of the warning points on the circuit. Warning points within the state will further disseminate the warning as required to local warning points. Only twenty-eight per cent of the local warning points have the capability of actually activating the public alerting devices, thus necessitating additional relay.[1]

The state warning point has supervision of its portion of the NAWAS warning circuit at all times. This provides a capability of the states to issue additional warning information and subsequent instructions, and to prescribe the actions to be taken upon the receipt of warning. The state warning point has two loudspeakers which provide a continual monitor of the warning circuit from the warning centers and a monitor of the state portion of the circuit. If the state warning point is in the process of issuing or receiving information on its portion of the circuit, and a warning announcement from the warning center is received over the speaker, the non-locking foot switch must be released immediately to allow the warning message to go to the warning points within the state. Warning points with two or more NAWAS extensions have the same equipment as a state warning point.

Equipments located at OCD locations and civilian warning points are essentially the same, although OCD locations such as warning centers will have some additional equipments such as grouping keys and signalling keys. Warning points are supplied with a bell, a loudspeaker with volume control and push to talk hang-up handset. State warning points have the same equipment, with the addition of the following: an extra loudspeaker, the non-locking foot switch used for state circuit disconnect, and a signalling key utilized in signalling the warning points on the circuit. The additional loudspeaker at the state warning point is connected to the area warning circuit, so as described earlier, when the state warning point is operating the disconnect switch in order to talk to the warning points, a monitor will be provided on the area warning circuit.

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1. Ibid., p. 76.

Warning points are supplied with a State and Local Warning Operations Manual, Appendix 1 to Annex 13 of the National Plan, which contains explicit instructions on warning point operation. Included in this manual are a time conversion chart, phonetic alphabets, world geographic reference system index, and instructions for the operation of the civil defense warning chart and speed distance rule which are supplied separately. These latter aids are used for the computation of warning times by the warning centers, and for the additional computation and plotting which may be done by the warning points.

b. Procedures

General operational procedures have been developed within each of the facilities responsible for the dissemination and receipt of warning on NAWAS. Although minor deviations in procedure are to be found, the guidelines have been standardized as much as possible, and will normally apply.

Each warning center controls the operation of its area warning circuit. All transmissions on the warning circuit will be by voice and will be heard by all stations connected to the circuit. All warning centers and warning points continuously monitor the warning circuit and the circuit is tested daily. Wherever possible, the NAWAS circuit routing avoids target areas. The circuits are routed over express and bypass routes of AT&T, and as new routes become available NAWAS will be rerouted so as to provide more reliability and continuity of operations. In the event of an attack it is AT&T's responsibility to provide OCD with alternate links of their system. Although AT&T has advised OCD of this capability, they do not normally provide their customers with any specific information they may require for planning or determining the effects of an attack.

Area warning circuits are party lines, and all facilities can receive and transmit over the circuit. The state portions of the area warning circuit are also party lines, and warning points may converse with each other with state warning point approval.

At each of the warning centers, a signalling key is installed, which when depressed prior to the issuance of a message, activates a signal bell at each of the NAWAS terminations.

The state warning points normally will have full control of the state portion of the NAWAS circuit except when actual warnings are being disseminated. When the state warning point wishes to talk to any or all of the warning points within the state, the operator must depress the non-locking foot switch, and utilize the signalling key. If the state desires to talk to other state warning points, permission must be obtained from the parent warning center.

Although the initial dissemination of warning is primarily the responsibility of the Federal government, the possibility exists that the initial warning of attack might come from a warning point. The two-way communication provision of the NAWAS system allows for this event. The circuit is designed for the normal warning information flow down from the National Warning Center and OCD warning centers. However, two-way capability for warning dissemination does exist and the system is utilized in day-to-day operations for the passing of other information such as natural disaster warning, reporting of nuclear incidents, reporting of downed aircraft, etc.

The NAWAS system is also utilized for the reporting of post-attack information.[1] The warning points are provided with the prescribed operating procedures to report Nuclear Detonations (NUDETS) and other FLASH reports. A FLASH report is a message as short and concise as possible which relates details of bombings or other types of disasters. Warning points will relay information of this type directly to the warning centers, which assess it and take appropriate actions.

c. NAWAS Extensions Program

The NAWAS extensions program provides for the dissemination of attack warning and information past the warning points to secondary warning points which are located normally in the county seats of the states. A secondary warning point is a facility which receives warning and other emergency information from warning points and further disseminates this information within its area of responsibility according to the provisions of state and local defense plans.

Under the NAWAS extension program, warning can thus be disseminated without relay to each county seat or other

1. For post-attack responsibilities, the reader is referred to Annex 13, Warning, of National Plan; also, Interim National Emergency Operations Reporting System Manual, Office of Civil Defense (Draft - March 1961).

approved location. Secondary warning points may be local warning points, which are capable of activating warning devices. Normally, however, this is not the case. Installation and recurring charges for the NAWAS extension program to the secondary warning points are paid for under the matching funds program described in the Federal Contributions Manual.

By June 30, 1961, there were 132 NAWAS extensions in operation, and ninety of these were located in the 26th OCD Warning Area.[1]

D. INDIVIDUAL RESPONSIBILITIES

The National Plan, Annex 2, Individual Action, states that, "Individuals are responsible for learning the warning signals and taking the recommended actions," and that the individual must be capable of caring for himself in an emergency. The annex states that each individual and family should learn:

1. Warning signals and what they mean.

2. The community plan for emergency action.

3. Protection from radioactive fallout.

4. First aid and home emergency preparedness.

5. Use of CONELRAD - 640 or 1240 kilocycles on AM radio - for official directions.[2]

In December 1961, the Department of Defense provided an official publication titled: Fallout Protection-What to Know and Do About Nuclear Attack. The preface states, "The factual information in this booklet has been verified by independent scientific authority, and represents the best consensus of the scientific community that we can establish."[3]

According to this booklet, the two public warning signals are: 1) the 3 to 5 minute steady tone which means to turn on the radio so as to receive directions from local authorities; and 2) the

1. Annual Statistical Report, op. cit., p. 83.
2. National Plan, op. cit., Annex 2, Individual Action, January 1959, p. 2.
3. Office of Civil Defense. Fallout Protection, What to Know and Do About Nuclear Attack, Publication H-6, December 1961, Introduction.

warbling tone or short blasts of 3 minute duration which is the signal to take cover immediately.

V. CONELRAD

A. GENERAL

(At the time this section was written (July 1962), CONELRAD was undergoing certain changes. The value of the system to deny navigational aid to the enemy has apparently been deemed no longer a valid concept. The value of CONELRAD to provide warning and/or vital public information has not yet been fully determined. Since this was written, CONELRAD has been cancelled.)

The Communications Act of 1934, as ammended, authorized the President in certain situations to provide for the control of electromagnetic radiations which were capable of being utilized for air navigational aid.

On December 10, 1951, Presidential Executive Order 10312 was issued, providing for emergency controls over radio communications or other devices transmitting between the range of 10 kilocycles and 100,000 megacycles which were capable of being utilized for navigational aid by an enemy at a distance of 5 miles from the source. This control of electromagnetic radiations has been termed CONELRAD.

Approximately 1300 commercial AM radio stations have been given national defense emergency authorization to continue broadcast operations under CONELRAD. Stations operating within the CONELRAD system will shift frequencies upon notification of CONELRAD implementation to either 640 or 1240 kc as previously designated and will provide information to the public under plans prescribed for each particular station. All other AM and FM radio and TV stations will leave the air after CONELRAD implementation notification.[1]

B. SYSTEM OPERATION

The Federal government has the responsibility to provide the Federal Communications Commission (FCC) with requirements pertaining to development of CONELRAD plans for all civil and state and local government communications. This includes the development and provision of program source material to state and local authorities for use in civil defense programing of an emergency nature by broadcast stations operating under CONELRAD and post-CONELRAD conditions.[2]

1. Annual Statistical Report, op. cit., p. 87.
2. Federal, state and local responsibilities for CONELRAD are found in Annex 9, Public Information, February 1960, and Annex 15, Communications, February 1960, of the National Plan.

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The Federal Communications Commission has drawn up engineered plans in all areas of the United States for the operation of CONELRAD stations, and the FCC and Secretary of Defense are authorized to issue those rules and regulations which were required to implement the system. All the CONELRAD plans were to be approved by the Secretary of Defense and the Director of OCDM.

In An Interim Plan for Continuity of Programing Under CONELRAD (FCC release 67094), the Federal government has established an emergency radio broadcast plan which can be implemented in an emergency to provide facilities for the President to broadcast messages to the public. In establishing the responsibilities for this plan, Annex 15, Communications, to the National Plan says, "This plan must be of sufficient flexibility to allow the maximum use of surviving broadcast facilities and interconnecting communications channels, including the use of remote pickup broadcast equipment and interconnected and fully automatic industrial microwave systems."[1]

CONELRAD initiation will be accomplished by the Commander in Chief of the North American Air Defense Command (CINCNORAD) or his authorized representative. Normally the NORAD Director of Operations is the individual who will have this responsibility. He will coordinate the appropriate military, government, and non-government agencies and will implement CONELRAD only after the declaration of an air defense emergency by NORAD. This issuance of CONELRAD is not a simultaneous action taken with the air defense emergency.

CONELRAD may be implemented and terminated in several ways. The majority of CONELRAD subscribing stations will receive CONELRAD implementation notification over the major news services teletype networks, AP and UPI. The message will be introduced into the news service teletype network at NORAD. All stations then subscribing to a news service will simultaneously receive the CONELRAD alert message. Those stations having emergency authorizations will then proceed to change frequencies and broadcast under CONELRAD procedures. Other stations will leave the air.

Not all stations which are integrated into the CONELRAD system subscribe to a major news service. The means by which these stations receive CONELRAD implementation is through the Military Air Defense Warning (MADW) network, described earlier.

Key stations receiving the implementation notice from the wire services may also transmit a code which actuates CONELRAD receivers in all commercial AM and FM radio and TV stations. The coded signal is followed

1. National Plan, op. cit., Annex 15, Communications, p. 8.

by an announcement, "This is a CONELRAD radio alert." Those stations previously designated as having national defense emergency authorization will immediately shift their frequency to the CONELRAD frequency assigned to them (either 640 or 1240 kc) and will broadcast information to the public under a plan prescribed for that particular station. The CONELRAD plans are so designed that each station can reach the maximum population within its area.

Under the CONELRAD system, radio stations may operate in clusters of two or more broadcasting the same program. In a cluster system each of the stations is on the air alternately for only a few seconds, but the listener in the cluster area hears a continuous program. As the broadcast passes from one station to another, there might be a decrease or increase in volume as power output and coverage will vary.

The state and local governments are responsible for developing and implementing plans for the emergency use of broadcast facilities, and for providing emergency information and instructions to the public. In accordance with state and local plans, they are to disseminate warning and survival information and instructions on family and individual survival, shelter availability, etc.

The objective to be reached in communications to the public is "to provide the capability for communications during emergencies to the general public that will allow appropriate officials to disseminate and relay necessary information and instructions to the maximum number of people without giving navigational aid to the enemy."[1] The Federal government will provide funds for program and control circuits to authorized CONELRAD broadcast stations to link the stations to appropriate state and local government control centers.

VI. NATIONAL EMERGENCY ALARM REPEATER (NEAR)

A. GENERAL

To date, the siren has been the principal method of alerting the public to the danger of attack. The attack warning system described in the previous pages provides the necessary implementation and dissemination of information to the facility which activates the local alarm devices. Sirens and outdoor sound systems are primary means of disseminating a signal, particularly in urban areas. However, these devices cannot always be heard indoors and their effectiveness for reaching rural areas is in some cases limited.

