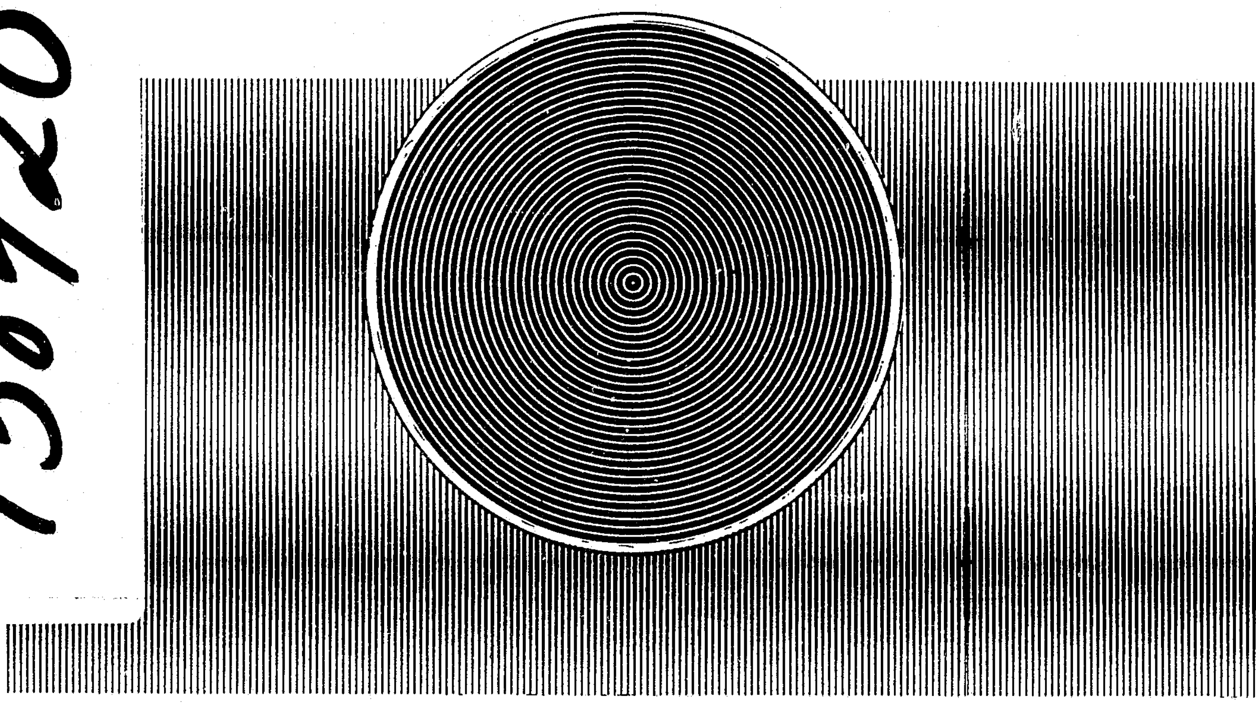
FEDERAL EMERGENCY MANAGEMENT AGENCY CPG 1–37 / September 1984

STATE and LOCAL

Communications and Warning Systems Engineering Guidance



Federal Assistance Handbook

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CPG 1-37

FEDERAL ASSISTANCE HANDBOOK:

STATE AND LOCAL

COMMUNICATIONS AND WARNING SYSTEMS ENGINEERING GUIDANCE

Federal Emergency Management Agency

Washington, D.C. 20472

Federal Assistance Handbook: State and Local Communications and Warning System Engineering Guidance

Foreword

This Civil Preparedness Guide has been prepared as a reference source for State and Local emergency management officials to assist them in their communications and warning systems engineering. This guide outlines the key characteristics of a well planned warning and communications system.

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GUIDANCE
COMMUNICATIONS AND WARNING SYSTEMS ENGINEERING

1.1 Purpose. The purpose of this Civil Preparedness Guide (CPG) is to provide guidance to FEMA Regional offices and State and local emergency management officials on communications and warning systems engineering.

