ANSI/NFPA 297 An American National Standard December 10, 1985

NFPA 297 Telecommunications Systems for Rural and Forestry Services 1986

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

NOTICE

All questions or other communications relating to this document should be sent only to NFPA Headquarters, addressed to the attention of the Committee responsible for the document.

For information on the procedures for requesting Technical Committees to issue Formal Interpretations, proposing Tentative Interim Amendments, proposing amendments for Committee consideration, and appeals on matters relating to the content of the document, write to the Secretary, Standards Council, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

A statement, written or oral, that is not processed in accordance with Section 16 of the Regulations Governing Committee Projects shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Users of this document should consult applicable Federal, State and local laws and regulations. NFPA does not, by the publication of this document, intend to urge action which is not in compliance with applicable laws and this document may not be construed as doing so.

Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

Licensing Provision

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

NFPA has no power or authority to police or enforce compliance with the contents of this document and any certification of products stating compliance with requirements of this document is made at the peril of the certifier.

MGR-FM-85

NFPA 297

Guide on

Telecommunications Systems — Principles and Practices for Rural and Forestry Services

1986 Edition

This edition of NFPA 297, *Guide on Telecommunications Systems — Principles and Practices for Rural and Forestry Services*, was prepared by the Technical Committee on Forest, and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 18-20, 1985 in Baltimore, Maryland. It was issued by the Standards Council on December 10, 1985, with an effective date of December 30, 1985, and supersedes all previous editions.

The 1986 edition of this guide has been approved by the American National Standards Institute.

Origin and Development of NFPA 297

The Guide on Telecommunications Systems was originally published by the NFPA in 1975. Its purpose was, and still is, to provide general information relating to communication requirements of agencies involved in wildfire suppression operations. The guide was revised by the Technical Committee on Forest and presented to the Association for adoption at the 1985 Fall Meeting as NFPA 297.

Technical Committee on Forest

R. L. Bjornsen, *Chairman*
Fire Management Assoc.

Fred G. Allinson, Nat'l. Volunteer Fire Council
John E. Birch, U.S. Dept. of the Interior
H. G. Doerksen, British Columbia Forest Service
John F. Goodman, R.P.F.
Salvatore M. Grasso, Fred S. James & Co. of N.Y. Inc.
Roy G. Hatcher, Iowa Conservation Commission
Gerald A. Letson, California Dept. of Forestry
Dan Lloyd, Western Fire Equipment Co.
David L. Martell, University of Toronto, Ontario
Donald G. Perry, Santa Barbara Cnty. Fire Dept., CA
Gary Tokle, Missoula Rural Fire District, MT
John D. Walker, Canadian Forestry Service

Alternate

Samuel G. Mauk, USDI
(Alternate to J. Birch)

This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

Contents

NFPA 297

Guide on

Telecommunications Systems — Principles and Practices for Rural and Forestry Services

1986 Edition

Chapter 1 Introduction

1-1 Scope.

1-1.1 This guide deals with systems, their components, and operations that involve the transfer of information over a distance utilizing electrical or electronic means. It is intended to provide general information only. More specific technical data should be secured from manufacturers or communication specialists in state, provincial, or local governments.

1-2 Purpose.

1-2.1 The need for reliable communications has long been recognized in the fire service. This guide focuses on four basic elements in the communications requirements of a fire protection agency. Included are communications between the public and the fire agency; communications within the fire agency under emergency and nonemergency conditions; communications among fire agencies; and communications between the fire agency and other agencies.

1-3 General.

1-3.1 Radio, telephone, and other electronic equipment, operating procedures, and personnel training must allow messages to be conveyed as quickly and reliably as the situation requires. Messages must be sent and received correctly with no delay. Effective operating practices must be developed and training must be provided to meet the needs of each agency. The measure of adequate service is the ability of the system to handle both emergency situations and the normal daily activities of the agency.

1-4 History. In early America, fire companies were brought together by the ringing of bells, gongs, shouting, and word of mouth. In contemporary America, municipal fire department companies are equipped with direct line or radio signaling systems, while suburban or rural companies may alert volunteers with a loud, audible signal produced by siren or horn, or by radios or paging systems at their homes or businesses.

The need for reliable communications has long been recognized in the fire service, and is exemplified by the fact that the insignia on chief officers' badges, designating rank, are crossed trumpets. The use of the trumpet as a megaphone by chief officers was one of the earliest methods of extending communications beyond the normal range of the human voice. The fire bell in the steeple was an early form of communication used to notify volunteers of the existence of a fire. Hand signals had their beginning in the early days of the fire service, and are still used successfully today. With the inventions of telephone and radio, fire telecommunications took giant leaps forward.

1-5 Definitions. Unless expressly stated elsewhere, the following terms will, for the purpose of this guide, have the meanings indicated below.

Acknowledgment. The act by which one operator signifies to another that a message has been received.

Added Information Message. A message sent to supplement a previous message and referred thereto.

Air Net. A radio communications network designed to provide air-to-air and air-to-ground communications for agency-owned or contract aircraft. They are often designed on a regional basis.

Amplitude Modulation (AM). Modulation in which the amplitude of the carrier-frequency current is varied above and below its normal value in accordance with the audio, picture, or other intelligence signal to be transmitted. The magnitude of the radio wave is varied in accordance with the information to be transmitted or exchanged.

Antenna. A system of wires or electrical conductors employed for reception or transmission of radio waves. Specifically, a radiator which couples the transmission line or lead-in to space, for transmission or reception of electromagnetic radio waves. (Also known as aerial.) (*See also "Gain."*) Also, a device used on a vehicle and at a station to radiate the transmitted signal and to receive a signal.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Attenuation. The decrease in amplitude of a signal during its transmission from one point to another. It may be expressed as a ratio or, by extension of the term, in decibels.

Audio. The voice component of the transmitted signal. The normal ear responds to audio frequencies.

Authority. The department responsible for the origination of a message.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or in-

dividual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Band. A range of frequencies between two definite limits. By international agreement, the radio spectrum is divided into nine bands. For example, the very high frequency (VHF) band extends from 30 MHz to 300 MHz. Also, a term applied to a group of frequencies.

Bandwidth. The width of a band of frequencies used for a particular purpose. Thus, the bandwidth of a television station is 6 MHz. Also, the range of frequencies within which a performance characteristic of a device is above specified limits. For filters, attenuators, and amplifiers these limits are generally taken to be three decibels below the average level. Half power points are also used as limits.

Bandwidth Occupied by an Emission. The width of the frequency band containing those frequencies upon which a total of 99 percent of the radiated power appears, extended to include any discrete frequency upon which the power is at least 0.25 percent of the total radiated power (FCC definition).

Base. Short for "Base Station."

Base Station. A land station in the land mobile service carrying on a service with land mobile stations. Also, the two-way radio transmitting location.

Battery Drain. The amount of electrical power taken from the battery through use of the two-way radio equipment. Usually measured in amps.

Bell Signal. The teletypewriter bell used to attract attention to the instrument for messages of extreme importance.

Broadcast. Radio or television transmission intended for general reception.

Broadcasts.

(a) *Broadcast.* The transmission of a message to the coded area concerned.

(b) *Direct Message.* A message addressed to a specific point or points on a system.

(c) *APB.* A message direction indicating that the message is to be sent to all points.

Cable. One or more insulated or noninsulated wires used to conduct electrical current or impulses. Grouped insulated wires are called a multi-conductor cable.

Call Directing Code. Usually a two-letter identifier assigned to a teletype machine. Required to be transmitted in order to turn on a teletype unit.

Cancellation. A message which cancels another, without delay.

Capture Ratio. The ability of an FM radio receiver to reject unwanted signals and interference on the same frequency as a desired one, measured in decibels. The lower the figure, the better the receiver performance.

Carrier. Radio wave radiated without modulation by a transmitter. Also, an electromagnetic wave at a specific frequency.

Carrier Frequency. The frequency of an unmodulated electromagnetic wave.

Channel. Sometimes used synonymously with "frequency." It is the electronic signal path through which radio frequency flows.

Channel, Point-To-Point. A radio channel used for radio communication between two definite fixed stations.

Channel, Radio. An assigned band of frequencies of sufficient width to permit its use for radio communication. The necessary width of a channel depends on the type of transmission and the tolerance for the frequency of emission.

Chassis. The part of the two-way radio which contains the transmitter and reciever assemblies.

Coaxial Cable. A transmission line in which one conductor completely surrounds the other, the two being coaxial and separated by a continuous solid dielectric or by dielectric spacers. (Also called a coaxial line, concentric line.)

Co-Channel Interference. Interference caused by other parties using the same transmitting frequency already being used.

Communication Center. The complex of equipment and personnel from which all communication activity in a particular system is controlled.

Communications Channel. Similar to a radio frequency, but more general. It is a medium over which communications are established and carried out.

Communications Link. Established communications between two parties.

Communications Network. A combination of links that are complete as to some specific function. Examples: a network to serve command personnel; a network to serve air-to-air control.

Communications System. A combination of links or networks that serve a general function. Example: ground

attack communications system made up of command, tactical, service, and intracamp networks.

Continuous Duty. A rating applied to receivers and transmitters to indicate their capability for use in a continuous duty cycle (as opposed to the term "intermittent duty").

Control Console. A desk-mounted enclosed panel which contains a number of controls used to operate a radio station.

Couple. To connect two circuits so that signals are transferred from one to the other.

Crystal. A device which controls the exact operating frequency of the transmitter or receiver.

Crystal Controlled. Radios in which each operating frequency is determined and controlled by a vibrating quartz crystal. This limits the number of channels available because of the physical size of the crystals required.

Crystal-Controlled Oscillator. An oscillator in which the frequency of oscillation is controlled by a piezoelectric crystal.

Crystal-Controlled Transmitter or Receiver. A radio transmitter or receiver in which the carrier frequency is controlled directly by a crystal oscillator.

Dash Mount. Term applied to equipment capable of installation under and/or attached to the vehicle dash panel.

Decibel (dB). A unit which expresses the level of a power value relative to a reference power value.

Digital Transmission. The passage of information which is coded with discrete integral numbers through a communication medium.

Directional Antenna. An antenna possessing the ability to strongly radiate signals in a specific direction.

Directivity. The value of the directive gain of an antenna in the direction of its maximum value. The higher the directivity value, the narrower the beam in which the radiated energy is concentrated.

Dispatcher. Common name applied to the station operator who relays message traffic in the system.

Distortion. Unfaithful reproduction of audio or video signals due to changes occurring in the wave form of the original signal somewhere in the course it takes through the transmitting and receiving system. Classified as linear, frequency, and phase distortion.

Duplex Channel. A communications channel providing simultaneous transmission in both directions. (*For comparison, see "Simplex Channel."*)

Duplex Operation. The operation of associated transmitting and receiving apparatus concurrently as in ordinary telephones without manual switching between talking and listening periods. A separate frequency band is required for each direction of transmission. (*For comparison, see "Simplex Operation."*)

Electromagnetic Energy. The type of energy contained in any electromagnetic wave such as radio waves, visible light, X-rays, gamma rays, or cosmic rays. The frequencies of radio waves go up to about 300,000 MHz.