1. *Ibid.*, p. 6.

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The need for an indoor alarm device has been apparent for quite some time. Preliminary investigations in 1956 were undertaken to determine the feasibility of developing an indoor home alerting device. Three major systems were looked at: the telephone, the radio, and the electrical power system. Due to limitations in coverage, technical difficulties, and cost, the telephone and radio were discounted and the electrical power system was determined to provide the best means for transmission in a home alerting system.

Nationwide, 96% of the population is serviced 24 hours a day by some electrical utility. In larger metropolitan and industrial areas, the percentage of coverage is closer to 99%.[1]

Midwest Research Institute (MRI) of Kansas City, Missouri, using the system requirements of speed, reliability, coverage and effectiveness, developed the NEAR system while under contract to the Office of Civil and Defense Mobilization.

Basically NEAR consists of a signal generator which, when activated, produces a higher cps signal (currently 255 cps) which is superimposed on the standard 60 cps power line. The signal may be distributed either through a mass repeating system from one key signal generator to adjacent signal generators, etc., or through utilization of the existing NAWAS system, thus reducing the need for the repeating action. The repeating or cascading of the NEAR signal requires less human intervention, but may require several minutes for full nationwide activation. The receiver, the final element in the NEAR system, plugs into the 110v 60 cps signal source, is actuated by the incoming 255 cps signal, and after a short delay provides a distinct audible sound which alerts the resident to turn on his radio.

Actual system tests of NEAR were conducted in February 1958, utilizing the facilities of the Consumers Power Comapny in Michigan. Although these tests conclusively proved the feasibility of employing the electrical utilities as a means of providing a mass indoor alarm system, more diversified and stringent testing is required.

Consumers Power Co. of Michigan will be running additional tests upon the NEAR equipment already installed, and the Arizona Public Service Co. has been selected for a 200kw and a 50kw installation in or around Phoenix. Other utilities and locations mentioned for additional NEAR testing are: Pacific G & E, Florida P & L, Consolidated Edison; the

1. H. L. Stout. NEAR - A Mass Warning and Signalling System Operating Through the Electric Utility Network, Paper No. 60-1372, Midwest Research Institute, Kansas City, Mo., no date, p. 1.

cities of Colorado Springs, Colorado, Hartley, Iowa, and Columbia, Missouri; the Dairyland cooperative in Wisconsin and Plains cooperative in New Mexico.[1]

Reasons for changing the location of the testing are to test the source of supply, the different voltage levels, and provide a larger reliability sampling. As a result of the forthcoming NEAR tests, technical problems of the system should be solved so as to allow nationwide implementation within several years.

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1. "Arizona Public Service to Test NEAR Generators," Electrical World. Vol. 157, No. 20, May 14, 1962, p. 20.

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VII. OCD FACILITY LISTING

A. OCD WARNING CENTERS

1. National Warning Center, Headquarters, North American Air Defense Command, ENT AFB, Colorado Springs, Colorado.
2. 25th Warning Center, McChord AFB, Tacoma, Washington.
3. 26th Warning Center, Hancock Field, Syracuse AFS, New York.
4. 30th Warning Center, Truax Field, Madison, Wisconsin.
5. 32nd Warning Center, Oklahoma City AFS, Oklahoma.
6. 29th Warning Center, Richards-Gebaur AFB, Missouri.
7. 28th Warning Center, Hamilton AFB, California.

B. OCD OFFICES

1. OCD Warning Branch Headquarters, Washington, D. C.
2. OCD National Headquarters Relocation site.
3. OCD Regional Offices:
   a. Region 1 - Harvard, Massachusetts
   b. Region 2 - Olney, Maryland
   c. Region 3 - Thomasville, Georgia
   d. Region 4 - Battle Creek, Michigan
   e. Region 5 - Denton, Texas
   f. Region 6 - Denver, Colorado
   g. Region 7 - Santa Rosa, California
   h. Region 8 - Everett, Washington

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C. FEDERAL WARNING POINTS[1]

25th OCD Warning Area

BPA, Portland, Oregon
AEC, Richland, Washington
AEC, Scoville, Idaho
AEC, Idaho Falls, Idaho
USCG, Port Angeles, Washington
USCG, Westport, Washington

28th OCD Warning Area

AEC, Berkley, California
USA, Presidio of San Francisco, California
USCG, Palos Verdes Estates, Calif.
USCG, San Bruno, California

29th OCD Warning Area

AEC, Boulder, Colorado
AEC, Grand Junction, Colorado
AEC, Kansas City, Missouri
AEC, Weldon Spring, Missouri
AEC, Albuquerque, New Mexico
USA, Fort Sam Houston, Texas
USCG, Galveston, Texas

30th OCD Warning Area

USA, Chicago, Illinois
AEC, Lemont, Illinois
AEC, Miamisburg, Ohio
AEC, Ross, Ohio
USCG, Chesterland, Ohio

30th OCD Warning Area Con't

AEC, Cincinnati, Ohio
AEC, Waverly, Ohio
USCG, Northbrook, Illinois
USCG, Sault Sainte Marie, Mich.
AEC, Paducah, Kentucky
GSA, Chicago, Illinois

26th OCD Warning Area

USA, Fort George G. Meade, Maryland
GSA, New York, New York
USA, Governors Island, New York
AEC, New York, New York
AEC, McKeesport, Pennsylvania
USCG, Long Island, New York
USCG, Pungo, Virginia
AEC, Germantown, Maryland
AEC, Schenectady, New York
DHEW, Charlottesville, Virginia

32nd OCD Warning Area

USCG, St. Petersburg, Florida
USA, Fort McPherson, Georgia
Federal Penitentiary, Atlanta, Ga.
AEC, Aiken, South Carolina
AEC, Oak Ridge, Tennessee
AEC, Pinellas County, Florida
USCG, Jacksonville, Florida
TVA, Spring City, Tennessee

AEC - Atomic Energy Commission
BPA - Bonneville Power Administration
GSA - General Services Administration
DHEW - Department of Health, Education and Welfare
TVA - Tennessee Valley Authority
USA - United States Army
USCG - United States Coast Guard

1. Annual Statistical Report, op. cit., p. 74.

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D. CIVILIAN WARNING POINTS[1]

CONNECTICUT
*Hartford
Bethany
Colchester
Hartford
Ridgefield
Stamford
Torrington

MAINE
*Augusta
Auburn
Houlton
Orono
Portland
Presque Isle

MASSACHUSETTS
*Boston
Holden
Middleboro
Northampton
Pittsfield

NEW HAMPSHIRE
*Concord
Berlin
Keene
Littleton
Nashua
Rochester

NEW JERSEY
*Trenton
Berlin
Hammonton
Morristown
Newark

NEW YORK
*Albany
Binghamton
Buffalo
Hawthorne

NEW YORK (continued)
Highland Falls
Mineola
New York City
Niagara Falls
Plattsburg
Rochester
Schenectady
Syracuse
Troy
Utica
Watervliet

RHODE ISLAND
Providence

VERMONT
*Montpelier
Bellows Falls
Burlington
Rutland
St. Johnsbury

DELAWARE
*Dover
Delaware City

KENTUCKY
*Frankfort
Ashland
Bowling Green
Dry Ridge
Henderson
LaGrange
Madisonville
Mayfield
Pikeville
Richmond

MARYLAND
*Pikesville
Annapolis
Cumberland
Elkton

MARYLAND (continued)
Hagerstown
Salisbury

OHIO
*Cambridge
Akron
Ashtabula
Bucyrus
Canfield
Chillicothe
Cincinnati
Cleveland
Columbus
Dayton
Findlay
Ironton
Jackson
Massillon
Piqua
Sandusky
Steubenville
Toledo

PENNSYLVANIA
*Harrisburg
Bethlehem
Blakely
Butler
Ebensburg
Erie
Greensburg
Hazelton
Hollidaysburg
Lancaster
Mercer
Montoursville
Philadelphia
Pittsburg
Punxsutawney
Reading
Uniontown
Washington
Wilkes-Barre
York

1. Letter from Virginia A. Staggers, op. cit.

*State Warning Points

APPENDIX A

VIRGINIA
*Richmond
Norfolk
Salem
Wytheville

WEST VIRGINIA
*South Charleston
Bluefield
Clarksburg
Huntington
Martinsburg
Morgantown
Parkersburg
Wheeling

ALABAMA
*Montgomery
Anniston
Birmington
Decatur
Dothan
Evergreen
Florence
Gadsden
Mobile
Phenix City
Selma
Tuscaloosa

FLORIDA
*Jacksonville
Bartow
Daytona Beach
Ft. Myers
Gainesville
Key West
Miami
Orlando
Panama City
Pensacola
Tallahassee
Tampa
West Palm Beach

GEORGIA
*Atlanta
Albany
Athens

GEORGIA (continued)
Augusta
Brunswick
Columbus
Dublin
Gainesville
Griffin
LaGrange
Macon
Rome
Savannah
Valdosta
Waycross

MISSISSIPPI
*Jackson
Batesville
Brookhaven
Greenwood
Gulfport
Hattiesburg
Meridian
Natchez
New Albany
Starkville

NORTH CAROLINA
*Cary
Asheville
Charlotte
Durham
Elizabeth City
Fayetteville
Goldsboro
Greensboro
Salisbury
Washington
Wilmington
Wilson
Winston-Salem

SOUTH CAROLINA
*Columbia
Aiken
Beaufort
Charleston
Florence
Greenville
Myrtle Beach
Rock Hill
Sumter

TENNESSEE
*Nashville
Cookville
Chattanooga
Jackson
Kingsport
Knoxville
Lawrenceburg
Memphis
Murfreesboro

ILLINOIS
*Urbana
Bloomington
Chicago
Danville
Decatur
DuQuoin
East St. Louis
Effingham
Elgin
Galesburg
Jacksonville
Joliet
Kankakee
Park Forest
Peoria
Quincy
Rockford
Rock Island
Springfield
Sterling
Waukegan

INDIANA
*Pendleton
Bloomington
Charlestown
Chesterton
Connersville
Fort Wayne
Green Castle
Indianapolis
Jasper
Lafayette
Ligonier
Peru

APPENDIX A

INDIANA (continued)
Redkey
Seymour
South Bend
Terre Haute

MICHIGAN
*East Lansing
Alpena
Battle Creek
Bay City
Detroit
Flint
Grand Haven
Houghton Lake
Jackson
Marquette
Paw Paw
Pontiac
Rockford
St. Clair
St. Ignace
Traverse City
Ypsilanti

MINNESOTA
*St. Paul
Bemidji
Brainerd
Duluth
Mankato
Minneapolis
Moorhead
Rochester
St. Cloud
Virginia
Willmar

WISCONSIN
*Stevens Point
Appleton
Barron
Eau Clair
Fond du Lac
Green Bay
Janesville
LaCrosse

WISCONSIN (continued)
Madison
Manitowac
Milwaukee
Racine
Rhinelander
Sherboygen
Superior
Wausau

ARKANSAS
*Little Rock
Batesville
El Dorado
Fort Smith
Harrison
Hope
Hot Springs
Osceola
Pine Bluff

LOUISIANA
*Baton Rouge
Alexandria
Bossier City
Lafayette
Lake Charles
Monroe
New Orleans
Thibodaux