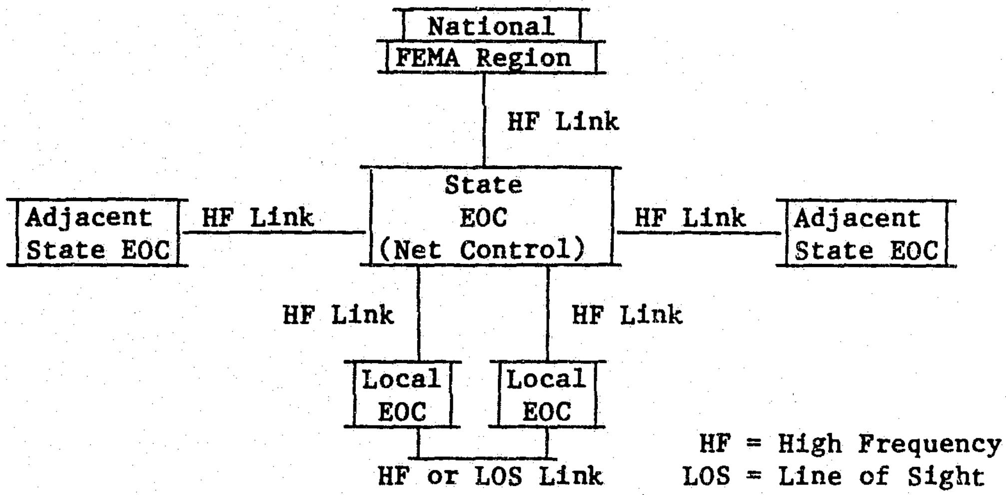
1.2 Key Characteristics of Warning and Communications Systems.

a. General. An effective direction and control emergency response system must be embodied in a dedicated, reliable, and survivable emergency communications and warning operational system. A dedicated system is designated for primary use in response to emergencies and under the control of the State or local emergency management officials. A reliable system is one that is in a constant state of readiness and performs up to its full capacity when put into service. A survivable system is one that can continue to operate during pre-, post-, and transdisaster situations, under peacetime and wartime conditions.

The direction and control emergency communications and warning systems necessary to support emergency management in peacetime or wartime should have the following key characteristics:

(1) Connectivity;
(2) Survivability;
(3) Capacity;
(4) Transportability;
(5) Security;
(6) Modes;
(7) Flexibility;
(8) Interoperability; and
(9) Responsiveness.

b. Connectivity. Connectivity defines and identifies systems and subsystems relationships. As an example, there should be a clear display of the communications links from the network control point to connecting points. Following is a simplified example of such connectivity:



c. Survivability. Survivability is that aspect of a system's characteristics that ensures a high probability of the system's continued operation during and subsequent to a disaster or emergency. This encompasses both peacetime and wartime conditions. Survivability can be enhanced by physically protecting equipment from damage such as severe shock, weather, and other physically damaging conditions. Survivability can also be enhanced by electronic protection, such as electromagnetic pulse (EMP) protection, which also protects against lightning. In addition to the above, survivability can be enhanced by cost effective redundancy of equipment and parts.

d. Capacity. Capacity is the ability of a system to provide the necessary level of operational capability in the time constraints specified. As an example, if a printing terminal is to be used to pass traffic, and the volume of traffic is predetermined to be heavy and to contain long messages, a traffic load study should be performed in order to determine the required printer speed. Multiple channels can increase capacity and improve survivability.

e. Transportability. Transportability is the characteristic of a system or equipment item that allows movement from one location to another location with relative ease and speed, and with a high degree of assurance that operational capability can be rapidly reestablished at the new location. Transportability does not imply equipment operation while in transition from one point to another point. It does, however, imply field deployability, preferably by one person.

f. Security. While security is often used in the context of "classified" information or use, such as "secret" traffic, security, herein, is referred to in the context of protection from unauthorized access or use of systems or equipment. For example, a warning activation system could have a coded touch-tone pad with code change capacity. This would allow an official to control the code to prohibit unauthorized access to the activation device.

g. Modes. Mode is the manner or way in which information is transmitted, such as voice, facsimile (pictures in shades of gray), and record (teletype). The mode or modes selected for incorporation should be determined by the requirements of the emergency management mission. Voice may serve part of the requirements, but record may be required for the movement of detailed information, such as weather data or emergency medical supplies information.

h. Flexibility. Flexibility is the capability to meet rapidly changing operational situations. For example, atmospheric conditions can change the effectiveness of transmission of radio signals. Equipment that can be readily tuned to various channels/frequencies is considered more flexible than crystal controlled or fixed frequency equipment.