Electromagnetic Radiation. Radiation associated with a periodically varying electric and magnetic field that is traveling at the speed of light, including radio waves, light waves, X-rays, and gamma radiation.

Electromagnetic Wave. A wave of electromagnetic radiation, characterized by variations of electric and magnetic fields.

Energy, Radio Frequency. See "Electromagnetic Energy."

Facsimile. The transmission of pictures, maps, or other documents via communications channels by means of a device which scans the original document and transforms the image onto coded signals. (*See "Slow Speed Facsimile."*)

Fading. The variation of radio field strength caused by a gradual change in the transmission medium.

Fading Margin. The number of decibels of attenuation which can be added to a specified radio frequency propagation path before the signal-to-noise ratio of the channel falls below a specified minimum.

Forest Net. A radio communications network designed to provide forestwide communications. They are designed for the specific forest requirements.

FM Capture Ratio. See "Capture Ratio."

Frequency. The number of cycles per second; the reciprocal of the period. Usually refers to the assigned channel. Literally means the time taken by a signal to complete one cycle.

Frequency Deviation. Frequency deviation of an FM signal is the change in the carrier frequency produced by the modulating signal. The frequency deviation is proportional to the instantaneous amplitude of the modulating signal.

Frequency Modulation (FM). A method of modulating a carrier-frequency signal by causing the frequency to vary above and below the unmodulated value in accordance with the intelligence signal to be transmitted. The amount of deviation in frequency above and below the resting frequency is at each instant proportional to the amplitude of the intelligence signal being transmitted. The number of complete deviations per second above and below the resting frequency corresponds at each instant to the frequency of the intelligence signal being transmitted.

Frequency Modulated (FM). The frequency of the radio wave is varied in accordance with the information to be transmitted or exchanged.

Frequency Stability. The ability of the transmitter to keep the transmitted signal within predetermined limits. (All signals radiate energy outside of their intended paths.)

Front Mount. A unit which is mounted in the cab or front seat area but which is not dash mounted.

Function. A special duty or performance required of a person or thing in the course of work or activity.

Gain Control. A control to vary the amount of modulation of a radio transmitter. The volume control on a receiver is also called a gain control.

Gain, of an Antenna. The effectiveness of a directional antenna in a particular direction, compared against a standard (usually an isotropic antenna).

Generator. A device which develops either direct or alternating electrical voltage at any frequency.

Go Ahead. Used as an invitation for the other station to reply when carrying on a two-way conversation between two stations.

Guard Band. A narrow band of frequencies provided between adjacent channels in certain portions of the radio spectrum to prevent interference between stations.

Half-Duplex Channel. A communications channel providing duplex operation at one end of the channel, but not the other. Typically, the base station is operated in the duplex mode. (*For comparison, see "Simplex Channel" and "Duplex Channel."*)

Half-Wave Dipole Antenna. A straight, ungrounded antenna having an electrical length equal to half the wavelength of the signal being transmitted or received.

Handset. A telephone-type combination microphone/speaker which allows privacy of the received message.

Heat Sink. A metal mass, usually finned, attached to a radio chassis for the purpose of dissipating heat.

Hertz. A unit of frequency expressed in cycles per second. One hertz equals one cycle per second.

High Band VHF. Radio frequencies from 150 to 174 MHz.

Hunting System Call Routing. Sometimes called a rotary system. It allows incoming calls to hunt for a free line among all those lines assigned to the subscriber. Calls can be held until parties otherwise tied up have an opportunity to answer the call.

I/C. Integrated circuit.

Instant Transmission. The ability of a two-way radio to transmit a message without waiting for component "warm up."

Interference. See "Radio interference."

Keying. Activating the transmitter. When the push-to-talk button on the mike is depressed, the transmitter is "keyed."

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Link. A transmitter-receiver system and transmission medium forming a two-way path for the transmission of information.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

Local Control. Term applied to a locally (rather than remotely) operated station.

Low Band VHF. Radio frequencies from 30 to 50 MHz.

Megahertz (MHz). A common technical term that refers to the frequency of the radio. 1 MHz equals 1,000,000 cycles, or hertz, per second.

Message Delay. In a radio system, the time it takes to get a message on the air, usually the result of waiting for other radio users to finish transmitting. It is precisely the length of the time interval between the moment when an operator decides to transmit and the moment when transmission begins.

Microwave. A term applied to radio waves in the frequency range of 1,000 MHz and upward.

Mike. Microphone.

Mobile Relay Station. A radio station established for the automatic retransmission of mobile radio communications which originate on the transmitting frequency of the base and mobile stations, and which are retransmitted on the receiving frequency of the base and mobile stations.

Mobile Station. A two-way radio station in the mobile service intended to be used while in motion or during halts at unspecified points.

Mobile Unit. A two-way radio equipped vehicle or person. Also, sometimes the two-way radio itself, when associated with a vehicle or person.

Modulation. The process of modifying some characteristic of an electromagnetic wave (called a carrier) so that it varies in step with the instantaneous value of another wave (called a modulating wave or signal). The carrier can be a direct current, an alternating current (providing its frequency is above the highest frequency component in the modulating wave), or a series of regularly repeating, uniform pulses called a pulse chain (providing their repetition rate is at least twice that of the highest frequency to be transmitted). Also, the strength of a voice applied to the microphone.

Monitor. To listen to mobile radio messages without transmitting.

Listening to a radio receiver.

Multi-Channel System. A radio system which uses more than one radio channel. Also known as multi-frequency system.

Multicom Aircraft Radios. AM radios, using synthesizer channel selection techniques, used in most public and private aircraft. These radios have been available for years.

Multiplexer. A device which simultaneously transmits two or more signals over a common carrier wave.

Network. See "Radio Network."

Noise. Interference characterized by undesirable random voltages caused by an internal circuit defect or by some external source.

Noise Cancelling. Applied to microphones which blank out bothersome background noises and permit communication in high-noise areas.

Omni-Directional Antenna. An antenna that radiates signals with equal strength in all directions.

Operator. Any person who transmits a message.

Output. The energy resulting from the work the radio performs. Power output: the strength of the signal as it leaves the transmitter. Audio output: the strength of the voice wave as it leaves the speaker. Both are usually measured in watts.

Pager. A compact pocket- or belt-carried radio receiver for providing one-way communications.

Peak. The maximum instantaneous value of a quantity.

Personal Radio. A small portable radio intended to be carried by hand or on the person of the user.

Phone Traffic. Messages handled by radiotelephone.

Portable Radio. A completely self-contained radio which may be moved from one position to another.

Power Supply. The voltage source for operating the radio equipment. The vehicle battery is a simple power supply.

Propagation Characteristics. Descriptions of how effectively a radio wave is transmitted from one place to another. For example, UHF and high band VHF have line-of-sight propagation characteristics.

Propagation (Electromagnetic). The travel of electromagnetic waves through a medium, or the travel of a sudden electric disturbance along a transmission line. Also called wave propagation.

Rack Mount. Radio equipment which is capable of being mounted and operated within a communications-type rack.

Radio. The transmission and reception of signals by means of electromagnetic waves without a connecting wire.

Radio-Frequency Power. The power associated with any signal consisting of electromagnetic radiation which is used for telecommunications.

Radio Interference. Undesired disturbance of radio reception. Interference is generated by electric devices, with the resulting interference signals either being radiated through space as electromagnetic waves or traveling over power lines or other conducting media. Radiated interference is also due to natural sources such as atmospheric phenomena (lightning). Radio transmitters themselves may interfere with each other.

Radio Network. A number of radio stations, fixed and mobile, in a given geographical area which are jointly administered or which communicate with each other by sharing the same radio channel or channels.

Radio Receiver. An instrument which amplifies radio-frequency (RF) signals, separates the intelligence signal from the RF carrier, amplifies the intelligence signal additionally in most cases, then converts the intelligence signal back into its original form.

Radio Transmitter. A radio-frequency power source which generates radio waves for transmission through space.

Radio Wave. See "Electromagnetic Wave."

Receiver. See "Radio Receiver."

Relay Station. Radio stations that rebroadcast signals the instant they are received, so that the signal can be passed on to another station outside the range of the originating transmitter. (*See also "Mobile Relay Station" and "Repeater Station."*)

Remote. A control, usually desk mounted, for operating a distantly located station transmitter.

Repeater Channel. A two-frequency channel that utilizes an intermediate repeater to extend the range of the channel. The repeater unit simultaneously receives on one frequency and transmits on another. It is inefficient in that two discrete frequencies are required to establish one communications channel.

Repeater Station. An operational fixed station established for the automatic retransmission of radio communications received from any station in the Mobile Service.

Selective Call. A system for communicating individually with selected vehicles, stations, or personnel.

Semi-Duplex. See "Half-Duplex."

Sender. The surname or initials of the operator who originally transmits a message.

Sensitivity of a Radio Receiver. The minimum input signal required in a radio receiver to produce a specified output signal-to-noise ratio. This signal input may be expressed as power or voltage at a stipulated input network impedance.

Shadow Area. A dead spot in a communicating area where radio communication is difficult or impossible.

Should. Indicates a recommendation or that which is advised but not required.

Side Band. A frequency band above and below the carrier frequency, produced as a result of modulation.

Signal. The form or variation of a wave with time, serving to convey the information, message, effect, or other desired intelligence in communications.

Simplex Channel. A communications channel providing transmission in one direction only at any given time. (*For comparison, see "Duplex Channel."*)

Simplex Channel, Single-Frequency. A simplex channel utilizing only one assigned band of frequencies. (*For comparison, see "Simplex Channel, Two-Frequency."*)

Simplex Channel, Two-Frequency. A simplex radio system utilizing two distinct assigned bands of frequencies. (*For comparison, see "Simplex Channel, Single Frequency."*)

Simplex Operation. A method of radio operation in which communication between two stations takes place in only one direction at a time. This includes ordinary transmit-receive operation, press-to-talk operation, voice-operated carrier, and other forms of manual or automatic switching from transmit to receive. Also called simplex. (Compare with "Duplex Operation.")

Single-Frequency Channel. A channel which is direct from transmitter to receiver. Transmitter and receiver frequencies are identical.

Slow Speed Facsimile. Facsimile is the process whereby images (either print or picture) are translated into electrical signals, transmitted over a communications link, and reconstituted at the receiving end into the original image. Slow speed facsimile uses voice grade (300-3000 Hz) communications links and consequently takes about four minutes to transmit an 8 × 10 in. page.

Solid State. Electronic design using solid state devices instead of vacuum tubes.

Speaker. Device that produces sound from a radio receiver.

Spectrum. Any series of radiant energies arranged in order of wavelength or frequency. The entire range of electromagnetic radiation extending from the longest known radio waves to the shortest known cosmic rays.

Squelch. A system for removing objectionable background noise from a speaker.

Squelch Control. The control to eliminate receiver noise when no signal is being received. It should be set to just eliminate this noise. Turning it further will reduce the receiving range of the receiver.

Standby. A condition of radio operation, usually in radios having tube transmitters, whereby only the receiver portion of the radio is activated. Usually accomplished with a manually operated switch. Used to conserve vehicle battery energy.