NEW MEXICO
*Santa Fe
Albuquerque
Clovis
Hobbs
Las Cruces
Los Alamos
Roswell

OKLAHOMA
*Edmond
Ardmore
Clinton
Enid
Lawton
McAlester

OKLAHOMA (continued)
Muskogee
Stillwater
Tulsa
Woodward

TEXAS
*Austin
Abilene
Amarillo
Beaumont
Bryan
Corpus Christi
Dallas
Del Rio
Edna
El Paso
Harlingen
Houston
Laredo
Lubbock
Lufkin
Midland
Paris
San Angelo
San Antonio
Tyler
Waco
Wichita Falls

COLORADO
*Denver
Colorado Springs
Durango
Grand Junction
Greeley
Pueblo

IOWA
*Des Moines
Burlington
Cedar Rapids
Clinton
Council Bluffs
Davenport
Dubuque
Ft. Dodge

*State Warning Points

APPENDIX A

IOWA (continued)
Mason City
Ottumwa
Sioux City
Waterloo

KANSAS
*Topeka
Garden City
Great Bend
Hutchinson
Kansas City
Newton
Salina
Wakeeney
Wichita

MISSOURI
*Jefferson City
Cape Girardeau
Columbia
Hannibal
Joplin
Kansas City
Poplar Bluff
St. Joseph
St. Louis
Sedalia
Springfield

NEBRASKA
*Omaha
Grand Island
Lincoln
North Platte
Scottsbluff

NORTH DAKOTA
*Bismarck
Devils Lake
Fargo
Grand Forks
Jamestown
Minot
Williston

SOUTH DAKOTA
*Rapid City
Aberdeen
Huron
Parker
Pierre

WYOMING
*Cheyenne
Casper

ARIZONA
*Phoenix
Flagstaff
St. Johns
Tucson
Yuma

CALIFORNIA
*Sacramento
Bakersfield
El Centro
Fresno
Los Angeles
Merced
Redding
Salinas
San Bernardino
San Diego
San Jose
San Leandro
Santa Barbara
Stockton
Ukiah

NEVADA
*Carson City
Las Vegas

UTAH
*Salt Lake City
Cedar City
Hot Springs
Provo
Vernal

IDAHO
*Boise
Coeur d'Alene
Lewiston
Pocatello
Twin Falls

MONTANA
*Helena
Billings
Butte
Glasgow
Great Falls
Miles City
Missoula

OREGON
*Salem
Bend
Eugene
Klamath Falls
Medford
Pendleton
Portland
The Dalles

WASHINGTON
*Olympia
Bellingham
Coulee Dam
Everett
Kelso
Pasco
Port Orchard
Renton
Spokane
Tacoma
Vancouver
Walla Walla
Wenatchee
Yakima

*State Warning Points

APPENDIX B

CURRENT CIVIL DEFENSE WARNING SYSTEM ENVIRONMENT

I. INTRODUCTION

This appendix (prepared in July, 1962) describes those systems, commands, networks and elements referred to as the "civil defense warning environment" that relate to carrying out the mission of civil defense warning. The environment is detailed in such a manner as to show how these systems, commands, networks, and elements, influenced by the threat and possible tactics, interrelate with the present civil defense warning system on various command or decision levels. The levels specifically used are NORAD headquarters and the OCD national warning center, NORAD region headquarters and OCD warning centers, state warning points, OCD regional office, and warning points within the state.

II. NORAD HEADQUARTERS AND THE NATIONAL WARNING CENTER

The North American Air Defense Command (NORAD) has the mission to provide a unified defense of the North American continent against all forms of air attack, including air-breathing vehicles, ICBMs, and sub or surface launched SLBMs. The responsibility for carrying out this highly important and complex task falls to the Commander-in-Chief (CINCNORAD) who maintains a command post, the NORAD Combat Operations Center (COC), which performs the following functions: monitor strategic intelligence; conduct tactical intelligence and air surveillance; declare defense readiness conditions (DEFCONs); prescribe states of alert; announce Air Defense Warnings to the military; and notify the OCD National Warning Center whenever an air defense emergency is declared or terminated and whenever the degree of military warning is changed.

CINCNORAD or his designated alternate has the responsibility and authority to determine that an attack upon North America is imminent. When this determination is made, he declares an air defense emergency. The purpose of this declaration is to alert higher headquarters, adjacent commands, subordinate commands, and selected civil agencies (FAA, FCC, OCD) to impending attack. The declaration of an air defense emergency is primarily based upon threat evaluation or reports of actual attack.

Coordination with OCD warning personnel and other civil agencies is required of CINCNORAD to alert, inform and assist in achieving the effective utilization of both civil and military resources. Based upon the declaration of an alert by CINCNORAD, the initiation of an alert is made throughout the Attack Warning System by the Civil Defense Attack Warning Officer from the National

Warning Center at NORAD Headquarters. However, an air raid warning may be initiated from any OCD warning center based upon actual attack.

The NORAD Headquarters/National Warning Center operational environment consists of various warning systems, intelligence systems, higher headquarters, civilian agencies and other military commands.

A. ATTACK INTELLIGENCE

Intelligence sources include the various military and government agencies which comprise the intelligence community. These agencies supply strategic and tactical intelligence to NORAD. NORAD is particularly interested in information relating to increased enemy activity which could be indicative of a buildup to a war condition. The possibility of strategic warning cannot be overlooked.

Several systems concerned with the collection and the dissemination of intelligence feed their output directly into NORAD. By utilizing the full spectrum of intelligence information, the possibility of strategic, tactical and technological surprise is lessened and warning of impending air attack can be determined.

B. ATTACK DETECTION AND WARNING

In its detection and military warning function NORAD receives information from a vast network of radars in Alaska, Greenland, Canada, the United States, and Atlantic and Pacific Oceans, from an extensive satellite surveillance network, and from automatic and manual reportings of nuclear detonations.

1. Air-Breathing Vehicles

Data are received on critical tracks from the Alaskan Air Command, the DEW Line, the Mid-Canada Line, the Greater-Iceland-United Kingdom and Pacific Naval Barriers, the SAGE and Manual Air Defense Systems, and the seaward extensions of these systems. This vast network of systems provides an electronic screen around the North American continent capable of detecting aircraft and other air-breathing vehicles.

The tactical warning time available upon the approach of enemy air-breathing vehicles would vary according to the place of penetration and the weapons being carried -- free fall or air-to-ground delivered.

2. Missiles and Space Objects

Data are received on missile launchings and orbiting satellites from space surveillance systems employing ground based radars as well as orbiting satellite surveillance sensors.

The tactical warning time available upon the launching of intercontinental ballistic missiles (ICBMs) is far more critical, because of the decreased time between launch and impact. The location of the launching in relation to its intended target and the warhead to be carried, plus the characteristics of the individual missile, would give a range of warning times. Intermediate and short range missiles that might be used against the fringe areas of the continent will give even less warning time.

Little or no warning of submarine launched ballistic missiles would be possible owing to their proximity to the target.

3. Nuclear Detonations

Positive indications of nuclear detonations (NUDETS) within the continental U.S. and Canada will be automatically reported via the bomb alarm system to NORAD. Additionally, "Flash" NUDET reports, which are one-time initial reports, from the local level (civil or military) are forwarded with all possible speed to succeeding higher levels. NORAD and OCD will corroborate information available to each.

The tactical warning time available upon the detonation of a nuclear weapon would be either the blinding flash from a close detonation or the report that another target area has just been struck.

C. COMMAND/CONTROL

The Department of Defense Reorganization Act of 1958, as implemented by DOD Directive 5100.1, defines the responsibilities of the Department of Defense, the Joint Chiefs of Staff (JCS), the three military departments and their four services. The Joint Chiefs of Staff organization is in direct chain of command from the President through the Secretary of Defense to the eight unified and specified commands having operational control over all U.S. forces.

In this capacity, the Joint Chiefs are the senior military advisors to the President in matters pertaining to the preparation for the conduct of war. The actual control of military forces is delegated to the unified and specified commanders. NORAD is one such command. CINCNORAD has command and control responsibility of all defense forces of the United States and Canada. CINCNORAD advises the Joint Chiefs of impending attack against the United States or other threatening situations, and implements JCS decisions regarding these situations. The NORAD COC will interact with the JCS, the Strategic Air Command, Headquarters USAF, and other commands in collecting, processing and analyzing current information necessary for evaluating the need for and implementing a national air defense emergency.

The warning time available to the civilian population is directly related to a rapid evaluation of a possible enemy attack and the implementation of the decision to put the country on an emergency condition by the President and all subordinate commands.

D. COMMUNICATIONS

1. Air Defense Warning System

Air defense warnings and defense readiness conditions for the North American continent are disseminated through a military air defense warning system. Provisions are made for initial notification to be disseminated to a limited number of military air defense warning (MADW) key points, which in turn, are responsible for further dissemination of this information (i.e., U.S. Army Headquarters to posts, camps and stations; U.S. Navy Districts to Naval air stations and bases; Federal Aviation Agency (FAA) Air Route Traffic Control Centers (ARTCCs) to designated Air Force and Air National Guard bases).

a. System Components

Components of the warning system are:

1) Readiness and Warning Network

A full-period multipoint teletypewriter network which interconnects Headquarters NORAD with NORAD regions and other key U.S. and Canadian agencies.

2) NORAD Military Air Defense Warning Network (MADW)

A combination of full-period multipoint teletypewriter service, and long distance or tactical telephone circuits used by NORAD regions and/or sectors and FAA ARTCCs to communicate air defense warnings, defense readiness conditions, nuclear detonation reports, and CONELRAD messages.

b. System Subscriber

Subscribers to both system component networks are listed in Attachments 1 and 2 of NORAD Regulation No. 55-12.

c. System Operation

Operational procedures have been outlined and the system is in full operation.

APPENDIX B

2. Defense Communications Agency

On May 12, 1960, Department of Defense Directive 5105.9 established within the DOD a Defense Communications Agency (DCA). This agency under the control, direction and authority of the Secretary of Defense is responsible to him through the Joint Chiefs of Staff.

The DCA has a part of its overall mission the objective to plan, program and engineer a single communication system within the DOD. The DCA is to exercise operational control and supervision of communication activities of the Defense Communication System (DCS). DCS includes all worldwide, long haul, government owned and leased point to point circuits, terminals, control facilities and tributaries to provide communications:

a. From the President, to and between the Secretary of Defense, the Joint Chiefs of Staff, and other governmental agencies.

b. From the Secretary of Defense and the Joint Chiefs of Staff to and between the military departments and the unified and specified commands.

c. From the military departments to and between their major commanders and subordinate fixed headquarters.

d. From the unified and specified commands to and between their component and subordinate commands.

The communication facilities involved are not to be taken over by DCA but are to be part of a single system supervised by DCA. The various departments will continue to operate the facilities.

> "...The Defense Communications Agency will be used for management of civil defense communications along with all other Defense Communications Systems."[1]

Prior to this statement, OCD by virtue of the Federal Civil Defense Act of 1950 and the Communications Act of 1934 had been given the authority for the establishment and maintenance of communications systems. This Federal responsibility includes:

a. Establishing and maintaining communications for civil defense and defense mobilization purposes, reasonably secure from attack effects:

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1. U.S. Government, Hearings before a Subcommittee of the Committee on Government Operations, House of Representatives, 87th Congress, First Session. Civil Defense, 1961, Washington D.C., 1961, p. 553.

1) Within and among Federal agencies having emergency responsibilities,

2) Between the Federal government and the states.

b. "Encouraging states and their political subdivisions to establish effective communications systems, through technical and where appropriate financial assistance."[1]

The operational functions of DCA of particular interest are:

a. Based on approved requirements, to allocate circuits and channels to the military commands and other Department of Defense or governmental agencies.

b. To allocate standby communications facilities to meet requirements or emergency situations.

c. To supervise the restoration and allocation or reallocation of circuits and channels under emergency conditions.