i. Interoperability. Interoperability is a system's ability to exchange information with other systems. For example, a State or local level emergency communications system should be interoperable with other public safety communications systems and with appropriate nongovernment systems such as the commercial telephone system(s). Effective interoperability requires clear procedures and priorities.

j. Responsiveness. Responsiveness is the ability to react rapidly and effectively to a spectrum of operational conditions and requirements. This includes such elements as rapid and accurate dissemination of alerts and warnings, clear transmission and reception of information in various modes of operation, and prompt reconstitution of system operation.

k. Effective Operations and Maintenance. Effective operation and maintenance of an emergency communications or warning system includes the following:

(1) User friendly equipment;
(2) Minimum essential number of personnel;
(3) Minimum training requirements;
(4) Appropriate Mean-Time-Between-Failures (MTBF);
(5) Appropriate Mean-Time-To-Repair (MTTR);
(6) Modular replacement for repair;
(7) Appropriate equipment and component redundency/back-up;
(8) Appropriate test equipment and operational monitoring equipment/devices; and
(9) Appropriate operations and maintenance documentation.

1.3 Engineering the System. There should be three sections to a communications or warning system development plan, namely, definition of operational requirements showing connectivity, definition of current operational capabilities, and definition of required operational capabilities not provided by the current system.

Following the above, a schedule of projected events/activities/products should be developed. It is anticipated that this time-line schedule will be multiyear due to time, staff, financial, and equipment delivery constraints. Therefore, it is acknowledged that achievement of a fully operational capability will most likely be a multiyear process. With this in mind, the system development plan should show the achievement of operational capability at the end of each year's effort. For example, if ten transmitters and ten receivers are required over a two year period, five transmit-receiver sets should be purchased in each year.

1.4 Communications Systems. Communications capabilities connecting National, Regional, and State level of government do exist. They are the National Warning System (NAWAS), the Federal Emergency Management Agency National Teletype System (FNATS), the Federal Emergency Management Agency National Voice System (FNAVS), and the Federal Emergency Management Agency National Radio System (FNARS). The National Emergency Management System (NEMS), made-up of the capabilities and resources of the Emergency Information and Coordination Center (EICC), the Alternate EICC, the Olney computer center and FEMA Regional resources, as well as the future Direction and Control Warning and Communications System (DCWCS), will replace current connectivity among FEMA National, Regions, and State offices.

a. Dedicated Systems. At the State and local levels of government, available direction and control communications systems range from comprehensive to sparse. While jurisdictions might have many emergency telephone or radio communications systems available, such as police, and public works, these systems (except telephone) are not usually tied into a common network for mutual aid, and are rarely available to the emergency management official.

In some communities, the only networks available to emergency management officials are reserved for police, fire and public works activities. During major disasters and emergencies these networks are generally overloaded with police, fire and public works traffic and are unavailable to the emergency management official. What is required, therefore, is a "dedicated" emergency communications system, under the control of the emergency management official for coordination of direction and control activities.

b. Survivable Systems. An emergency communications system must be "survivable" in that it can maintain operation during and subsequent to emergencies. While it is difficult to harden a system against the direct effects of a nuclear weapon, a system can be made more survivable through such techniques as shock mounting equipment and electromagnetic pulse (EMP) protection. Additionally, a radio emergency communication system tends to be more survivable by its nondependence on landlines, such as in a telephone system. This level of survivability is evident when considering areas that are impacted by severe natural phenomena such as earthquakes, tornadoes, hurricanes, floods, high winds, and winter storms.

Another consideration in the survivability of a system is that of the capability to operate without the dependency on commercial electrical power. This is normally achieved in two ways - by the use of a standby emergency power generator or by the use of batteries. In most instances, the emergency power generator is the technique used for offline operation of emergency communications equipment, as this power is often also needed to operate other electrical and electronic equipment in facilities such as an emergency operating center. Batteries are a viable secondary power source for operating low power consumption electronic equipment for short periods of time.

c. Reliable Systems. An emergency communications system must be "reliable" in that operational readiness is maintained. To ensure a high probability of operational readiness in an emergency communication system, consideration should be given to the meantime-between-failure (MTBF) of the equipment, the availability of backup equipment, parts for repair, qualified personnel to perform corrective maintenance on the equipment, and the scheduled testing of the equipment.