Station Identifier. The radio call sign assigned by the FCC. Used in the preamble following the message number in a radio message. In a teletype message, it is an abbreviation of the station's name.

Station, Radio. A fixed installation or mobile unit which is equipped to transmit and receive radio signals.

Switchboard, Telephone. A board or panel equipped with apparatus for controlling the operation of telephone circuits and routing incoming and outgoing calls.

Synthesizer. Term applied to radios in which each operating frequency is determined and controlled by some multiple of one single precisely controlled quartz crystal. Each multiple can be selected to dial-up the required operating frequency. Synthesized radios are truly all-channel radios within their frequency range. FM radios with synthesizer channel selection techniques are now available.

TCCO Abbreviation for Temperature Compensated Crystal Oscillator. A plug-in, self-contained module with a crystal and circuitry to maintain the crystal at a constant frequency regardless of temperature.

Telecommunication. Communication at a distance, as by telegraph, telephone, cable, or electromagnetic radiation.

Telephone Patch. An instrument that allows a radio to be used as an entrance and exit point from the commercial telephone system.

Teletype. A system of communication in which the Teletype — a trademark applied to a kind of teletypewriter — is used. (*See "Teletypewriter."*)

Teletypewriter. An electromechanical device, similar to a typewriter, such that messages typed on the keyboard of the transmitter unit are converted into electrical signals, which, when conveyed to the receiver unit, are printed on paper.

Text. The body of a message. That portion of a message that contains the information being transmitted from one department to another.

T/R. Abbreviation for Transmitter/Receiver.

Traffic. A message, or communications between stations.

Transceiver. Combined transmitter and receiver unit.

Transistor. (Transfer resistor). An active semiconductor device having three or more electrodes. The three main electrodes used are the emitter, collector, and base. Conduction is by means of electrons and carriers or holes. Germanium and silicone are the materials most often used as the semiconductor material. Transistors can perform practically all the functions of vacuum tubes, including amplification and rectification.

Transmission Line. A waveguide, coaxial line, or other system of conductors used to transfer signal energy efficiently from one location to another.

Transmit Time Limiter. An electronic circuit that automatically limits the time allowed for transmitting a message. Prevents accidental tie-up of the radio channel.

Trunk Line. A telephone line which terminates at a switchboard.

Trunk Mount. Indicates trunk or rear compartment installation of T/R unit with control unit mounted near driver.

TT. Teletype. Sometimes called PLTT for private line teletype.

Tuning. Adjusting the transmitter for on-frequency operation. (Must be done by a licensed technician.)

Two-Way Radio. A radio which is able to both transmit and receive.

TWX. A teletypewriter exchange service which is furnished on substantially the same basis as long distance telephone service.

Ultra High Frequency (UHF). Radio frequencies from 30 MHz to 3000 MHz. The upper portion from about 1000 to 3000 MHz is often referred to as low capacity microwave.

Unit Identifier. An identifier assigned by the licensee to a mobile station for exact identification such as "Car 3" or "797," etc. Not the same as or eliminating the need for the FCC-assigned station identifier or call sign.

Vacuum Tube. An electronic device used in radios, televisions, etc., which consists of an evacuated enclosure containing two or more electrodes between which conduction of electricity can occur.

Whip. Term applied to the long, slender mobile antenna usually found mounted on vehicle bumper.

Width Channel. The difference of the upper and lower frequency limits of a channel, expressed in hertz.

Chapter 2 Basic Concepts

2-1 System Elements. There are four basic elements in the communications requirements of a fire protection agency:

(a) Communications between the public and the fire agency.

(b) Communications within the fire agency under both emergency and nonemergency conditions.

(c) Communications among fire agencies.

(d) Communications between the fire agency and other agencies.

Each plays an essential part, enabling the fire agency to meet its protection responsibility. The particular method used must provide for each in order to be effective.

Radio, telephone, and other electronic equipment, operating procedures, and personnel training must allow messages to be conveyed as quickly and reliably as the situation requires. Messages must be sent and received correctly with no delay. Time delay and the number of messages to be handled are strongly interrelated with service. Systems and equipment must be provided so that the public may notify the fire agency of fires or other emergencies. Attention must be given to message types, the number and length of messages, the equipment capabilities, radio frequencies, and system organization. Effective operating practices must be developed and training must be provided to meet the needs of each agency. The measure of adequate service is the ability of the system to handle emergency situations as well as the normal daily activities of the agency. A major conflagration, or multiple fires, generates a much greater need for communications than do normal daily activities.

2-2 Communications Between the Public and the Fire Agency. Communications between citizens and the fire agency revolve around several areas:

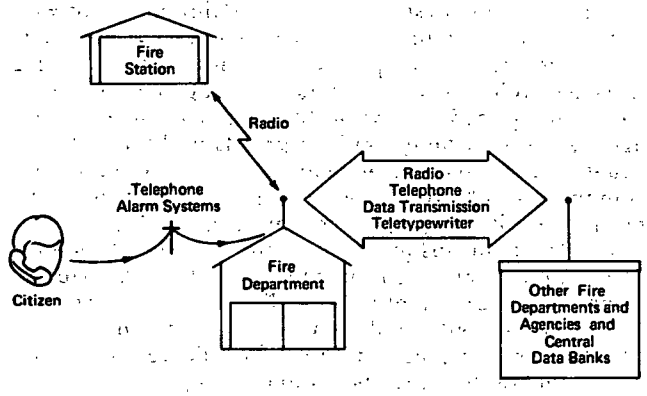


Figure 2-1 Fire Communications.

(a) Calls from citizens for emergency assistance or for reporting fires.

(b) Calls from citizens giving information to, or requesting information from, the fire agency.

(c) Calls from the fire agency to citizens.

Calls from citizens, usually received through the telephone system, giving or requesting information, may be of an emergency nature. Whether or not such a call is an emergency is decided by the individual answering the telephone. Many fire agencies maintain different administrative and emergency telephone numbers to keep the two types of communications separate. Calls from the fire agency to citizens usually are of an administrative nature. "911" (universal emergency telephone number) reporting has become common. It is most easily accomplished in "rural" areas rather than urban areas.

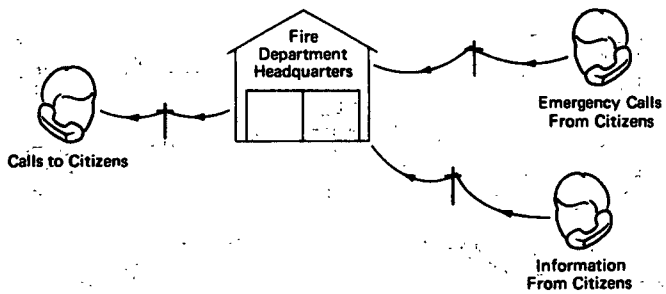


Figure 2-2 Typical Fire Department Communications with the Public.

2-3 Communications with the Fire Agency. Communications between members of the fire agency include emergency and nonemergency messages. Most of these are accomplished by radio, and may involve the dispatcher, radio-equipped vehicles (land, water, or air), personnel equipped with two-way radios, or personnel at outlying stations in a variety of emergency situations. Examples of such communications are:

(a) The radio dispatcher gives information to the fire stations and/or mobile equipment.

(b) Personnel report location and work status to the dispatcher for emergency assignment.

(c) The dispatcher gives coordination information and status to personnel and equipment responding to an emergency.

(d) Field commanders give instructions to ground or air mobile units and to fire line personnel under their command in a tactical situation.

(e) Communications between equipment units or personnel at a fire or other emergency.

(f) The field commander requests information or assistance, and the dispatcher advises status.

(g) Reports of fire are transmitted from lookouts or aircraft to dispatch centers.

(h) Information on status of personnel and equipment, fire danger rating, fire weather forecasts, and legal burning is transmitted between fixed stations, mobile units, and the radio dispatcher.

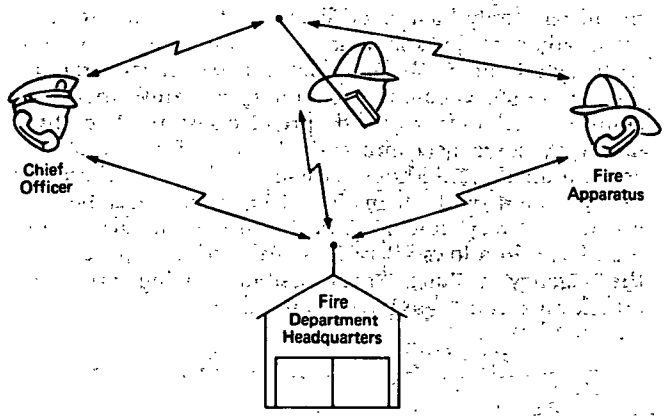


Figure 2-3 Base-Mobile Radio Communications.

2-4 Communications Among Fire Agencies. Many fire agencies supply their neighbors with requested information. Such communications are necessary because many small agencies depend on mutual aid agreements and wildland fires are likely to cover more than the jurisdiction of a single agency. In addition, many fire agencies have common information needs.

Interchange may be divided into two kinds of communications — directed and incidental. Directed communication is the conveying of information from one agency to one or more specifically selected agencies. Incidental communication is the exchange of information among agencies that is a by-product of the primary purpose of the communications.

An example of directed communication is the exchange of information regarding burning permits or other smokes of interest to stations of other agencies, or the transmittal of a fire danger rating or fire weather information. It may also be advice regarding equipment in adjoining stations where first attack arrangements exist.

Incidental or nondirected communication among agencies occurs whenever one agency monitors the transmissions of another, although the information is not specifically intended for interagency distribution. Most of this kind of communication is by radio, especially among agencies that share a radio channel. (When agencies have

a choice of channels on which to operate, they must weigh the advantages of mutual monitoring by all system users against the disadvantages of greater message traffic and the resulting problems of channel loading.) This kind of communication is no less important than directed communication, for it allows one agency to be aware of situations in another community or area that may "spill over" or involve it directly in a short time.

Monitoring of nearby fire departments' or fire agencies' transmissions helps the listener to anticipate the need for mutual aid and to be aware of the level of emergency activity in an area larger than the department's or agency's own boundaries. If two fire service agencies anticipate a need for mutual aid or cooperation, they frequently monitor each other's calls even when not on the same radio channel. Monitor-receivers at the dispatcher positions are generally used.

Special mutual aid radio frequencies or channels for mobile use only have been licensed so that fire agencies from adjacent jurisdictions can communicate directly with each other. Such a channel can assist normal day-to-day interagency communication needs and emergency communication during widespread disasters. The channels may serve as command channels for interagency communication. Although these are helpful, there are also problems with them. The frequencies may become overloaded very quickly. The multi-channel synthesizer mobile radio allows all radio traffic to be conducted on the "Agency in Charge" radio system, starting with initial attack on through large fire operations.

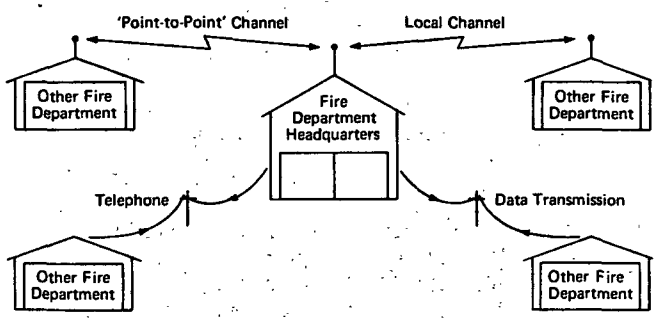


Figure 2-4 Interdepartmental Communications.