Implementation of a Defense National Communications Control Center in Washington, D.C. and a Defense Area Communications Control Center at Ft. Carson, Colorado has taken place. Other area and regional control centers are being established.

3. Commercial Facilities

NORAD has access and in some cases outputs information to nationwide commercial facilities that have pre-arranged networks that serve Air Force, civil defense and many other government and civilian agencies.

The FAA communication networks, the weather bureau circuits, and the national news service networks are examples of two-way commercial circuits available to the NORAD facility.

III. NORAD REGIONAL CENTERS AND OCD WARNING CENTERS

The NORAD Regional Centers are the next lower command level in the flow of warning information originating at national headquarters. NORAD Regional Centers can be SAGE Combat Centers (CCs at the 25th, 26th, and 30th Regions), Remote Combat Centers (RCCs at the 28th, 29th Regions), Manual Combat Centers (MCCs at the 32nd Region), or a combined Combat Center/Direction Center (CC/DC

1. Office of Civil and Defense Mobilization. National Plan For Civil Defense and Defense Mobilization, October 1958, Annex 15, Communications, February 1960, p. 3.

in the case of the Ottawa Region). The inputs to a NORAD Region Center are from subordinate DCs or from higher headquarters, the NORAD COC.

The functions of the NORAD Region Center include transmitting command, intelligence and logistic information from higher headquarters to personnel in the various DCs in its Region; and ordering conditions of alert for its Region, disseminating defense warnings to civilian (FAA, FCC, OCD) and military agencies, and implementing SCATER and CONELRAD plans when SCATER and CONELRAD have been initiated by the NORAD COC. Although the NORAD Regions have different facilities, each Region has a Command Post staff and associated liaison personnel.

The Civil Defense Attack Warning Officer in his liaison capacity has access to military warning, surveillance and tactical data in addition to his NAWAS information. His office and location link the OCD Regional Office, the State Disaster Control and/or Civil Defense office and the military personnel associated with the air defense system. The operational environment of NORAD Regional Centers/OCD Warning Centers consists of higher headquarters, the air defense warning system and civilian agencies.

A. ATTACK INTELLIGENCE

Attack intelligence information is distributed from NORAD Headquarters to subordinate commands. Defense readiness conditions from the NORAD COC are translated into increased activities and preparations within the Region Combat Center as well as in subordinate commands. No original attack intelligence begins here, but evaluations are made of the effects the available data will have on their regional activities.

B. ATTACK DETECTION AND WARNING

Attack detection and warning information comes from the NORAD COC with specific impact areas of missiles and numbers and locations of attacking aircraft from DEW Line, Mid-Canada Line, Naval Barriers and SAC, and NUDET reports from other areas of the North American continent. DEFCON and air defense emergency information is also received. Inputs from subordinate Direction Centers (DCs) and associated weapons and surveillance facilities provide information on "hostile" and "unknown" aircraft that have penetrated to the sector coverage. NUDET reports from within the region are forwarded by the individual sectors to the region for correlation, evaluation and relay to NORAD Headquarters.

C. COMMUNICATIONS

Communications with NORAD Headquarters are via the Readiness and Warning Network, whereas the Military Air Defense Warning Network provides service for subordinate and component needs.

D. MILITARY/CIVILIAN LIAISON

Liaison personnel of the Federal Communications Commission (FCC) and the Office of Civil Defense are the Regional contacts with civilian agencies. FCC representatives prepare and implement plans with respect to radio stations to minimize the use of electromagnetic radiations as an aid to navigation of attacking forces, determine the availability of existing non-government radio services, advise Region CC personnel accordingly, and apply FCC policies and procedures regarding CONELRAD plans for non-government radio services.

The civil defense warning center personnel disseminate information from NORAD to other civil defense officials. They also advise Region CC personnel of the operational capabilities and limitations of the National Warning System (NAWAS) and coordinate activities and information between NORAD Region personnel and OCD Regional and/or state civil defense personnel. The OCD Warning Center personnel maintain contacts with other governmental agencies in the Region area to gather information from them or to alert them directly. For example, personnel of the OCD 28th Warning Center have direct contact with FAA facilities for earthquake or tidal wave information from and/or to Hawaii. Contacts are maintained with FBI representatives for sabotage information or pre-attack alerting to allow detention of known subversives.

IV. STATE WARNING POINT AND WARNING POINTS WITHIN THE STATE

The state warning point provides the link between the Federal level of responsibility and the state level. Four states have their state warning points in full-time operational state civil defense offices.[1] The other states use state police or patrol offices as the state warning point on the NAWAS circuit. The immediate environment of the state warning point is thus in the majority of cases essentially that of a state police office. Interaction with other elements of the state civil defense organization and other state government agencies develop from this point via pre-arranged operating plans and procedures.

The operational environment of the state warning point consists of the state civil defense office, the state government agencies, and the regional civil defense office.

A. STATE CIVIL DEFENSE OFFICE

In carrying out the responsibilities of the direction and coordination

1. Office of Civil and Defense Mobilization. 1961 Annual Statistical Report, Progress Report, Fiscal Year 1961, Battle Creek, Michigan, June 30, 1961, p. 76.

of the civil defense and defense mobilization activities of the state and its political subdivisions, the government of each state has established a state civil defense plan. Notifying key civil defense personnel, alerting civil defense subdivisions not immediately part of the NAWAS circuit, receiving NUDET reports, and receiving emergency status reports are usual activities undertaken by the state warning point in carrying out state plans. State communication systems vary in size and effectiveness. Most states with large populations and a number of military targets have well developed state communication systems. Some states, such as California, make use of an extensive radio microwave system entirely separate from commercial facilities plus commercial teletype and telephone circuits. Others rely wholly on the NAWAS circuit with no back-up capability.

State governments are responsible for the development and implementation of non-military operational radiological defense plans and programs. State monitoring systems had 21,073 monitors as of June 30, 1960 reporting radiological hazards to the state directly.[1] This information must be processed, correlated, and summarized in such a manner to enable it to be passed to regional civil defense offices as well as to subordinate divisions over the communication network. Only "Flash" reports are passed over the NAWAS system.

B. STATE GOVERNMENT AGENCIES

Implicit to the notification of specific groups is the alerting of the governor and other state governmental personnel and agencies. Sudden demands upon state highway patrols, fire fighting units, and water patrol units to control the immediate effects of a nuclear attack are anticipated. Government officials must be protected to maintain continuity of government and to enable them to carry out the agency's part in the civil defense effort. Public health officials must be ready to identify and treat the after effects of any radiological, biological, or chemical weapons.

V. OCD REGIONAL OFFICE

The interaction between warning points on the NAWAS circuit is dependent upon the survival of the communication circuit. An alternate means of national communications, tying the state civil defense office to the OCD regional office, would be the National Communications System (NACOM 1 and 2). In this way, information could flow both ways from local levels to the state and hence to the region and national levels, and vice versa.

1. *Ibid.*, p. 92.

APPENDIX B

A. NATIONAL COMMUNICATION SYSTEM (NACOM)

NACOM 1 is the basic link connecting Federal, OCD regional, and state civil defense agencies used for both daily administrative purposes and for attack and post-attack coordination. NACOM will also be connected with the National Resource Evaluation Center (NREC).

It consists of about 22,000 miles of leased wire facilities -- private line telephone and teletypewriter services set up for full-time operation--connecting OCD's operational headquarters with the regional offices and relocation site. Extensions of these circuits from the regional offices to the state civil defense offices are currently set up on an engineered military circuit (EMC) or stand-by basis, but it is anticipated that they will be converted to full-time circuits as soon as funds are made available. These EMC circuits are tested frequently in OCD exercises, and are used for natural disaster purposes. Certain alternate inter-regional circuits are also on an EMC basis. These circuits can be used in case of failure in the primary system of communications and in case it is necessary to implement emergency plans to re-establish national command.

At present, all traffic between the Classified Location and all regional headquarters passes through operational headquarters in Battle Creek, Michigan. To eliminate the necessity of this procedure, additional funds have been requested to provide alternate direct routes between the Classified Location and the OCD regional offices.

Capacity of teletypewriter service of all regional circuits recently was increased from 60 words per minute to 75 words per minute, and the classified circuits to 100 words per minute.

The NACOM 1 circuits between operational headquarters at Battle Creek, the Classified Location, Region 1, and Region 5 have been arranged for alternate voice, teletypewriter, and data transmission usage to provide for National Resource Evaluation Center (NREC) data transmissions.

The relaying of message traffic between NACOM 1 and the Interagency Communications System (ICS), which connects the relocation sites in the Federal areas, is accomplished through the operational headquarters communications center at Battle Creek.

NACOM 2, a radio network being established to back up NACOM 1 for communications with regional and state offices in the event of landline disruption, is currently operational at six regions, operational headquarters, and one state. The other two regions, the Classified Location, and 20 state installations are scheduled for completion during fiscal year 1962. The balance of the state installations are programmed for subsequent fiscal periods, as funds become available. The network will ultimately afford communications with Alaska, Hawaii, Puerto Rico, the Canal Zone, American Samoa, and the Virgin Islands.

B. INFORMATION EXCHANGE

An example of information that can be exchanged, correlated, and evaluated concerns the radiological hazard within the region.

> "Approximately 2,900 Federal monitoring stations have been placed in operation at field installations of the Department of Agriculture, Department of the Interior, U.S. Weather Bureau, Federal Aviation Agency, and the Air Weather Service of the U.S. Air Force. Plans are to increase this to nearly 4,500 stations, with at least one in each county, by the end of FY 1962, and to about 6,000 stations by the end of FY 1963.
>
> Of the approximately 2,900 Federal stations in operation as of June 30, 1961, a total of 1,043 stations were in operation round-the-clock with an existing communications system for reporting directly to OCD regional and national levels."[1]

The fixed-station Federal monitoring network will provide general assessment of the fallout situation, whereas the state and local systems are to provide more detailed monitoring services.

VI. WARNING POINTS

The warning point is the end of the line on the established NAWAS circuit. It is at this point that the warning goes through the final phase prior to reaching the population. It is at this point that local NUDET reports and other essential information enters the NAWAS circuit to go to the state level and, if necessary, to higher levels.

> "The typical warning point is located 3.4 miles from a city and is manned by either the state or city police. Generally, the controls for the local warning devices are located elsewhere than at the warning points. No specific provision for shelter against blast or fallout has been provided for the personnel manning most warning points."[2]

The operational environment of a warning point would consist of county and local civil defense plans, local communications, local shelters, and local knowledge.

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1. *Ibid.*, p. 90
2. *Ibid.*, p. 75

APPENDIX B

A. COUNTY AND LOCAL CIVIL DEFENSE PLANS

> "Only 28 per cent of the civilian warning points have the controls for activating local warning devices for the target city and its vicinity."[1]

Within the structure of the local civil defense plan, 72% of the warning points cannot activate the local warning devices. The procedures for either activating the warning devices by warning point personnel themselves or informing other personnel who will then activate the warning devices are outlined for the warning point personnel for pre-planned civil defense action. The current status of county and city plans on a national basis[2] reflect that 54% of all counties in the U.S. have a full-time or part-time director and have a published, state-approved plan, whereas 46% of all counties in the United States have little or no civil defense activity. The interaction between warning point and civil defense personnel is of great importance. Elements of the county/city civil defense plans of particular interest are the chemical, biological and radiological monitoring.