To achieve a direction and control capability that is dedicated, survivable, and reliable, the communications systems both at the State and local levels of government, must include, as a minimum, the following characteristics:

(1) Network control by a designated emergency management official or officials;

(2) Electromagnetic pulse protection;

(3) Standby emergency power (noncommercial, available on a 24-hour basis);

(4) Ease of equipment operation by staff with minimal technical skills;

(5) A high level of readiness assured by daily use and frequent exercising and testing;

(6) Adequate staffing, preferably on a 24-hour basis;

(7) A calldown structure for system staffing on short notice;

(8) Adequate backup spare parts, and repair capability when equipment failure occurs;

(9) Interface capability with other systems and equipment to be interacted with in time of emergency (e.g., frequency compatibility);

(10) Redundancy whenever financially practical;

(11) Interchangeability with other pieces of equipment based on relocation and deployment requirements; and

(12) Transportability for relocation or field deployment.

d. Linking and Augmenting Existing Systems. All State governments have some level of emergency communications operational capability. Examples are public safety, public works, and transportation agency networks. Linking and augmenting these existing communications capabilities through common frequency equipment, proper systems planning and development can often establish more effective emergency communications operational capability in the form of a Statewide network. This network can then be used for emergency management purposes by State and local emergency managers. This capability can often be achieved at a fraction of the cost of a completely new system.

e. Interfacing Dissimilar Systems. Many State and local governments have emergency communications systems or subsystems currently in place, such as VHF or UHF radio communications. In most instances, it would be financially infeasible for the State and local governments to discard their current operational systems in order to purchase and implement totally new systems. State and local governments can take advantage of their current direction and control operational capability and expand or augment this capability by the use of patching equipment and in-out frequency converters. One example of this is where a State or local government having a VHF or UHF emergency communications system desires to expand that system with the use of HF equipment for long haul communications (i.e., 100 miles or more). This can be accomplished by the use of frequency conversion equipment. As an example, a receiver can receive radio signals on VHF or UHF and the conversion equipment can convert these signals to HF and retransmit these signals. In this case, the equipment at the receiving point would be supplemented with a converter and a repeater.

Another method of enhancing emergency radio communications while maintaining the current operating systems, is by the use of geographically remote repeaters. In this instance, if the system currently in place is inadequate for reliable communications across a State or from State to State, repeaters can be strategically placed so that the signal can be received at mid-points and retransmitted the remainder of the distance. Where possible, repeaters should be located in low hazard areas. Repeater equipment is currently available that can operate in an automatic unattended mode

f. Engineering the New System. The mission to be accomplished and the operational requirements must be defined. Considerations to be addressed include:

(1) The geographical area to be covered;

(2) The number of end points or transmit/receive points to be placed in the system;

(3) The topography such as high-rise buildings, and/or mountainous terrain;

(4) The transmission modes and frequency requirements relative to contiguous communities both at the State and local levels of government;

(5) The ability of the State or local government to provide adequate financial support for the purchase, implementation, and ongoing operational and maintenance costs of the system; and appropriate staffing.

(6) FCC rules and regulations governing the services desired.

When designing and engineering a new emergency communications system, the operational requirements for the system should be specified. As an example, one important consideration is the distance from transmit to receive points in the system. This operational requirement will eventually lead to the determination of the amount of transmitter power to send a signal a certain distance, and, possibly, the part of the radio frequency spectrum that should be selected in order to achieve the operational capability. In all cases, the operational requirements should be clearly defined. Once this is accomplished, the types of hardware, software, and operational procedures can be addressed. As a final step in designing a new system, a system level diagram should be developed pointing out any unusual requirements in the system. Examples of this are such items as repeater stations required due to terrain, and the need for mobile equipment.

g. Backup Communications. When manmade or natural disasters occur, primary communications systems may be totally destroyed or severely damaged. During this time amateur radio operators can handle vital messages for emergency management officials. A structured organization of amateur radio operators can supplement State and emergency communications systems in time of emergency or disaster. Such a network can be a critically important element in State or local emergency management. State and local offices of emergency management can obtain the necessary information for contacting amateur radio operators through the American Radio Relay League (ARRL) section managers offices.