2-5 Communications Between the Fire Agency and Other Agencies. Another function of a communications system is to pass messages between the fire agency and public safety oriented agencies, such as public works, highway maintenance departments and utilities, hospitals and ambulance services, towing and wrecker services, law enforcement agencies, civil defense units, forest industries, and fire weather forecasters.

Fire agencies exchange a large variety of information with nonfire agencies or cooperators. Perhaps the information most widely exchanged in the rural and mountain areas is the local fire danger rating or fire weather information, reports of road conditions, flooding, fallen trees, and similar useful data. Reports of vehicle accidents are often made to the fire agency by police agencies where a fire department or rescue company response is required. Since many of these companies are radio equipped, they can be of assistance during large fires or other major incidents.

One of the greatest demands for communications with other agencies can occur during major emergencies. The ability to meet this problem requires planning for message volumes, and possible language barriers. Telecommunications for a fire department or forest agency must include contingency plans for emergency situations. During an emergency is no time to set up new communications links. The volume of messages that must be handled is likely to exceed most estimates, so plans must include means for handling the volume of message traffic to prevent system breakdown due to overloading. Concerned citizens and news media can rapidly overload a telephone system. Nonfire agencies may not understand the standard language of fire radio. Therefore, liaison personnel familiar with the radio language of the fire service and the assisting organizations are needed to maintain effective communications. The National Interagency Incident Management System (NIIMS), which is being adopted by many fire agencies, includes two important communications concepts which should improve communications effectiveness during major emergencies. These are:

(a) Common Terminology — using "clear text" or "plain language" radio and established standard terms and phrases.

(b) Integrated Incident Communications — which intends the best possible use of all participating agency radio systems including frequency sharing agreements.

The new synthesizer mobile radios can also be very useful here. Police, fire, and other public safety agencies can now converse with each other "at the scene" and not depend on time-consuming relays through dispatchers.

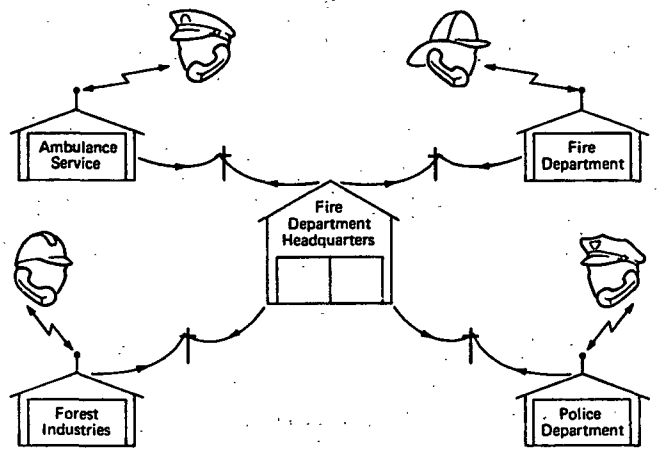


Figure 2-5 Communications With Other Agencies.

2-6 Communications Systems. Many types of equipment comprise a fire telecommunications system. First, the basic element is a public telephone. Next is the base station (headquarters) radio equipment. It consists of transmitters capable of sending messages to every point in the area and radio receivers to hear messages sent from the mobile units. Often a control console is used to coordinate communications such as transmitter and receiver control, telephone, teletypewriter, and other functions. Antenna systems complete the base station segment of the system. Remote and extended control base stations may

be used or control may be by microwave systems. New technology allows use of mountaintop repeaters with thermoelectric or solar-powered generators for power sources. Portable mobile relays may be used during large fires or remote emergencies. Mobile units complete the system and include two-way radios in administrative vehicles, fire apparatus, aircraft and other transportation, radios carried by individuals, mobile command posts, pocket pagers, and similar units.

2-6.1 There may also be data transmission systems, utilizing a teletypewriter or facsimile duplication, which permit exchange of maps, data, and other information within the agency or with other agencies. Low-cost minicomputer systems can provide users with a broad array of intra- and inter-agency capabilities.

Electronic mail service, utilizing microcomputers (personal computers), are often less costly and more efficient for the transmission of messages than conventional mail or voice telephone systems. A wide range of options can be used to tailor electronic mail service to specialized needs.

A computer (typically micro, or personal), modem, communications software, and telephone are required to use electronic mail service.

An originator can send documents or messages directly to a recipient, utilizing a compatible electronic messaging service, for immediate reading — or, if more convenient, for storage until it can be read. An "electronic mailbox" is an option whereby an originator stores a message in a central computer until it is electronically collected by the recipient at a convenient time.

Worldwide Telex (telegraph exchange) and TWX (teletype exchange) communications are possible using electronic mail facilities.

2-6.2 The Telephone System. Any citizen should be able to contact a fire agency quickly when in need of assistance. The telephone system is a natural means of citizen - fire agency contact. It is usually available and most people know how to use it even under stress conditions. (Use may increase as the universal emergency telephone number "911" becomes adopted in additional areas of the country.) In addition, the telephone system gives (1) a backup means of communication in case of radio failure, and (2) a means of passing lengthy information not appropriate for radio transmission. In some areas, a system of emergency call boxes is used for reporting fire and is available to the public or the fire agency. This provides an alternate means of communication which may augment the radio system.

The telephone system is also relied upon to exchange urgent information between fire agencies or cooperating communication with some agencies by special "hot lines" that connect agencies.

2-6.3 The Radio System. Radio communication is used by most fire control agencies as two-way equipment in officers' cars and most apparatus, and in fire stations and homes of fire fighters. It is uniquely suited to the needs of mobility required for rural and forestry fire services. Radio keeps fire fighting units in touch with headquarters and facilitates reporting of emergency situations

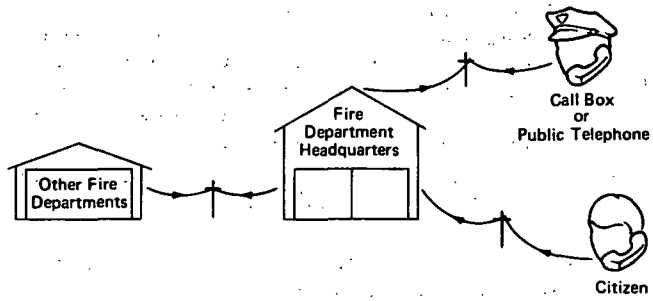


Figure 2-6.2 The Telephone System.

to request additional assistance and to inform other units of emergencies. Radio is also used on special duty work, such as fire prevention, fire hazard inspections, or other projects. Thus, it promotes efficient use of equipment and personnel.

Large, rapidly moving wildfires, or multiple wildfires, require field commanders to be able to direct their forces continually, minute to minute. Control of sizable forces of personnel and equipment may be required. Command level personnel cannot make intelligent decisions about deployment unless they obtain constantly updated information on the situation; contact with radio-equipped members of those forces provides the information so it can be acted on at command level.

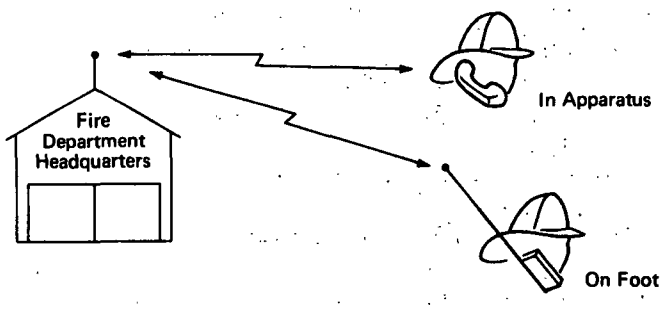


Figure 2-6.3 The Radio System.

2-7 System Requirements. Telecommunications systems must convey all messages for effective response, protection, and service. The ability to convey messages means that:

(a) There are no excessive delays in sending messages.

(b) Length and content of messages is appropriate.

(c) Information is not degraded by interference on the radio system.

(d) The means of transmitting messages is determined by their emergency nature, privacy needs, and length.

Radio systems should be designed with the goal of making average waiting time no more than five seconds during busy periods. Maximum waiting time should be kept to a tolerable length. The number of people wishing to use the system will vary in emergency situations, but waiting time increases during periods of heavy message traffic, even though the urgency of messages may be great.

The second requirement for an effective system concerns the length and content of messages sent over the system. These must be adequate to convey necessary information, but average length of messages and conversations allowed on a system at a given time determines the average waiting time for any user of the system.

The third requirement is that messages should not be degraded by interference. Radio interference can consist of:

(a) Signals generated by electrical devices, such as auto ignition, electric motors, and neon signs.

(b) Other radio stations using the same or nearby frequencies.

(c) Background noise picked up by the user's microphone.

(d) Faulty radio equipment.

The fourth general requirement is that the system provide an alternative means of communication to the radio network. Many messages are not urgent and do not require the speed the radio system provides, or they may be lengthy, using excessive transmission time. The public telephone offers an alternative and provides a means of communicating with other fire agencies and public service agencies.

One factor determining system demands is the fluctuation in message traffic over hourly, daily, weekly, monthly, and yearly periods. The quantity of radio and telephone messages changes from minute to minute, and there are five reasons for this fluctuation:

(a) Chance occurrence of events requiring fire services.

(b) Daily and weekly patterns of human activity.

(c) Changes in patterns due to seasonal and weather conditions.

(d) Special events which require fire services.

(e) Catastrophes and emergency situations with related events requiring fire services.

It is imperative that a fire telecommunication system be reliable and flexible and always available for use. Reliability depends on equipment and method of operation, and can be increased with good quality equipment and competent preventive maintenance with backup capability. Because fire agency communications systems perform a variety of functions, they must be flexible to fulfill these functions. It also includes the ability to circumvent equipment failures to get messages through and meet the greater demands that future growth may put on the system.

Since telecommunications must provide emergency service, reliability requirements for equipment are much higher than for less critical services. It must handle normal peak loads with almost the same rapid response as during times when message loads are minimal. This requires that equipment and personnel capacities be geared to handle peak loads rather than average loads.

For maximum reliability, a communications center should not depend upon commercial power as the only source of electrical supply. A continuing source of electrical power may be assured with a standby power plant. If a power blackout occurs, the standby generator takes over as the power source, automatically. Selection of a generator should include consideration of the expected power load. The standby power should be capable of handling the essential load of the building, but need not supply the entire electrical load, since it is unlikely that all equipment will be in use at one time. In addition, installation of battery operated equipment at key locations such as headquarters and relay stations assures a more "fail-safe" condition. The standby generator is still needed.

Chapter 3 Telephone Communications

Fire agencies require three types of telephone service: (1) incoming emergency calls; (2) incoming administrative calls; and (3) outgoing emergency and administrative calls. The telephone portion of the system can vary widely depending upon the size of the fire agency and the workload. The system may sound a warning alert, summoning volunteers, or may be monitored by an answering service, by a local law enforcement agency, or by a central dispatch service.