> "Of the 105,508 monitors assigned to state and local governments, 20 per cent were reported by state governments, 54 per cent by municipalities, and 26 per cent by counties."[3]

Detailed information as to the extent, intensity and duration of radiological hazards needed for operational use are provided by state and local monitoring systems. Approximately 24,000 state and local monitoring stations were in existence (as of June 30, 1961) primarily at fire, police, highway patrol and maintenance stations, high schools, hospitals, airports, and conservation offices. The plans of OCD are to expand this network to 144,000 stations by the end of FY 1963. Detection and identification systems for warning the general public of a CW - BW attack are the object of research and development by the U.S. Army Chemical Corps and Department of Health, Education and Welfare. Protection masks (57,500 by June 30, 1961)[4] have been procured for many monitoring and civil defense personnel. Chemical agent detector kits and atrophine injections have been distributed for emergency use. A civilian protective mask was to be available commercially in 1962.

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1. Ibid., p. 76
2. Office of Civil Defense. Status of County Planning and Organization for Civil Defense, June 30, 1961, preface.
3. Annual Statistical Report, op. cit., p. 91
4. Ibid., p. 108

B. LOCAL COMMUNICATIONS

The responsibilities of local governments require that communications be established for keeping the general public informed and for directing the action of large segments of the population in times of emergency.

1. Radio Amateur Civil Emergency Service (RACES)

The utilization of the equipment and talents of American radio amateurs in the RACES program was established in 1952 by the Federal Communications Commission, the Federal Civil Defense Administration, and the American Radio Relay League. RACES has had a steady growth from 12 approved plans in 1953 to approximately 1,400 plans as of January 1, 1961, encompassing approximately 35,000 radio amateurs. The ultimate goal in this program is to provide each of the more than 3,000 counties in the United States, and most cities, with a RACES plan for integration into their already established communications systems. This program is intended only to supplement any established local communications systems, not to replace them. The basic concept of the program is to utilize the reservoir of trained radio operators to assist local civil defense directors in maintaining effective communications at the local level. The goal can be accomplished in this program with about 5,000 RACES plans. To accommodate the rapid expansion of this program, additional radio channels have been allocated. A bulletin assigning these additional radio frequencies on an area basis has been published and is currently being distributed.

To encourage the RACES program, Federal matching funds and Federal surplus equipment are available under certain conditions for assisting the states and their political subdivisions in providing essential facilities for the program.

2. Military Affiliate Radio System (MARS)

The primary mission of MARS is to supplement normal Air Force communications channels, provide emergency back-up communications for all AF communications circuits, and provide communications for use in implementing domestic emergency plans of AF commands. MARS will also provide communications to civil defense forces that can be effected without interference with the military mission. Membership requirements for the radio amateurs associated with the system as well as a comprehensive manual of operations can be found in Air Force Manual (AFM) 100-15.

3. Public Safety Radio Services and Private Organization Radio Services

These services provide additional radio communications facilities in times of disaster and/or national emergencies and can support civil defense actions and efforts.

These services are:

a. Police Radio Services

Radiotelephone and radiotelegraphy provide three-way communications: from a fixed land station to mobile units; from mobile units to land stations; and from one mobile unit to others.

b. Fire Radio Service

Radiotelephone between headquarters and the fire apparatus and between the fire chief and individual firemen on the scene.

c. Forestry-Conservation Radio Service

Radio communication similar to police and fire radio networks.

d. Highway Maintenance Radio Service

Radio communication between base stations and mobile units, and between the latter.

e. Railroad Radio Service

Safety communication uses radio for end-to-end (caboose to engine cab) and wayside point-to-train communication. Operational uses are restricted to yard and terminal operations.

f. Taxicab Radio Service

Communication between a base and mobile units.

g. Automobile Emergency Radio Service

Communication between garage and emergency road service vehicle.

h. Motor Carrier Radio Service

Communication between terminals and vehicles in operation.

i. Industrial Radio Service

1) Power Radio Service

Communication from garage to construction-restoration crews and between generating stations, gas storage areas and pumping stations.

2) Petroleum Radio Service

Communications are very widely used along pipelines, in exploration, under emergency fires, explosions, well blowouts, etc., during drilling operations and under many other conditions.

3) Forest Products Radio Service

Communications for timber and logging companies for operations in remote areas.

4) Relay Press Radio Service

Communication between a central transmitter and mobile equipment in autos carrying reporters and photographers.

5) Motion Picture Radio Service

Communication between a terminal and location site.

6) Industrial Radio Service

Short-range communications between base points and mobile units.

7) Citizens Radio Service

Communication between house and workers in the field, on the range, etc.

C. SHELTERS

The President has stated that the use of shelters presupposes effective warning devices, training, radiological monitoring and stockpiling of foods and medicines. The availability of shelters for the protection of the populace against the effects of an attack is a prime requisite for meaningful response to an alert signal and warning information. The present national policy regards protection from radioactive fallout as the criterion for shelter protection to safeguard the populace.

1. Mine, Boat, and Basement Shelters

Shelter and Fallout by E. D. Callagan, L. Rosenblum, and J. R. Coombe in an April 7, 1961 publication[1] used a criterion of at least one hour warning time in surveying the potential shelter space available in boats and mines. Additionally the survey regarded existing fallout shelter potential in basements of buildings on a nationwide basis.

> "The survey shows that about 60% of the population in the U.S. would have access to basement shelter, with the figures ranging from better than 80% in OCD Regions 1, 2 and 4 to less than 20% in Regions 3, 5 and 7. Mine shelter could be an important shelter resource for two to four million people in some 16 states, including West Virginia, Illinois, Michigan, Missouri, Kansas, Oklahoma, and New Mexico. Shelter in covered boats on lakes, rivers, and the ocean is likely to provide the best available means of protection for several million people particularly in the states of New York, Delaware, Maryland, Virginia, Florida, Louisiana, California, Oregon, and Washington.
>
> A survey of public and private buildings in a typical northeastern suburban city of 25,000 population indicated that the basements of schools, churches, and other large buildings do not offer significantly better protection than that of the average home basement.
>
> In terms of the number of people per state who do not have even remote access to any fallout shelter (including home basements), the four most needy states are California, Texas, Florida, and Georgia."[2]

Usage of mines and boats as shelters would depend upon the local civil defense plan providing for an orderly evacuation or movement to these facilities. Usage of basements as shelters would necessarily be only temporary unless additional materials were on hand to construct a more adequate structure or a more adequate structure had been constructed in advance. Basement protection would be better

1. E. D. Callahan, L. Rosenblum, and J. R. Coombe. Shelter From Fallout, Civil Defense Survey, Technical Operations Incorporated, Burlington, Mass., April 7, 1961.
2. Ibid., p. vi.

than no protection.

2. Prototype Fallout Shelter Construction

This program is to provide a variety of shelters nationwide for study of shelter programs and for stimulation of shelter construction by individuals, families, industry, organizations, and state and local governments.

> "As of June 30, 1961, construction of 303 prototype shelters had been completed, with at least one shelter in every state except North Dakota. Another 391 shelters were under design or being constructed, and contracts for 63 prototype shelters were under negotiation."[1]

The shelter types were family, group or community and high school. Additional incentive is being given to promote shelter construction through land-grant college and high school vocational departments by constructing a family-type fallout shelter on each campus of 14 land-grant colleges and by offering to pay $250 to each of several hundred high schools which construct such shelters.

All of these shelters are intended to provide usable shelter space for the area residents.

3. Current Civil Defense Shelter Effort

On February 19 and 26, in his opening and closing statements, Hon. Steuart L. Pittman, Assistant Secretary of Defense, Civil Defense, outlined the present shelter program for the Military Operations Subcommittee of the Committee on Government Operations, House of Representatives. Ninety-three million dollars is presently being spent for a shelter survey to identify shelter space in buildings, tunnels, caves, and subways throughout the country with capacities of 50 or more. Fifty million spaces are anticipated from these surveys. The next step will be to obtain from the building owners, or their agents, the necessary permission to use the identified space for public shelter purposes. The marking and stocking of this shelter space could then be accomplished. By the end of 1962, this shelter effort will be well under way and the location of additional shelter spaces needed can be determined.

1. Annual Statistical Report, op. cit., p. 62.

4. Current Individual, Industrial, State, and Local Shelters

Voluntary shelter efforts have been cited by Mr. Pittman,[1] and are noted in various local press releases, but the extent of this effort on a nationwide basis is yet to be ascertained and documented in any detail. The number of shelter spaces provided would certainly be small compared to the total population of the United States.

D. LOCAL KNOWLEDGE

An informed and knowledgeable public is better equipped to protect itself from the effects of an attack or a disaster and probably has a greater chance of surviving than an uninformed, ignorant public.

In a 1958 Washington area survey when respondents were asked to describe the nature of the warning signals,

> "only one-fourth of the sample could correctly identify at least one of the warning signals; 16 percent did not even know that sirens provide the warning signal."[2]

The same survey showed that only 43% had a knowledge of CONELRAD.

> "When asked where they would tune in the radio for information, about 4 out of 10 persons said they would spin the dial or tune to a local radio station. Two out of 10 professed complete ignorance."[3]

In a 1961 Austin, Texas area survey when the participants were asked about the siren sounds for the practice alerts,

> "...some 40 percent of these representative citizens would not have known what the signals meant. Among those in the random sample, 137 or 44 percent said they did not know what the wailing tone signified and 47 others gave wrong answers or did not answer. Thirty-four percent of these informants recognized the signal as

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1. Office of Civil Defense, Statements before the Military Operations Subcommittee of the Committee on Government Operations, House of Representatives. Hon. Steuart L. Pittman Opening and Closing Statements, Information Bulletin No. 21, Battle Creek, Michigan, 23 March 1962, pp. 21-22.
2. John S. Edelsberg, et al., Knowledge and Attitudes Concerning Civil Defense Among Residents of the Washington Metropolitan Area August 1958, Operations Research Office, Johns Hopkins University, September 1959, p. 31.
3. Ibid., p. 33.

an 'Alert'. The record of the leaders is better. An even 50 percent correctly identified the signal, but 72 said they did not know or did not answer, and only 18 gave incorrect answers. The recognition test of the 'Take Cover' signal followed the same pattern; 31 percent of the leaders and 23 percent of the non-leaders recognized it. But 19 leaders, and 10 non-leaders thought it meant 'all clear' --an error which might very likely be fatal in an actual attack. But again the largest categories for the two groups are the 'Don't Know', with almost half the leaders and 69 percent of the general population representatives giving this answer. Most of the people made some guess, but could have joined in with the individuals who said simply, 'Har'!"[1]

VII. THE THREAT

The various contingencies and attack factors most directly affecting civil defense planning are contained in Annex 1, Planning Basis of the National Plan.[2] International tension, limited war, and general war are the three categories of contingencies around which civil defense planning has been developed. Attack factors detailed relate to the extent of vulnerability, enemy capability, and warning.

A. CONTINGENCIES

1. International Tension

The kind of international tension which has prevailed since the end of the Korean War will continue in varying degrees for some time. The Berlin and Congo crises are examples of outstanding problems still to be resolved.

2. Limited War

Limited war is occurring in various parts of the world. The Southeast Asia campaigns are involving the United States and could impose an increased demand upon our general economy and increase our anxiety concerning possible extensions of this area war.

3. General War

The deliberate initiation of general war does not appear likely. However, there does exist the possibility of general war by mis-

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1. H. E. Moore. Attitudes and Knowledge Concerning Fallout Shelters in Austin, Texas, University of Texas, January 1962, pp. 24-25.
2. National Plan, op. cit., Annex 1, Planning, June 1959, pp. 1-3.

calculation or inadvertence or through the expansion of the present limited hostilities.