1.5 Alerting and Warning Systems. Alerting is defined as obtaining the attention of a person or persons. Warning is defined as giving information about the nature of the emergency situation. An effective emergency alerting and warning system must be reliable and capable of delivering rapid and understandable signals and information to government officials and the general public at all times, day or night. This is necessary, both for attack warning and for natural and manmade emergencies and disasters, to give the population time to take lifesaving actions and to mitigate the potential destruction of property.

a. Relationship to Direction and Control Components. Alerting and warning systems designs must show the relationship to the key elements of the associated direction and control system namely, an Emergency Operating Center, an Emergency Broadcast System station, and an Emergency Public Information System or Plan. Each of the elements of the direction and control system must be integrated for effectiveness. Additionally, the warning system plan or design must include those operational elements required for the control and activation of the warning system.

b. Existing Systems. The majority of the emergency warning systems exist at the local levels of government. These are mostly outdoor warning systems, basically sirens with wireline activation. Since warning systems are expensive to replace in their entirety, their reliability and cost effectiveness can often be enhanced by converting from landline activation to radio activation.

Existing outdoor warning systems can be augmented with and enhanced by devices such as tone alert receivers, and available resources in a community, such as cable television (CATV), and the Emergency Broadcast System (EBS). Where institutional or industrial warning systems exist, such as in schools or factories, consideration should be given to linking the government-controlled activation system to these existing warning systems.

c. System Design Factors. Important factors to be considered in designing a warning system are:

(1) The geographic size and population of the community to be warned;

(2) Local conditions of the warning area, such as terrain, natural barriers, such as trees or wooded areas, and the architecture, such as large buildings;

(3) Groups of special concern such as children and teachers during schooltime, the elderly, and the handicapped;

(4) Weather conditions over various periods of the year, such as heavy fog conditions, which can cut down severely on the distance sound will travel through free space; and

(5) The ability of the government purchasing the warning system to provide the necessary financial support for its initial purchase and its subsequent maintenance and operation.

d. Using Existing Resources. Effective use of the community's total resources should be fully explored. A review and discussion of the options available and those being incorporated into a warning system should be included as part of the plan.

A well designed and engineered warning system should contain the following minimum elements:

(1) Description of the types of warnings that will be given, such as impending emergency and firefighting alert.

(2) Specification of authority for activation of the warning system.

(3) Description of actions to be taken by government officials and the general public upon receipt of the warning.

(4) List of key officials to be alerted, by title, agency, and telephone number.

(5) Description of planned tests of the warning system, including test frequency.

(6) Definition of the type of back-up emergency power (independent of commercial sources) to be provided.

e. Sirens. Electronic sirens are lighter in weight than electro-mechanical sirens, resulting in reduced mounting problems. They can operate from a battery supply that is continually trickle charged by a 115 volt AC single phase standard commercial power source. They can provide a public address capability using the same mechanism that generates the warning signal. They can provide a multiplicity of signals based on user requirements, with with practically no difference in cost from that of a siren that produces a limited number of signals.

Electronic sirens designed and produced in the last several years have output power capabilities equal to electro-mechanical sirens. This has been brought about by the advances in the design of solid state circuitry. Many electronic sirens now have a power output ranging from 106 decibels to 126 decibels. This power output equals that generated by current electro-mechanical sirens.

Electronic sirens usually operate from two 12 volt batteries connected in series to develop 24 volts DC. They normally require a 90 ampere operating current. This means that an electronic siren requires approximately 2,160 watts of power to operate. Electro-mechanical sirens, however, operate only from primary AC power sources. This can range from 115 volts AC single phase up to 480 volts AC three phase. This higher power requirement is due to their use of motors to drive the sirens. As an example, 115 volt AC single phase siren systems may require more than 150 amperes for initial startup current. This means that an electro-mechanical siren could require as much as 17,250 watts of startup power.

In addition to the great disparity in the amount of power required to operate an electro-mechanical siren, compared to that required for an electronic siren, an electro-mechanical siren cannot be operated off of batteries. Therefore, if primary power is lost, an electro-mechanical siren system becomes inoperable. The use of large power generators to provide backup power is impractical. However, electronic sirens operate continuously off of the inplace batteries that are constantly being trickle charged by primary power, usually 110 volts AC single phase. If primary power fails, the electronic sirens can still be operated off of the inplace batteries that provide the 24 volts DC necessary for operation.

f. This CPG is not intended to provide guidance on the use of the media or public information practices when alerting and warning the public. However, when enhancing an alerting and warning system, consideration should be given to a program of public understanding as to what actions are to be taken when hearing certain signals. Additionally, whenever possible, contiguous communities should have agreements on what certain signals are used for and what actions are to be taken by the public.

U.S. GOVERNMENT PRINTING OFFICE : 1984 O - 455-892