The system may be answered by a clerk or radio dispatcher, or the telephone calls may be divided among several persons, who may be radio dispatchers. There may be single or multiple lines for emergency calls only, or the system may consist of several trunk lines divided between the emergency and administrative needs of the agency. A fire control agency should lease enough lines on the "emergency" number for all calls, or it may establish a separate group of trunk lines on a second number for callers who do not want emergency service. Different types of lines are available and are used by fire agencies. Information on these services is available from local telephone companies. Dispatch centers need at least one "out only" line so they can always make an "out" call when all other lines are busy. All lines should be the type whereby the outside calling party cannot "hold" the line if the called party hangs up.

It is important that the phone system remain in operation during a power failure. This may require a battery system. Phone companies do not normally provide this.

An increasing number of fires are reported by telephone in rural and forested areas. This reporting is facilitated by an appropriate listing in the telephone directory. In these locations a telephone number should be assigned for fire alarm emergency service only and another for normal fire agency business. The fire department or control agency listing in the telephone directory should appear in two places: on the introductory pages under "Emergency Numbers to be Called" and in the alphabetical section under "Fire Agency" listing fire and business numbers. The fire agency listing should also appear in the alphabetical section under the name of the agency or jurisdiction. The number designated for fire calls from commercial telephones should be one easy to remember and simple to dial. The fire agency should encourage telephone subscribers to post the fire emergency call number at each telephone.

Telephone operators are trained in the handling of calls to emergency numbers and usually will route emer-

gency calls properly. Equipment of the telecommunications system must be tailored to the needs of the agency, so consultation with the telephone company is always needed. Two subjects of concern are: design for overload conditions and line control so the agency retains capability during extreme emergencies.

The particular type of telephone used at the dispatcher's location depends on the preference of the fire control agency and people using the telephone. Some agencies record incoming emergency telephone calls for clarification or in case questions arise about the fire department's or fire control agency's action.

Local telephone companies offer a variety of services, hardware, and alternatives which should be explored when developing the telephone system. Private telecommunications companies also provide a variety of equipment and services which should be compared to the telephone company's for price and performance. It is usually possible to consolidate telephone equipment for handling emergency calls into the communication console.

Equipment backup is ordinarily the responsibility of the public telephone utility since most telephone equipment is leased. However, the backup for important leased circuits can be obtained by the use of parallel lines. Maintenance of telephone equipment is almost always performed by the utility's personnel.

Chapter 4 Radio Communications

4-1 The Radio Spectrum. Radio waves (or more precisely, electromagnetic waves) are the means by which radio communications are achieved. The fire control agency radio system operates on a certain frequency, and usually includes a band of frequencies, or side bands around that frequency. When radio frequencies are taken as a group, the term "radio-frequency spectrum" is used. This is a means by which energy can be transmitted at one point and received at another, and, in the process, convey information. Every transmission has three basic attributes: (1) it occupies a certain geographic area; (2) it occupies a certain period of time; and (3) it occupies a certain portion of the radio spectrum. These are very important to remember. A basic rule is that no two radio users can use the same portion of the spectrum at the same time in the same area without interfering with each other. In order to prevent interference, users must be separated adequately in frequency, area of operation, or time.

The radio spectrum may be compared to the light spectrum; just as a rainbow has colors easily separated from each other, so does the radio spectrum have frequencies with unique characteristics. Groups of frequencies have been assigned for specific uses, such as broadcast radio, television, radio communications for vehicles, and radio voice and data communications. These have been assigned for land mobile service: 30-50 MHz (VHF low band); 150-174 MHz (VHF high band); and 450-470 MHz (UHF ultra high band). In addition, the 800 MHz band is now available as are the so-called "T" (television) bands, channels 14-20 (470-512 MHz) in certain areas.

Each of these bands has its unique characteristics. Presuming the transmit power is the same and no repeaters or automatic relays are used, the VHF low band provides the longest signal range of the three bands and is ideal for open country operation, but may be seriously affected by sunspots or other long-range interference. The VHF high band provides shorter range than low band, but is less subject to radio interference, ideal for combination city-country coverage. The UHF band provides the shortest range of the three bands. It is least affected by interference, and seems to provide the best communications in congested city areas with tall structures.

Certain radio frequencies have been made available for use by fire agencies around the country. Each band consists of a group of frequencies, with center frequencies 15 KHz apart in the VHF high band and 25 KHz apart in the UHF band. In order to transmit information, a certain amount of the frequency spectrum is needed. This portion of the spectrum is termed the "bandwidth" of the transmission. Each user is assigned a certain amount of spectrum space, including a small amount of buffer called the "guard band," which serves to prevent interference from adjacent channels. Radio transmission equipment must generate a precise signal on one channel or frequency, and the receiving equipment must select this signal without being disturbed by signals on nearby channels. Just as a highway or a river can be narrow or wide, so can a radio channel. The narrower the channels, the more conventional channels can be placed into a given section of the radio spectrum. However, as channels are made narrower, radio equipment becomes more complicated and expensive to purchase and maintain.

Channels on the VHF high band and UHF bands have desirable "propagation" characteristics. If used properly, they provide the most efficient coverage of an area, reaching into all locations, but they do not travel over long distances or "skip" to cause interference in distant places. Because of their desirability and the relatively small area of spectrum available in each, the VHF high band and UHF bands have become crowded. Interference exists in some areas due to violation (often unavoidable) of the basic rule that radio transmission must be separated in time, geographical area, or frequency.

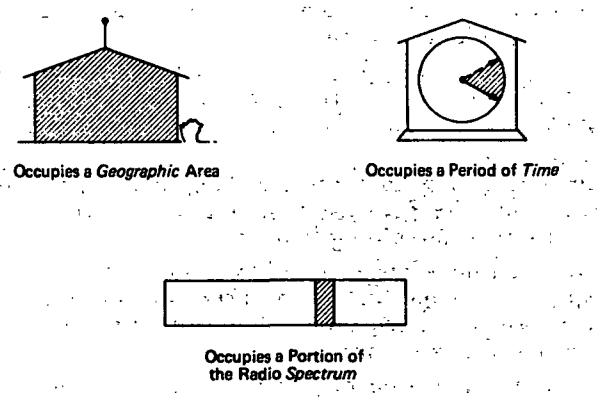


Figure 4-1 Basic Attributes of a Radio Transmission.

4-2 FCC Rules and Regulations. Frequencies, their assignment, and the widths of channels are regulated throughout the world. In the United States, the Federal Communications Commission (FCC) provides this regulation through allocation, licensing, and rule making for all except federal government allocations. [In Canada, the similar regulating agency is the Department of Communications (DOC).] The Office of Telecommunications Policy helps develop national spectrum utilization policy. The Interdepartmental Radio Advisory Committee (IRAC), under the Office of Telecommunications Policy, performs functions similar to the FCC, but only for federal agencies, and wire line and radio communication are subject to FCC rules and regulations, which govern many areas of radio usage (called "service"). Of primary concern to fire telecommunications systems users is the Public Safety Radio Services, which provide for use of radio communication systems by "nonfederal governmental entities."

The needs of fire communications fall primarily within this category of regulations. The FCC must apportion frequencies between commercial broadcast uses and nonbroadcast services, such as fire service radio. The Commission's prime resource, the radio spectrum, is not available without prior restrictions, since the federal government claims large portions of spectrum space for military and other operational use. Competition for frequencies is intense between broadcast and nonbroadcast users. The fire radio service and the forestry conservation radio service are only two parts of the land mobile group.

The FCC has established requirements and specifications for radio equipment characteristics to reduce, or eliminate, harmful interference and to conserve the use of the radio-frequency spectrum. During discussions with radio equipment manufacturers, the system planner must have knowledge of the regulations that deal with frequency stability, type of emission, power level, and acceptable equipment. The provisions are in Part 90 Subpart B of the FCC Rules and Regulations. In the interest of reducing interference, the FCC has established certain rules basic to any station operation. Supervisors should make sure these rules are being observed constantly. Violations could result in suspension of their radio license.

The basic FCC rules are as follows:

(a) All communications, regardless of nature, are restricted to minimum practical transmission time (excepting microwave systems).

(b) Continuous radiation of an unmodulated carrier (excepting microwave systems) is prohibited except when required for test purposes.

(c) Licensee are to take reasonable precautions to prevent unnecessary interference. If harmful interference does result, the FCC may require any or all stations to monitor the transmitting frequency before transmission.

(d) Tests may be conducted by any licensed station as required for proper station and system maintenance, but such tests are to be kept to the minimum. Precautions are to be taken to avoid interference to other stations.

Fire service personnel should follow these FCC rules and regulations:

(a) Maintain the required radio station records.

(b) The frequency and modulation must be measured and recorded when the transmitter is initially installed and when any change is made in the transmitter which may affect the frequency or modulation.

It is well to have frequency, power output, and modulation measurements made frequently (once or twice a year) to ensure that the equipment operates within the parameters stipulated by the FCC.

(c) Posting of the radio license is required.

(d) Identify radio station when transmitting.

(e) Do not reassign or transfer a radio station license without the approval of the Commission.

4-3 Frequency Coordination and FCC License Application. Frequency assignment in the land mobile service is difficult because there are more users than can be readily accommodated in available spectrum space. This is particularly true for fire and police radio in and near metropolitan areas. The FCC, which issues licenses and allocates frequencies, has asked user groups in land mobile services to coordinate assignments in a given service and geographical area. This is usually accomplished by voluntary frequency coordination, or frequency advisory committees, such as the International Municipal Signal Association (IMSA) for municipal fire services. In police and local government service, the Associated Public Safety Communications Officers (APCO) performs this function and the forest products industry's advisory group is the Forest Industries Telecommunications (FIT). The Forestry Conservation Communications Association (FCCA) coordinates frequencies assigned to the forestry-conservation radio service. The Associated State Highway Transportation Officers (ASHTO) provides coordination for the highway maintenance radio service.

Frequency coordination is the process of selecting and recommending to an applicant and the FCC one or more radio frequencies for use by the applicant which will cause the least amount of interference to other radio users and to the applicant, and yet provide serviceable channels. This includes coordination of applications for new licenses and license modifications (involving power and antenna heights) with existing frequency assignments. Thus, the function of these frequency advisory committees is to minimize the likelihood of harmful interference being caused to other systems by the operation of a proposed system. An application may require a committee to perform extensive research in determining physical separation, propagation paths, and the existence of other systems licensed on adjacent channels but in another service. If the application is favorably commented upon by a frequency advisory committee, the statement of the committee accompanies the application to the FCC, where it is processed.

Seeking a letter of clearance from a frequency advisory committee is generally considered the most satisfactory method for processing the application. If a dispute arises, or other considerations merit action, an application may be forwarded to the FCC without a clearance letter. FCC rules and regulations limit the power of frequency advisory committees, and point out that these committees are purely advisory in character. In many states, advisory committees have worked out frequency utilization plans for the state which have been filed with the FCC. Such

plans cover intra-district, or intra-county, network frequencies, and inter-district, or inter-county, frequency assignments. The names of the frequency coordinator and chairperson of the frequency advisory committee can be obtained through the local chapter or from the national chairperson of the several coordination groups.