B. ATTACK FACTORS

1. Extent of Vulnerability

> "Because of heavy population concentrations in the United States, a relatively small number of nuclear detonations could bring very high percentages of the population and industry under attacks."[1]

Military targets, critical communication centers and choke points are in most cases coincident with population concentrations. Therefore, an enemy attack even with an objective to spare unnecessary population destruction would still bring a high percentage of the population under attack in the course of accomplishing its military objectives.

2. Enemy Capability

a. Weapons

The U.S.S.R. is producing and stockpiling:

"1) High, medium, and low yield nuclear weapons--varying from a few kilotons...to megatons...in quantities rapidly becoming adequate for most potential attack requirements.

2) Biological and chemical warfare agents.

3) Incendiary weapons and conventional high explosives."[2]

b. Means of Delivery

1) Intercontinental ballistic missiles with high yield nuclear warheads are expected to assume a major role in any attack on the United States.

2) Enemy capabilities of launching short range guided missiles and eventually medium range ballistic missiles, from submarines toward United States land targets are increased for use in conjunction with land based missile or bomber attack on the United States.

1. _Ibid._, p. 3.
2. _Ibid._, p. 4.

3) Jet bombers are still a major means available for delivering a nuclear attack against the United States and will probably remain an important element of an attack for years. Delivery of nuclear warheads may be by free-fall bombs or missiles launched from bombers.

4) A small number of nuclear devices could be introduced into the United States clandestinely, and clandestine use could also be made of conventional weapons and chemical and biological warfare agents for sabotage purposes.

3. Attack Strategies

a. Assumptions

Those assumptions pertaining to attack strategies made in 1959 in Annex 1 of the National Plan and still valid in 1962 are as follows:

"1) The potential enemy could attack a large number of targets within the United States. It is unlikely that every possible target would be attacked either in an initial nuclear assault or in subsequent attacks. Neither the total number of intended targets nor the pattern of attack can be predicted.

2) Weapons employed would be predominantly nuclear and of multimegaton yield.

3) In general, the surface detonation of nuclear weapons probably would be attempted by an enemy attacking force, since the radioactive fallout from surface bursts would increase casualties and interfere with military operations and civilian survival activities for an extended time. However, some air bursts would be likely for tactical military reasons and because of U.S. military defense operations.

4) The destruction or malfunction of enemy bombers and missiles could result in random detonation of nuclear weapons in non-target areas.

5) Subsequent attacks may be possible and may even be directed at targets previously struck.

6) Chemical and biological warfare might be used before, during, or after a nuclear attack, but would be on a smaller scale, in order to increase confusion, impair morale, reduce the will to resist, and impede military operations and civilian survival and recovery activities.

7) Animals and crops might be targets for biological warfare, especially if long term recuperative powers of the United States appear to be a decisive factor.

8) Because of the size and nature of likely target areas and the variety of enemy objectives, target areas should plan for multiweapon attack.

9) Psychological warfare before, during, or after attack would be aimed at undermining confidence in U.S. leadership, weakening in other ways the will to fight, and disrupting essential survival operations."[1]

b. Target Priorities

The approach one adopts to the problem of considering which targets an enemy might select for attack depends in part on his purpose. The basic purpose of Communism is world domination. If in pursuit of this goal the U.S.S.R. finds it necessary or desirable to resort to global war, they would undoubtedly have three major objectives in an attack against North America:

1) Destruction of retaliatory capabilities.

2) Destruction of war supported industries.

3) Destruction of the people's will to fight.

One cannot second guess the target system which the enemy will pick. Ground zeros could be classified in three categories and could be combinations of these three categories:

1) Prime Targets

Strategic Air Command (SAC) airbases, SAC missile bases, critical communication points, and command and control points.

2) Secondary Targets

Air defense forces, communications points, and selected cities and/or choke points.

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1. Ibid., pp. 3-7. Assumptions have been regrouped to provide continuity.

3) Tertiary Targets

All others.

"The indication of target prominence is the province of OCDM" said Barney Oldfield, Chief of Information, NORAD in mid-1961.[1] The National Plan, Annex 1, dated 1959, states that although the Federal government will assist in the designation of target areas, the prime responsibility is vested in the respective state civil defense authorities. The National Plan, Appendix Series NP-1-1, provides a list of assumed targets. Civil defense emphasis has shifted from critical targets per se to an area concept for target priority determination.

4. Attack Tactics

In 1962, a Soviet attack against this continent would be made by a family of weapon systems, consisting primarily of ballistic missiles, missile launching submarines, and aircraft carrying free fall and standoff nuclear weapons. This family of weapons would be employed in such manner and proportion as to blunt the effectiveness of our retaliatory capabilities and best exploit vulnerabilities of North American defenses.

Any of several attack tactics could be employed. One of these is simultaneous time on target (STOT). That is, the launching of all weapons would be timed so as to deliver the weapon at all targets at the same time. Simultaneous launch (SLAUNCH) of all attack vehicles is another tactic. All weapons would be launched at the same time but would result in differential arrival times of weapons at the target. A compromise between these two extremes is the simultaneous detection time tactic (SDET) in which the launch time of all vehicles (missiles and aircraft) is such that they all come into sensor range of the appropriate detection system simultaneously.

a. Simultaneous Time on Target (STOT)

In a mixed missile-bomber attack, a STOT approach would necessitate a launch of aircraft hours in advance of the missile attack so that they would arrive at the same time. The build-up of forces and the take-off and the refueling bases would require at least several days, giving us a chance for strategic warning.

The detection of the launching of intercontinental ballistic

1. North American Air Defense Command Press Release, 1961, p. 2. (Exact date unknown.)

missiles (ICBMs) would provide a warning time of usually less than 30 minutes, but the attacking aircraft would have had to penetrate the DEW Line, Pacific barrier, or GIUK barrier several hours before the ICBM launchings to fire stand-off or release free-fall nuclear weapons. The submarine launching would have to be synchronized to arrive at the same time as the other weapons and would rule out the possibility of zero warning time. This tactic would result in maximal retaliation, optimal utilization of the defense facilities, and maximum warning time.

b. Simultaneous Launch (SLAUNCH)

If all weapons were to be launched at the same time, a differential arrival time would result. Submarine launched ballistic missiles (SLBMs) would arrive upon target first, giving little or no warning to the impact areas. The submarines could stand off and fire at coastal targets or approach the continental shelf and use their range from that point. These submarines undoubtedly could invididually fire but one missile at a time. Some areas of our continent could not be reached with this initial effort from the oceans, Gulf of Mexico, or Hudson Bay. The ICBMs would be next to arrive, but only a part of their current operational missiles could come in the first salvo due to the availability and capability of the Soviet launchers. The warning time prior to the ICBM arrival would be less than 30 minutes and actually be the difference in time between detection of the SLBM or its detonation and the 15 - 30 minute detection time for the ICBM through our space surveillance system. The bomber attack would follow in several hours.

The obliteration of the first target would be sufficient to alert the continent, so that retaliation could be nearly maximal, defensive fighter forces could be deployed and airborne, and the populace throughout most of the continent could be warned.

c. Simultaneous Detection Time (SDET)

The detection systems of the continental defensive forces as detailed in previous sections would detect the approach of the SLBM, ICBM, and aircraft at the same time when the attacker is using this tactic. The timing of such an attack would be monumental. Enemy knowledge of our detection system's capabilities would have to be as precise as our own. The hiding of the build-up of aircraft and their support and the subsequent take-off would be fantastically difficult. But if these prerequisites were accomplished, the warning time would be minimal, 0-15 minutes, and a high rate of weapon delivery and subsequent destruction would result. This tactic would provide the least amount of warning and greatest destructive capability of the three discussed.

C. WARNING

There are two types of warning which might be available for civil defense dissemination concerning an enemy attack: strategic warning and tactical warning. While the warning could be an indication of a possible attack in advance of its launching or knowledge of an attack after it has been launched, an attack could come without warning.

1. Strategic Warning

It is possible that there might be strategic warning of an all-out nuclear attack on the United States. Strategic warning may range from verified information of an enemy's intent to attack to an accumulation of many interconnected actions and reactions interpretable as indicating a potential enemy's probable intention to attack the United States. Despite the possible difficulty of recognizing strategic warning, there might well be evidence of such a high degree of probability of attack that it would appear only prudent to take certain steps in military, civil defense, economic, and political fields to greatly accelerate readiness measures.[1]

2. Tactical Warning

An enemy attack against the North American continent is expected to commence with an ICBM and SLBM initial attack. The anticipated maximum tactical warning of an initial ICBM attack would be 10-15 minutes for the continent as a whole. However, less warning time could be available as a result of an initial SLBM attack and the detonation of the first weapon could serve as warning for the entire country. Manned aircraft are still considered as a major means of weapons delivery. They could be used to mount a small sneak raid of intercontinental bombers, but more realistically would be used as a follow-on attack to take advantage of initial strike devastation and to modify target objectives as reconnaisance necessitated.

Thus, initial tactical warning should most realistically be based upon the threat of the guided or ballistic missile with manned aircraft becoming a secondary consideration, although no prediction can be made of the exact "mix" of weapons used.

1. National Plan, Annex 1, Planning, op. cit., p. 8.

APPENDIX C

SKYWAVE PROPAGATION OF RADIO WAVES AND THE CLASSES OF AM BROADCAST STATIONS

I. SKYWAVE PROPAGATION OF RADIO WAVES

In Chapter Seven it was stated that the range of FM and TV stations is limited to approximately the line of sight between the transmitting and receiving antennas. This is due to the fact that the energy radiated skyward is not returned to earth. On the other hand, while the medium frequency waves of AM radio hug the ground and will travel great distances, reception of these waves is greatly different during daytime and nighttime. This results from the difference in effect of the ionosphere on the skyward radiation during these two time periods. Understanding of this effect is important to the warning system design, since it results in different coverage of AM radio stations during daytime and nighttime.

Above an altitude of about 40 miles there exist several layers of electrons and ionized particles called the ionosphere. The electron density in these layers ranges from about ten to over one million electrons per cubic centimeter.

When a free electron is exposed to a radio frequency wave, some of the energy of the wave is transferred to the electron as energy of vibration. If the electron does not lose this energy as the result of a collision with a neutral particle (atom or molecule) in the air, it will radiate a new electromagnetic signal at the same frequency. Thus the energy is restored to the wave without loss. If, however, the air density is appreciable, e.g., more than about one ten-thousandth of the sea-level value, collisions between electrons and neutral particles will take place at a significant rate. In such collisions, most of the excess (vibrational) energy of the electron is transformed into random kinetic energy and cannot be re-radiated. The result is that energy is absorbed from the wave and the electromagnetic signal is attenuated.

It is apparent, therefore, that marked loss of signal strength will occur only when the electron density and air density are both moderately large. Other conditions being held constant, more energy is absorbed by an ionized gas as the frequency of the signal is decreased. Both positive and negative ions can, in principle, absorb electromagnetic energy in the same way as do electrons, but their larger mass makes them much less effective. Therefore, the effect of ions may be disregarded in this connection.

After sunset, the electron density in the lower layers of the ionosphere decreases markedly with the result that less absorption of radio waves occurs. Waves in the medium frequency region (broadcast band) now are refracted back to earth with enough strength to be usably greater than natural and man made interference from 30 to 50% of the nighttime hours at distances as great as 1,000 miles. Since the ionosphere is continuously in motion, these distant signals encounter what is known as fading.