Multi-frequency operation should be planned, even if facilities are not immediately provided. Messages on one frequency generally are heard by all units with receivers tuned to that frequency. However, receivers which are activated only by a discrete tone can be used to reduce messages heard by persons not required to act on them. Nevertheless, the volume of messages to be expected during operations determines the number of frequencies required. A busy fire agency might use one frequency for calls coming into the alarm communications center and another for outgoing calls. Sufficient frequencies should be provided so that one or more may be used for fireground communications.

4-4 System Design Considerations. A network (or system) is defined as a number of radio stations in a certain geographical area, jointly administered, or communicating with each other by sharing the same channel or channels. The size and degree of formal organization of fire radio networks varies widely. Many have been formed as a result of unstructured evolutionary growth and there is little cooperation among users. Others are highly organized and feature strong cooperation. The following basic factors roughly characterize network structure:

(a) Location of dispatching points or those points receiving reports of fire.

(b) Location of base station radio equipment and/or repeaters or mobile relays.

(c) Number of frequencies in each channel.

(d) Number of channels in the network.

(e) Operation of channels which make up the network.

In general, one can consider each factor to be independent of the others. For each, there exists a pair of tradeoffs, which must be considered when building up a network, such as the following pairs:

(a) Dispersed or central location of dispatching points.

(b) Dispersed or central location of base station equipment.

(c) Single or multi-frequency channels.

(d) Single or multi-channel networks.

(e) Simplex or duplex operation of the channels.

Networks can be compared by the following:

(a) Types of interference to which the network is susceptible.

(b) Available methods of channel "isolation" to prevent interference within the network.

(c) Performance under heavy message loads.

(d) Radio coverage characteristics.

(e) Existence, or nonexistence, of mobile-to-mobile and base-to-base communications in the network.

(f) Possibility of using special devices (such as radio teleprinters) within the network.

Radio systems differ by the number of frequencies used to provide a base-mobile channel, by the number of two-way channels in a system (or network), by whether system operation is simplex or duplex, and by whether or not repeater stations are used. The most commonly encountered systems are:

(a) Single-frequency simplex (simplex means that signals can be transmitted in only one direction at a time between two users).

(b) Two-frequency simplex.

(c) Two-frequency half-duplex (duplex means that signals can pass in both directions at the same time between two users).

The single-frequency simplex system, the most widely used two-way radio system, requires the least radio spectrum space and is the most economical two-way system to purchase and operate. With this system, the base station and mobile units share the same channel (frequency). This means that only one user of the system can transmit at any one time. Multiple transmissions usually will interfere with each other, although in an emergency a mobile unit will try to transmit messages despite this. All receivers within range can listen to the same transmission — somewhat like many people listening to the same station on their home radios. Under this method, communication is three-way: base to mobile, mobile to base, and mobile to mobile. Single-frequency operation is advantageous to fire control agencies because all units coverging on a fire location are kept informed of all messages that affect the fire fighting operation.

Then there is the two-frequency simplex system. It is similar to the single-frequency simplex system except that the base station broadcasts to the mobile units on one frequency, and they broadcast to the base station on a different frequency. This prevents base station broadcasts of one agency from interfering with mobile unit broadcasts of another agency when they are nearby and share the same frequencies. Thus, it is suited to areas requiring densely packed stations on the same frequency. A disadvantage of this mode of operation is that mobile units cannot hear each other's transmissions because their receivers are tuned to the frequency of the base station transmitter.

A third radio system is the two-frequency half-duplex system. It differs from its simplex counterpart in that operation at the base station is duplex, that is, the base station can receive and transmit simultaneously. If a large geographic area must be covered by radio communications, or if obstructions such as mountains separate the service area, it may be necessary to use one or more repeater stations to amplify signals and rebroadcast them. Repeater stations may also be used to assure complete coverage by low-powered portable radios.

Because of the relatively small number of frequencies available for the fire service, it is not possible for every agency to have its radio system operating on a separate frequency that is free from interference and not used by any other agency. A group of small agencies adjacent to each other should operate on a single frequency for coordination of response under mutual aid arrangements. (All fire agencies operating their own radio service, or agencies operating in a group, should have one or more separate frequencies and additional frequencies where

the radio traffic load warrants.) The disadvantage of a single-frequency group system is that during normal periods, each agency will hear the calls of all other agencies. This may be annoying and interfere with fire fighting emergencies arising simultaneously in two or more jurisdictions. In planning to operate on a single frequency, a group of agencies should prepare a set of rules or operating procedures, to which each should agree.

Under FCC rules and regulations, a fire frequency utilization plan can be filed for the state. Under such a plan, the state may be divided into fire districts or counties used as fire districts. A common or intra-district frequency is designated for each district, with one or more frequencies assigned for inter-district or intra-state communications. The setup in a district will vary with the size of the agencies, the radio traffic load, and normal mutual aid operations between various individual places. Experience has shown that 15 to 30 radio-equipped vehicles can operate at a fire or emergency on one frequency, but more vehicles result in a message load too great for one frequency. Radio units should be purchased with the idea that they will be adapted to operate on two or more frequencies. Some single-frequency units can be converted to four or more frequency operation.

A group of agencies may choose to operate a regional communications system. Each group should designate a chief communications officer to assist in planning intra-district and inter-district communications. A location should be selected as the communications center for the region. Each region should be allocated a common, or intra-region, frequency, and there may be one or more frequencies assigned for inter-region or intra-state communications. System planning on a regional basis is required if channel overloading and overlap of tone coding is not to occur in the future. In general, system planning in the fire radio service has been inadequate. This guide cannot possibly, nor is it intended to, cover the many technical details of system design. A qualified communications engineer or technician should always be consulted for system technical aspects.

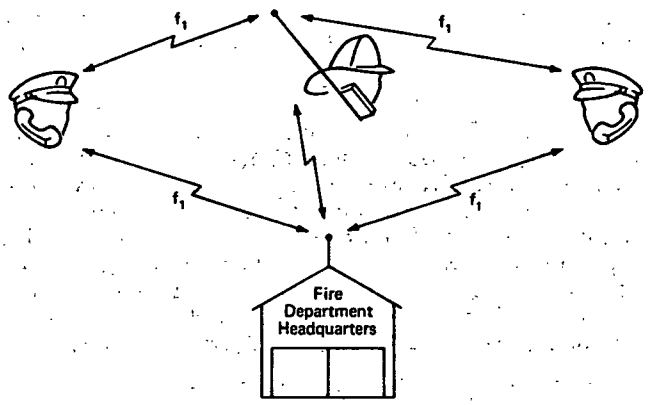


Figure 4-4 Single-Frequency Simplex Operation.

4-5 Radio Equipment.

4-5.1 Vehicular Two-Way Radios. Radio equipment installed in vehicles is used by field personnel to communicate with the dispatch center, or headquarters, and with each other. These units are indispensable links of the communications chain which aid supervisory personnel in command and control of personnel and equipment in the field. An option offered by some manufacturers is selective calling, which allows mobile units to be called individually. Selective calling is usually coupled with a "recall" feature which informs an individual, who is away from the vehicle, of a call by activating the dome light, headlights, siren, or horn.

4-5.2 Portable Two-Way Radios. The portable or "handie-talkie" two-way radio has become fairly common in fire agency and other public safety radio systems in recent years. These are designed with self-contained power supplies and antennas, making them suitable for independent operation. Size and weight are kept low enough so these units may be carried by field personnel, providing two-way radio communication to the person on foot. They vary in power output. Fixed crystal controlled tuning is employed and units with multiple-channel capabilities may be purchased. Some portable units can be connected easily to draw power from a vehicle's electrical system, and contain other features which make them suitable for vehicle usage. Selective calling is optionally available.

Units may be purchased with relay capability and used as "mobile extenders" in which the portable unit activates the mobile unit as a "relay" point.

Fire agencies can use portable radio equipment even though they have no base station or vehicle radios. Three frequencies have been designated for inter-system operation only — primarily base to portable and portable to base. Units on these frequencies are useful for local inter-agency cooperation in order not to interfere with the main radio system or when the heavy message load on the regular radio system would not permit use of portable units. Fire agencies may license portable units on the same frequency as vehicular units so they can be used from widespread locations.

4-5.3 Pocket Pagers. Pocket pagers, commonly called "beepers," may be used for summoning off-duty or volunteer fire personnel. These can also send a brief message at the end of the attention tone.

4-5.4 Communications Vans — Mobile Control Centers. Emergency situations resulting from large fires, transportation accidents, floods, severe storms, and other disasters often create a need for a temporary communications center located close to the scene of the disaster. This need is filled by a communications van, sometimes called a mobile command post. The van, a mobile command and control headquarters, serves as the hub from which activities necessary to control an emergency situation may be directed and coordinated without dependence upon the agency's fixed dispatch and communications center. These activities include the efforts of local and outside fire agencies, and of other public safety organizations, such as police departments and civil defense, in addition to public utilities concerned with the distribution of gas, water, and electricity. Being near the site of the disaster gives communications van personnel and those in command immediate access to the latest information in situations where rapid change is common. Further, the ready availability of communications provides the means to call for additional help or to inform

other areas of approaching danger. A recent analysis of major disasters of all types recommends the establishment of a command post at the incident or disaster scene as soon as possible so that all command and control and service may be handled locally and directly without dependence upon the agency's fixed dispatch and communications center.

A communications van should carry a variety of equipment which must allow communication with other fire agencies, public safety organizations, and utilities. Radio equipment includes several single-frequency FM two-way radios for operation on various emergency channels, a unit with multiple-channel capabilities, or various combinations. Other radio equipment which increases the flexibility of the system is a citizens band (CB) transmitter and receiver. Some vans may be equipped for mobile relay operation, to pick up transmissions of mobile units and retransmit them at higher power levels or on different frequencies to the regular fire agency communications center. Electric bull horns or power voice speakers and public address systems for directing personnel and for crowd control are useful. Commercial radio and television receivers and telephones (connected by the phone company at the site) also are valuable in some situations.

In areas where telephone lines are unavailable, radiotelephone or microwave equipment can be employed to obtain telephone service. Since a normal power supply may not be available, an independent power supply system should be incorporated. The van may have provisions for more than one dispatcher with a communications control center type of arrangement. If it is to serve as a temporary headquarters, the van should contain chairs and one or more work tables so that maps and other large documents may be studied. Adequate lighting is also necessary. Some emergency situations may warrant use of the van for extended periods of time. Under such conditions, it is advantageous if the vehicle is self-contained, with heating, cooling, kitchen, sanitary, and sleeping facilities for personnel. In some jurisdictions or agencies, very complex communications vans have been developed which are practically mini-dispatch centers on wheels and which may accommodate 6 to 12 telephone lines, a computer terminal, etc.

4-5.5 Scanning Receivers. A scanning receiver provides the capability of monitoring several channels automatically. With numerous fire control agencies using different frequencies, these receivers provide economical means of inter-communications and mutual aid cooperation. Some sample each channel sequentially, waiting for a signal to appear. As soon as a signal is detected, the receiver locks to that channel and stops scanning as long as the signal remains. Some scan with priority, with one channel taking precedence over the others when signals appear simultaneously on both the "priority" channel and on another. If the receiver is monitoring a nonpriority channel and a signal is heard on the priority channel, the nonpriority channel is released and the priority channel held. Scanning receivers with multi-channel capabilities usually have switches on the front panel to include or delete channels from the scanning process; thus, one, several, or all channels may be monitored, allowing operational flexibility for different situations. Frequency synthesized scanning receivers are available which can be set to include virtually any channel in the low VHF, high VHF, or UHF bands. The active channels are selected by the operator and do not require crystal or other changes by a technician. The scanning receivers can provide communications between cooperating agencies without the need for multi-channel transmitters — up to a point. That is, each agency transmits on its own assigned frequency but the transmissions are received by anyone equipped with a scanner. The addressed party then transmits on its own frequency and is likewise received on the other scanners.

Separate scanning receivers programmable by the operator have one major fault and they cannot and should not be depended upon for a primary channel. Although they are generally as sensitive (able to pick up weak signals) as the most expensive radio receivers, they are not as selective (able to reject adjacent channels). Thus, many multi-channel receivers may completely fail to do the job when placed in an environment in close proximity to transmitters transmitting only 15-30 KHz apart.

The above does not apply to built-in scanning receivers associated with transmitters in a standard mobile radio configuration. These are very selective but the operator must remember that a scanning receiver can only reproduce one channel at a time and will lock out all others (except a priority one if so equipped).

4-5.6 Special and New Devices. There are many areas of advancing technology which have found, and will continue to find, direct application to fire agency telecommunications systems. Among other things, adoption of improved and new equipment in the near future will help fire agencies to:

(a) Keep in constant personal contact with all personnel and equipment, either in mobile units or on foot.

(b) Exchange written messages between vehicles and base stations.

(c) Improve command and control by television transmission to command centers of fire perimeter or fire activity.

(d) Improve status information by facsimile transmission of maps and other written data over wire lines or microwaves.

Low-cost minicomputers can provide users with a powerful array of intra- and inter-agency capabilities. Most of these systems are extremely simple to learn and users can be building their own programs in a matter of weeks. Some examples of fire service programs that can be used on these systems are:

(a) Initial attack dispatch,

(b) Resource status keeping,

(c) Incident reports,

(d) Equipment inventories, and

(e) Hazardous materials information.

In multiple-agency environments, small computers can be inter-connected to provide an electronic coordination and information system. These small systems are becoming very popular and reasonably easy to obtain.

Agencies contemplating the purchase of any computer system (large or small) should make detailed studies to determine their present and future requirements before

purchase. They need to study the kinds of data they wish to store, retrieve, and transmit. How much data and how many times per day (or hour) the system will be used is important. Who needs access to the system must be determined. And finally, some hard looks need to be taken at alternative methods to accomplish the same needs. A number of manufacturers will perform these types of studies for agencies, but the prospective purchaser needs to remember that the manufacturer's mission is to sell computers.

Digital radio systems are available which reduce the system's "on" time, can automatically send messages from memory, provide a hard copy printout of the message, etc. They also provide a degree of communication security since the transmissions are in digital format rather than voice.

4-5.7 Tone Signaling and Tone Code Squelch. Coded audible and subaudible tones sent prior to, or during, transmission time are used in fire radio systems to implement a number of functions not obtainable with voice alone. Tone coded squelch, recall, radio relay control, and remote transmitter keying are examples of tone coding applications. An encoder is needed for transmission of the coded tones and a decoder is necessary in the receiver to interpret the coded tones. Some "tone coded squelch" and "tone signaling" schemes employ single tones sent continuously with regular voice transmission; some use two simultaneous tones with different frequencies. In another variation, two sequential tones are sent, first one, then the other.

The purpose of tone coded squelch is to eliminate nuisance interference by other users of the radio channel. The receiver is equipped with a decoder that responds only to proper tone coding. When a signal with correct coding is detected, the receiver squelch opens and the desired signal is heard by the operator. The squelch cannot be opened by signals without correct coding. Tone coding may be used for selective calling and recall. In a system with selective calling, the base station is equipped with a tone encoder console capable of generating a number of different code combinations. The desired code is selected by one or more push-button switches. Particular receivers at fixed locations, or at mobile radios, may be provided with unique decoders corresponding to selective codes. The decoder only allows a properly coded signal to be heard at the receiver output. This system gives the base station the ability to call one or a group of receivers and/or mobile radio units at a time rather than all simultaneously. At fixed locations, selective calling may be used to turn on alarms, sound sirens, turn on lights, open station doors, etc. Most selective call decoders for mobile units provide a "recall" feature which alerts individuals to a message when they are out of the vehicle. When in the recall mode, the receipt of a properly coded signal causes activation of a call indicator light, horn, headlights, or dome light of the car, to inform the officer that the base station called.

Tone signalling decoding techniques are used for remote control of base station transmitters. The need for special and costly direct-current telephone lines to provide for transmitter keying from a remote dispatch point is eliminated. The ordinary voice-grade telephone line which carries voice information to the transmitter is used to carry the tone also. A simple encoder at the dispatch point generates a tone when the push-to-talk switch on the microphone is actuated. This tone is sensed by a decoder at the station control panel, causing the transmitter to be keyed on.

4-5.8 Maintenance. Ordinarily, three methods of maintaining telecommunications system equipment are used. One method is for the agency to operate its own service facilities. Another is to call upon one or more technical service companies to maintain the agency's equipment. In some instances, a combination of agency operated and contracted maintenance service is used. A third method is for several agencies, a municipality or a county, or other agency to operate the service facilities. This may result from a compact among several agencies for a jointly operated maintenance department, or may be part of a more extensive joint operation of fire communications facilities. A county or other governmental unit may have a communications department that provides services for all of its governmental communications systems.

Major components of a communications system can be expected to fail despite the best maintenance program. This need not produce a system failure if proper preparations are made for such events. Standard techniques to prevent system failure are to provide backup equipment and system redundancy. Both can be provided at reasonable cost.

4-6 Citizen Cooperation and Assistance. Two important adjuncts to a communications system under emergency conditions are the Citizens Radio Service, generally known as "CB" for citizens band radios, and the Amateur Radio Service, otherwise known as "hams."

Citizens band radio is a restricted, short-range service limited in the number of channels, the distance and duration of communication, power output (5 watts), age of licensee, and ability to adjust equipment. CB radios are now widespread and can be used to relay emergency messages. An emergency channel (Channel 9) is reserved for such messages. Radio Emergency Associated Citizens Teams (REACT) are groups of CB radio owners organized to provide an emergency or public service. A CB radio at the station or dispatch center, tuned to the emergency channel, or an agreement with a local CB group, REACT group, or other group of enthusiasts to relay any emergency information or participate in emergency operations can be very helpful.

Amateur radio is the personal use of shortwave radio equipment for direct, worldwide communications on a one-to-one basis. Every day, amateurs or "hams" talk across the ocean or across town, using their radio gear in many different ways, from assisting motorists in distress to "patching" telephone calls from Antarctica. "Hams" are allowed up to 1,000-watt input power, have no age, channel, distance, or time restrictions, and are actually encouraged to modify and experiment with their equipment.

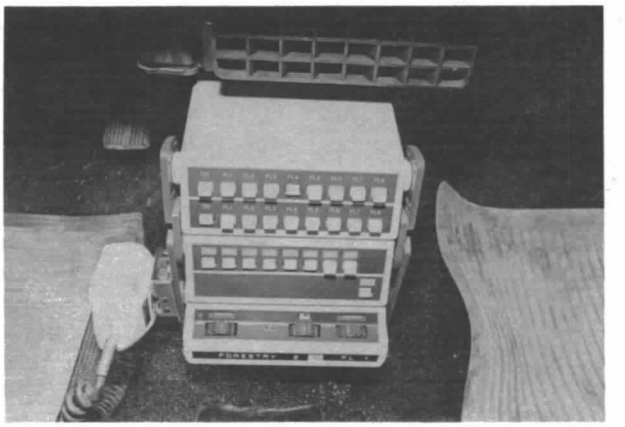
Under the auspices of the American Radio Relay League (ARRL), the national membership society of licensed radio amateurs, dedicated to the interests of amateur radio, and its Amateur Radio Public Service Corps (ARPSC), licensed amateurs are organized into two groups that can provide radio emergency service:

RACES (see below) and ARES. The Amateur Radio Emergency Service (ARES) consists of licensed amateurs who have voluntarily registered their qualifications and equipment for communications duty in the public service when disaster strikes. Every licensed amateur, whether or not a member of ARRL or any other local or national organization, is eligible for membership in ARES. The only qualification other than holding a license is a sincere desire to serve. Since ARES is an amateur service, only amateurs are eligible for membership. The possession of emergency powered equipment is desirable but is not a requirement for membership. There are three levels of ARES organization: national, sectional, and local (large sections may be further subdivided into districts). Operational leadership consists of local, district, and section emergency coordinators appointed by elected administrative officials at ARRL. The emergency coordinator represents the Amateur Service in its dealings with civic and relief agencies.

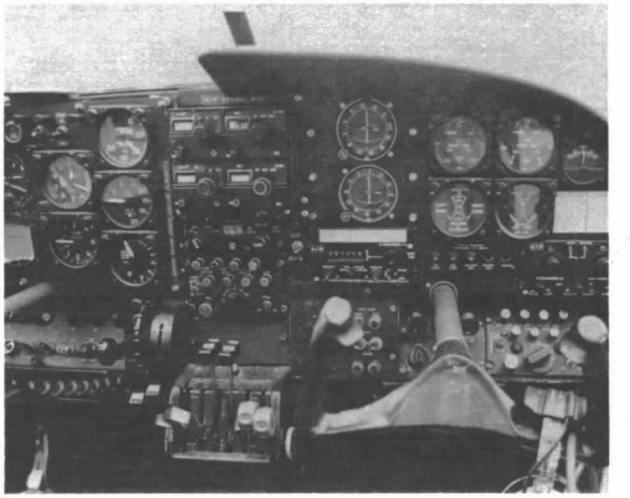
The Radio Amateur Civil Emergency Service (RACES), administered by the Federal Emergency Management Agency of the United States government, is a part of the Amateur Radio Service that provides radio communications for civil preparedness purposes only during periods of local, regional, or national civil emergencies. These emergencies are not limited to war-related activities but can include natural disasters such as fires, floods, and earthquakes. RACES is a radio communication service conducted by volunteer licensed amateurs designed to provide emergency communications to local or state civil preparedness agencies. RACES' operation is authorized by the FCC upon request of a state or a federal official and is strictly limited to official civil preparedness activity in the event of an emergency communications situation.

"Hams" are often very well versed in radio communication methods, equipment, and techniques. A mobile "ham" at a fire working with another "ham" at home with a phone patch could provide communications from the fire scene to many different locations. The local amateur club or enthusiasts should be consulted in advance to determine their capabilities and willingness to help where needed. They could also provide some valuable consultation in the selection, installation, and operation of a fire or other emergency communications system.