While the skywave may be considered a boon by those in remote regions who are completely dependent on this phenomona for their news and entertainment, it is a plague to those who live in what is called the fringe area. During the daylight hours, when only the ground wave signal propogates, good reception of a 50kw clear channel station may be had up to 250 miles from the station when the path is over good conductivity earth. The range for a 1 megawatt station would be 4.5 times this distance or from 700 to 1,100 miles. However, at night interference between the ground wave and the sky wave occurs at a distance of about 50 to 70 miles from the transmitter. This zone is relatively independent of station power. Figure C-1 shows how the ground wave and average sky wave behave as a function of distance. The net result is that the primary ground wave coverage of the high powered broadcast stations is very much less at night than during the daylight hours, while the nighttime secondary or sky wave coverage is the only signal available to a large area of the United States.

For better or worse, all radio and television stations in the United States have been located primarily on the basis of reaching listeners (or viewers) for the purpose of gaining revenue returns from advertising. Hence, the stations are located where most of the people live. In addition, four principal nationwide networks compete for the advertising business along with a number of independent stations. These networks are: the National Broadcasting Company (NBC), the Columbia Broadcasting System (CBS), the American Broadcasting System (ABC) and the Mutual Broadcasting System (MBC). These networks may offer a large legacy to a civil defense warning network in the wire-line facilities which link their network stations together and represent a very substantial investment and annual rental charges of many millions of dollars per year.

II. CLASSES OF AM BROADCAST STATIONS

In the continental United States, approximately 3,700 network affiliates and independent broadcast stations share the 107 medium frequency channels which range from 540 to 1600 kc with other North and South American countries as well as the rest of the world. These 107 channels are assigned by the Federal Communications Commission to essentially five classes of stations as follows:

APPENDIX C

A. CLASS IV - LOCAL STATIONS

Six of the 107 channels are reserved for local stations in North America and as many as 160 operate on each of the channels. There are over 900 such stations in the United States. Owing to the sky wave phenomenon discussed above, as well as the large number of stations operating on each channel, these stations can be heard only in their interference-free ground wave coverage area. They are usually low power stations ranging from a hundred watts to one kw. Nighttime operation is limited to 250 watts.

B. CLASS III - REGIONAL STATIONS

Forty-one of the 107 channels are used by the 775 full-time regional stations in the United States. From 13 to 24 operate on each channel. Most stations are required to protect each other's coverage at night by means of directional antennas. Almost 300 other stations are permitted to operate on these channels during the daylight hours only. Regional stations are limited to a power of five kw.

C. CLASS I - NATIONAL OR CLEAR CHANNEL STATIONS

The remaining 60 channels are used by all countries in North America for clear channel stations of which there are two types, Class I-A and Class I-B. These clear channel stations are intended to serve not only the cities and urban areas surrounding them, but also the large rural and small town areas which are not served by local and regional stations. Class I-A and I-B stations are presently limited to 50 kw power. The FCC has indicated that this limit may be raised.

D. CLASS I-A

On each of the Class I-A clear channels, only one nighttime station is assigned with the result that these stations provide interference free service for great distances, especially at night. Only 24 clear channels remain in the United States.

E. CLASS I-B

On each of the Class I-B clear channels, only one or two dominant full-time stations and a limited number of Class II full-time stations are assigned. The United States has Class I-B rights on 19 channels and foreign countries have rights on 2 channels.

On the 19 United States Class I-B channels the United States has assigned a total of about 33 full-time stations, 79 Class II full-time stations and about 56 Class II daytime-only stations. Each of the 33 United

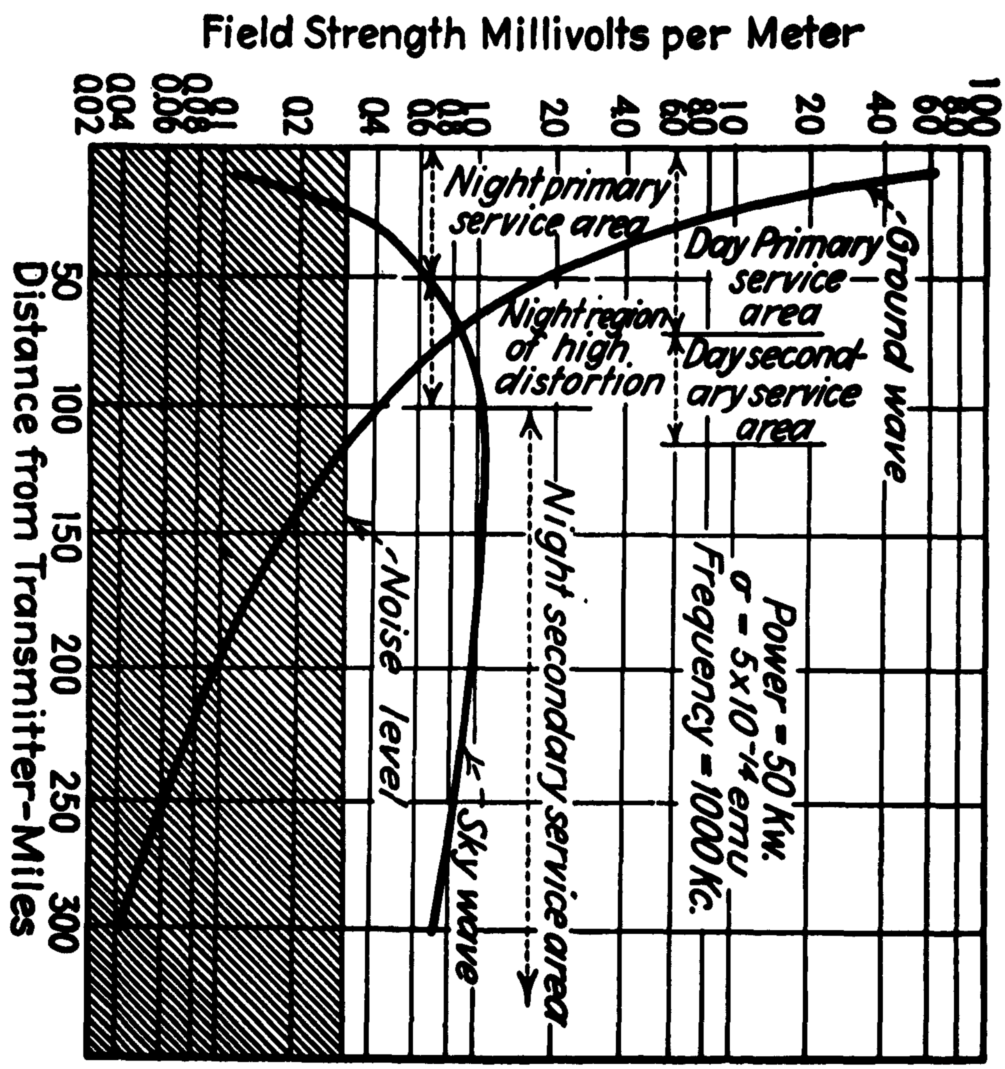

Figure C-1. Skywave Propagation of Radio Waves.

APPENDIX C

States Class I-B stations render a fair service to some rural and remote areas. On the two foreign Class I-B channels the United States has some 15 full-time Class II stations and about 48 Class II daytime-only stations.

F. CLASS II

Under limited conditions Class II stations are permitted to operate on Class I-A and I-B channels. Such stations are predominantly local. Within the continental U.S. 57 stations operate on the 24 U.S. Class I-A channels during daylight hours only and 493 on the 14 foreign Class I-A clear channels. Class II stations receive no protection from Class I stations but must protect Class I stations to a high degree. To some extent, each North American country is permitted to operate Class II stations on the clear channels assigned to other countries. The U.S. has about 43 such stations. On the two foreign Class I-B channels the U.S. has some 15 full-time Class II stations and about 48 daytime-only stations.

The following table summarizes the U.S. utilization of the medium frequency broadcast spectrum.

Type of Channel	No. Channels	Full-time Stations	Daytime Only Stations	Total
U.S. Class I-A Clear	24	24	58	83
Foreign I-A Clear	14	45	500	545
U.S. Class I-B Clear	20	114	60	172
Foreign I-B Clear	2	16	54	70
Regional Class III	41	775	1130	1905
Local Class IV	6	945	2	947
Totals	107	1919	1804	3722

APPENDIX D

DERIVATION OF TEN YEAR COST OF FOUR WARNING SYSTEMS

I. INTRODUCTION

The total cost of any system is comprised not only of research and development costs and the initial implementation costs, but also of the annual operating and maintenance costs. For that reason, ten year costs are the most meaningful in the comparison of alternative systems and have been used in recent years by the RAND Corporation and military agencies for comparing weapon systems. In order to provide as detailed an estimate of the system costs as possible, they have been provided here for the various aspects of competing warning systems.

Where cost estimates were available from other sources, they have been used. Where estimates were not available, they have been made by or in consultation with experienced and competent persons in the particular area involved. However, more accurate costing is recommended for several of the warning systems considered, necessitating more detailed design studies for each system.

All major cost categories except research and development have been included for each system in the following cost summary. Each item is self-explanatory and indicates how each was developed.

II. POWER LINE SYSTEM (e.g., NEAR)	Millions of Dollars
1(a) Signal generators-initial cost .... An average cost of $4 per meter is used for an initial quantity of 60 million meters (the power companies had 52.6 million domestic and 7.4 million commercial and industrial customers in 1961).	240.0
(b) Signal generators-follow on cost .... Power system growth, which determines NEAR generator capacity requirements, is doubling approximately every 8 years. Therefore, an increase of 1.378 times the original investment is required in 10 years.	330.7
2. Signal distribution facilities-existing	No cost
3. System engineering for growth .... It is estimated that on the average, 1 senior, 1 junior, and 1 draftsman per million meter system will be required to do the engineering for the 255 cycle system. Total direct salaries of $25,000 per year, 100% overhead, and 60 average systems indicate $3.0 million per year.	30.0
4. Signal generator maintenance .... 1% per year of average capital cost over the 10 year period.	38.2
5. Receiver cost .... Initial number (60 million) increasing to 70 million in ten years, $10.00 receiver cost and $5.00 distribution cost.	1050.0
6. Receiver installation cost .... $3.50 per receiver.	245.0
7. Receiver maintenance .... Assuming 2%/year failure rate (10% in 5 years), on the average 1.3 million sets will fail per year over the 10 year period. An average repair cost of $3.65 per set was derived on the basis of the same repair time and part cost as used for radio sets. (See Chapter 7 on reliability and maintenance.)	47.5
8. Administrative .... This includes cost of billing for service rendered, etc.	Unresolved
Total 10 year cost	1981.4

		Millions of Dollars
III.	**SYSTEM UTILIZING EXISTING TELEPHONE PLANT**	
1(a)	Modification to central office equipment........ 50 million phones at $20 each	1000.0
(b)	Follow-on equipment............................. Growth of 10 million phones at $20 each	200.0
2.	Signal distribution facilities-existing.........	No cost
3.	System engineering for growth...................	Insignificant
4.	Additional plant maintenance.................... 1% per year of initial equipment cost ($100 million) plus 1% of average follow-on equipment cost ($10 million).	110.0
5.	Receiver cost-use existing receivers............	No additional cost
6.	Administrative..................................	Minimal
	Total 10 year cost..........	1310.0

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		Millions of Dollars
IV.	PRIVATE WIRE TELEPHONE SYSTEM (e.g., TELEGLOBE)[1]	
1(a)	Signal generating equipment..................... $5,000 per control center for 10,000 subscribers. 6000 control centers required for 60 million subscribers results in a $30 million capital outlay.	(Included in subscription cost)
1(b)	Follow on central office cost.................. For additional 10 million subscribers 1000 control centers would be required at $5000 each, resulting in $5 million capital outlay.	(Included in subscription cost)
2.	Signal distributing facilities................. Lease from common carrier, not estimated.	(Included in subscription cost)
3.	Receiver cost included in the $3.00 per month.. service charges per subscriber and an average number of 65 million over 10 year period-- this total cost on subscriber-paid basis amounts to $23.4 billion.	(Included in subscription cost)
4.	Receiver installation......................... 70 million receivers at $3.50 each, results in a $245 million capital outlay	(Included in subscription cost)
5.	Maintenance...................................	(Included in subscription cost)
6.	Administrative................................	(Included in subscription cost)
	Total 10 year cost to public (on subscriber basis)...	23.4 billion

1. Although the private wire telephone system costs shown are based on $3.00 per month per subscriber, typical equipment and operational costs are indicated where it is possible to delineate them.

		Millions of Dollars
V.	**RADIO**	
1.	Cost of special sub-carrier..................... Generator and relay control equipment for 1000 stations at $2000 each.	2.0
2.	Signal distribution facilities-free space.......	No Cost
3.	Signal generator maintenance.................... Part of normal operation.	Minimal
4.	Additional cost of night standby operators...... 400 stations at $5000 per year.	20.0
5.	Receiver cost.................................... 60 million sets initially increasing in 10 years to 70 million at $20 per receiver.	1400.0
6.	Receiver installation cost...................... 70 million at $3.50 per receiver.	245.0
7.	Receiver maintenance............................ Average number of 65 million sets with .01% per 1000 hour parts indicates 430,000 set failures per year. This results in cost of $1.7 million per year. (See Chapter Seven, section on the cost of radio maintenance.)	17.0
	Total 10 year cost......................	1684.0

APPENDIX E

LIST OF SELECTED TERMS
(Including "L" System Projects)

AIRBORNE EARLY WARNING (AEW) OR AIRBORNE EARLY WARNING AND CONTROL (AEW&C) - Air surveillance and control provided by long-range aircraft equipped with search radar, communication, and intercept-control facilities; information is relayed to SAGE Direction Centers, picket vessels, and Texas towers.

AIR BURST - Explosion of a bomb in the air, above land or water, at such a height that the fireball does not touch the surface of the earth (or water).

AIRBORNE LONG-RANGE RADAR INPUT (ALRI) - Radar data from an airborne radar platform.

AIRCRAFT CONTROL AND WARNING (ACW) - Air Force long-range radar squadrons whose functions include detection, tracking, and reporting airborne objects; evaluation and identification of this information; and ground control of airborne aircraft.

AIR DEFENSE EMERGENCY - Declaration of an emergency indicating that hostile action is in progress or imminent.

AIR DEFENSE REGION - A geographic subdivision of a territory designated as the area of responsibility of a NORAD force.

AIR DEFENSE SECTOR (ADS) - A geographical subdivision of an air defense region.

AIR DEFENSE WARNING (ADW) - The degree of air raid probability. Warning RED: Attack imminent or taking place. Warning YELLOW: Attack probable. Warning WHITE: Attack improbable.

AIR RAID WARNING - A Civil Defense warning of probable or imminent attack by hostile forces.

ALERT - As used here, indicates the attention getting signal or alarm used to call the intended recipient to a state of action. As opposed to warning, alert or alerting provides only an initial awareness of a threatening situation and does not in itself define what, where, or when. (See Warning.)

AREA WARNING CIRCUIT - That portion of NAWAS which is within one of the warning areas and connects the warning points of that area with a warning center.

ATTACK WARNING OFFICER - An OCD warning center staff member who is responsible for declaring and disseminating warnings and other emergency information over NAWAS.

ATTACK WARNING SYSTEM (AWS) - The system by which a warning or other emergency information is transmitted throughout the nation. It consists of three parts - the Federal, state, and local portions.

BALLISTIC MISSILE EARLY WARNING SYSTEM (BMEWS) - A real time, long-range missile detection and tracking system providing three-dimensional information to special-purpose computers.

BATTLE STAFF - A group of officers of various military services assigned to an air defense organization and designated by its commander to supervise air defense operations within a geographical area of responsibility.

COMBAT CENTER (CC) - In SAGE, the NORAD division center supervising air defense operations.

COMMAND POST (CP) - A facility within a SAGE Combat or Direction Center from which division or sector supervision of air defense operations is exercised.

DEFENSE READINESS CONDITION (DEFCON) - Actions to be taken to bring the Air Defense system to a desired readiness posture to meet any contingency.

DIRECTION CENTER (DC) - An Air Defense Sector Headquarters center from which active air defense operations are conducted.

DISTANT EARLY WARNING LINE (DEW LINE) - A string of radar stations running along the Arctic edge of the American continent. The DEW Line is a joint U.S. and Canadian project.

GROUND ZERO - The point on the earth's surface either at or immediately below the point of detonation. For a water burst, the corresponding point is referred to as "surface zero."

INCREASED INTELLIGENCE WATCH - A condition of command alertness directed by the Commander-in-Chief, North American Air Defense Command (CINCNORAD) when closer scrutiny and evaluation of intelligence is required.

INTELLIGENCE - Knowledge or information that has been evaluated and interpreted in terms of the capabilities, limitations, vulnerabilities, and probable intentions of the enemy or potential enemy.

INTERCONTINENTAL BALLISTIC MISSILE (ICBM) - A ground-to-ground missile capable of spanning continents or oceans.

INTERMEDIATE - An organizational level in the warning system between the national and strictly local levels. Intermediate centers will normally be at state or regional level, and will have functions which will require interactions with Federal, state, and sometimes local civil defense organizations.

INTERMEDIATE-RANGE BALLISTIC MISSILE (IRBM) - A ground-to-ground missile of lesser capability than the ICBM.

LOCAL WARNING CENTER - A facility capable of 24 hour operation found normally at the city or county level. The local warning center must be capable of performing all functions required to provide warning to the inhabitants within its jurisdiction.

MAGNETIC DRUM RECEIVING EQUIPMENT (MADRE) - A doppler radar system which utilizes ionospheric propagation in the high frequency region together with a cross correlation integration technique based on sampling the bipolar video output of the radar and magnetic drum storage. It has a range capability of about 1500 miles.

MID-CANADA LINE (MCL) - A chain of detection stations in Canada built by the Canadian government along the 55th and 56th parallels.

NATIONAL WARNING CENTER - The OCD facility staffed by Attack Warning Officers and situated within the Combat Operations Center at NORAD Headquarters. Controls NAWAS when the warning area circuits are tied together.

NATIONAL WARNING SYSTEM (NAWAS) - The Federal portion of the Attack Warning System, used for the dissemination of warnings and other emergency information from OCD warning centers to warning points in each state.

NORTH AMERICAN AIR DEFENSE COMMAND (NORAD) - A joint command coordinating operations of various services in defense of the continental United States and portions of the North American continent specified by the Department of Defense.

OCD WARNING CENTER - A facility staffed by Attack Warning Officers and located at the source of first available information that an attack on the United States is probable, imminent, or in progress.

REGIONAL WARNING OFFICER - A staff officer located at each OCD Regional Headquarters to assist states and local areas in solving warning problems.

RISK II - A National Resource Evaluation Center (NREC) computer program which provides combined probabilities of nuclear attack experience in terms of blast over-pressure, fallout arrival time, radiation dose rate and total radiation dose or in terms of damage, casualties or denial, for weapons and resource points of interest anywhere in the world.

SEMI-AUTOMATIC GROUND ENVIRONMENT (SAGE) - An air defense system using radar and other air surveillance data automatically correlated with known flight plans and other information to detect the presence of unknown aircraft; also provides automatic guidance of interceptor aircraft.

SIMULATION - A process of using synthetic information in a system for training, evaluation, and testing purposes.

STANDING OPERATING PROCEDURE (SOP) - An authorized written procedure established as a standard to be followed in performing an operation.

SURFACE BURST - A surface burst is one in which the weapon is exploded either at the actual surface of the earth (or water) or at any height above the surface, such that the fireball touches the land or water.

THREAT WARNING - A report originating at the NORAD Combat Operations Center and disseminating early warning information to lower echelons of the air defense system.

UNIVERSAL TRANSVERSE MERCATOR (UTM) - A projected rectangular system of equally spaced East-West and North-South lines which provides a reference system made up of parallel grid lines.

WARNING - As used here, and as applied to civil defense, means the advance notification of a nuclear threat, the effects of an attack, and impending natural disasters. Notification includes the providing of information about the nature of the threat, its extent or scope, and its imminence. Warning is completed when the recipient has received and interpreted the data presented and decided to act. (See Alert.)

WARNING AREA - A geographical area consisting of a number of states which is the responsibility of one of the OCD warning centers.

WARNING POINT - A facility which receives warnings and other emergency information over NAWAS and which relays this information according to instructions contained in state and local civil defense plans.

WARNING RED - Attack imminent or taking place. (See Air Defense Warning.)

WARNING WHITE - Attack improbable. (See Air Defense Warning.)

WARNING YELLOW - Attack probable. (See Air Defense Warning.)

WORLD GEOGRAPHIC REFERENCE SYSTEM (GEOREF) - A geographic reference system for the world, used in the USAF for aircraft position reports, target designation, and the control and direction of air units engaged in air defense, air-sea rescue, and tactical air operations.

APPENDIX E

"L" SYSTEM PROJECTS

COMMAND SYSTEMS

System No.	Name and Mission
425-L	NORAD COMBAT OPERATIONS CENTER: A system which collects, processes, and displays data to assist the Commander-in-Chief, North American Air Defense Command (NORAD) in commanding and controlling his forces. Prime contractor - Burroughs. Status - under implementation.
465-L	STRATEGIC AIR COMMAND AND CONTROL SYSTEM: A system which collects, processes, and displays data to assist the Commander-in-Chief, Strategic Air Command (SAC) in commanding and controlling his forces. Prime contractor - IT & T. Status - development.
473-L	AIR FORCE CONTROL SYSTEM: A data processing and display system to assist USAF Headquarters in making command decisions. Prime contractor - IBM. Status - design.

CONTROL SYSTEMS

416-L	SAGE AIR DEFENSE SYSTEM: A semi-automatic area air weapons control and warning system for detecting, identifying, tracking, and providing weapon intercept control capability against air-breathing missiles and aircraft attacking North America. Systems Management - Western Electric. Status - has implementation.

INTELLIGENCE SYSTEMS

466-L	ELECTROMAGNETIC INTELLIGENCE SYSTEM: A world-wide system for collecting intelligence by electromagnetic means and processing for transmission to users. Prime contractors for study - RCA/IBM. Status - study and preliminary design.
438-L	INTELLIGENCE DATA-HANDLING SYSTEM: A system for high-speed processing of world-wide intelligence data. Prime contractor - IBM. Status - active.

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SUPPORT SYSTEMS

480-L	AEROSPACE COMMUNICATION SYSTEM: 480-L designation Deleted 1 July 1962. Replaced by 483-L & 484-L. Program still active under "SPACECOM."

WARNING SYSTEMS

474-L	BALLISTIC MISSILE EARLY WARNING SYSTEM: A system to provide early warning of a mass ICBM attack on the North American continent from the north. Prime contractor - RCA/Western Electric. Status - under implementation.
413-L	EXTENSION OF DEW LINE: A distant warning system for detecting hostile air-breathing threats approaching the North American continent from the north. Prime contractor - Western Electric. Status - under implementation.
477-L	NUCLEAR DETECTION AND REPORTING SYSTEM: A system to provide NORAD and other military and civilian agencies with essential information on nuclear detonation occurring within the NORAD area of responsibility. Prime contractor - General Electric. Status - study.
496-L	SPACE TRACK: A system for detecting, tracking, identifying, and cataloging orbiting objects. Prime contractor - Aeronutronic. Status - under implementation and study.

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