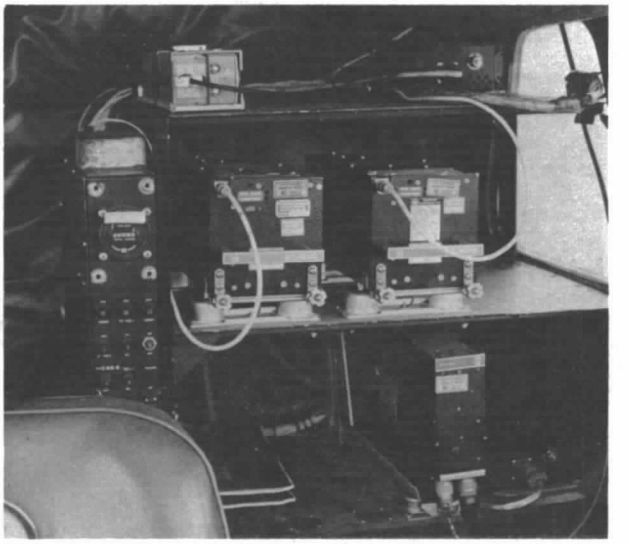
Portable base station with public address system, an 8-frequency scanner at top as installed in fire station.



Solid state transmitter-receiver capable of 12-channel operation. Includes an 8-frequency scanner with 16-tone transmit capacity.



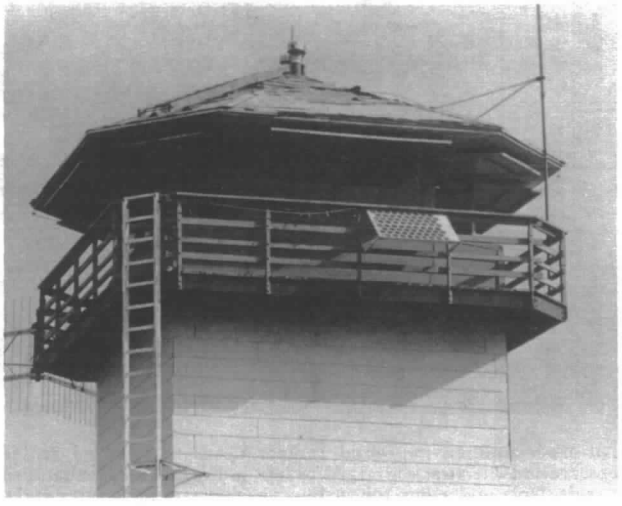
Air-to-air and air-to-ground control heads as installed in light observation/air attack aircraft (to left and right of right-hand control). Note mixer box for various aircraft radios in lower right.



9600-channel air-to-air and air-to-ground radios as installed in light observation air attack aircraft.

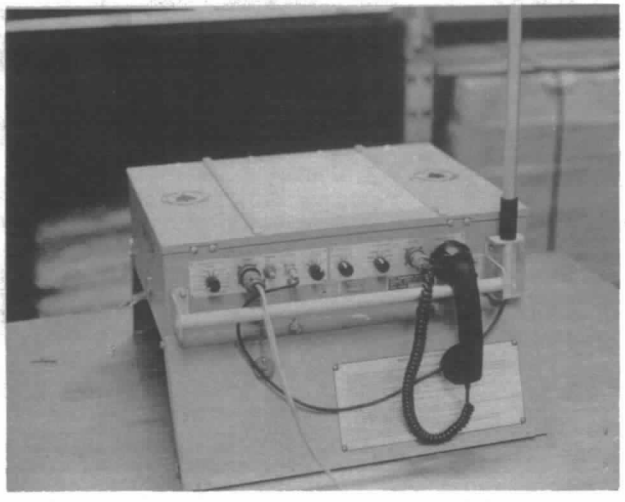
32-channel synthesized mobile transmitter-receiver unit. Mobile unit also includes an 8-channel scanner with two levels of priority and is capable of 16 tones on any of the 32 transmit frequencies.

Emergency standby electric power generator.



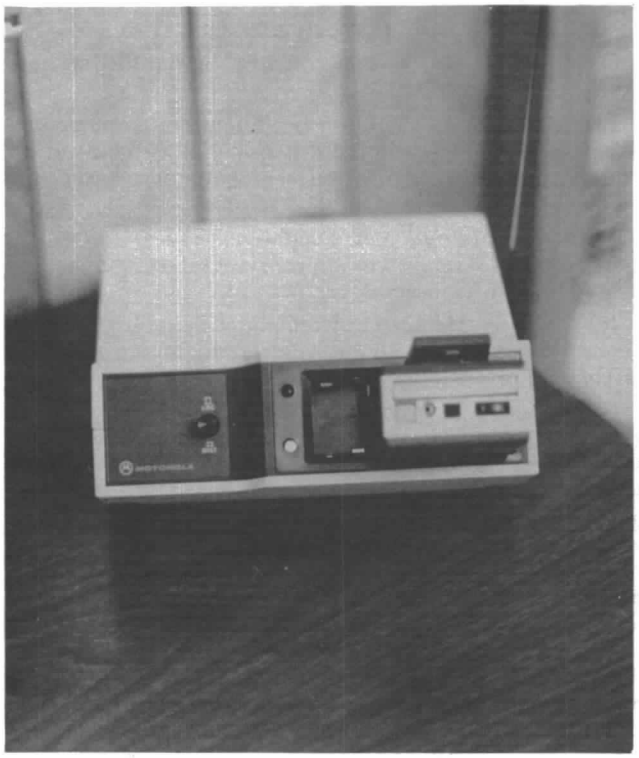
Solar collector panel on mountaintop lookout.

Left to right: repeater-capable handie-talkie, two simplex handie-talkies.

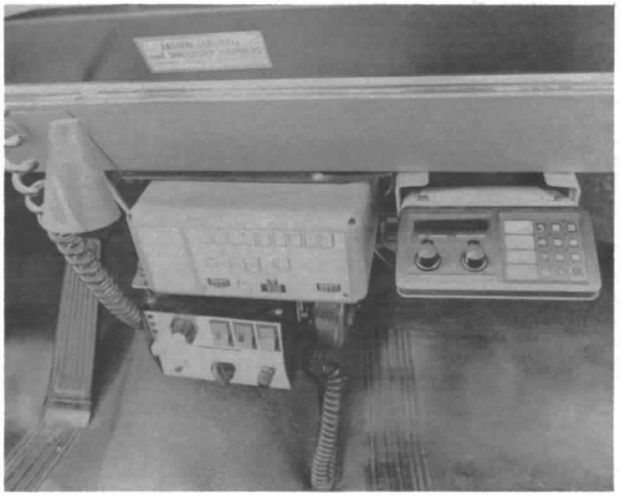


Portable mountaintop repeater unit.

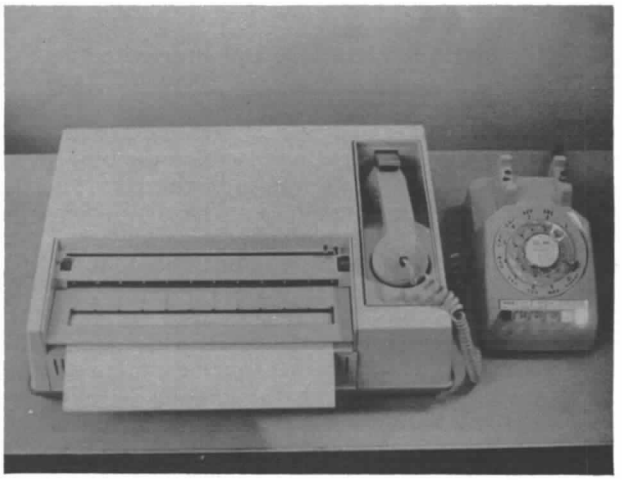
Handie-talkie with repeater capability in charger base.



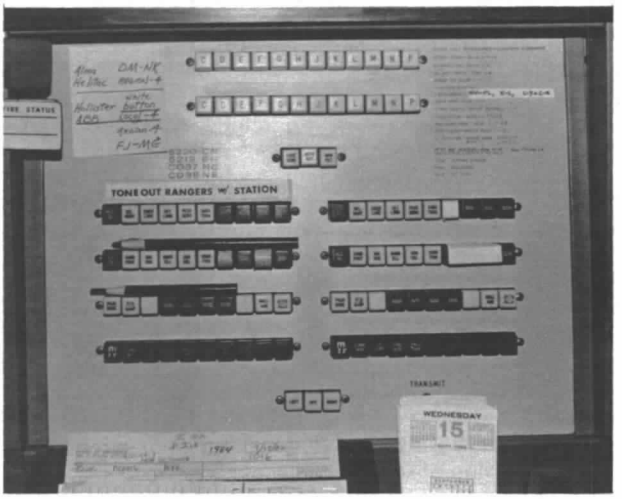
Pager in desk-top pager/monitor unit.



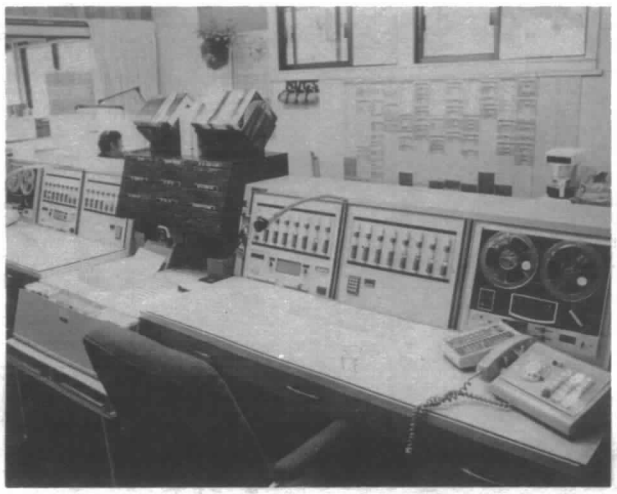
Left: four-frequency mobile radio control head with electronic siren/public address system below. Right: 20-frequency programmable scanner as mounted in sedan.



Portable facsimile transmitter-receiver unit with acoustic coupler.



Tone encoder panel.



Two-position dispatch and communications console with tape recorders, response card file, and dispatch records. Note T card resource status display on back wall.

Chapter 5 Operations and Procedures

5-1 Communications Centers. There must be a communications center, or a definite location established, at which all calls by telephone, radio, or fire alarm system are received and action taken. This location should be constantly attended during the time it is needed. Suitable extensions (such as telephone) may be utilized for interim periods.

The complexity and size of this center will vary with the agency. A large operating center may be maintained, or may be a continuously attended watch desk at a fire station. The communications center may be any location where a 24-hour watch service is maintained, including a local answering service. The staffing needs for watch desk operators or communications center dispatchers pose serious problems for agencies with limited funds and limited full-time personnel. Some jurisdictions solve this problem by having one center handle the emergency calls of all public safety or emergency organizations. Another solution for fire agencies is to have a number of neighboring fire agencies operate a joint communications center or fire alarm headquarters. To achieve maximum value from limited facilities, fire agencies may pool operations with mutual aid arrangements, which are facilitated when a common communications center is used. There are many regions and rural and suburban areas, for example, where no one fire agency can afford a really good fire alarm headquarters operation. However, they could establish a county or regional fire alarm headquarters and share the expense.

Populated areas frequently extend over several contiguous communities with multiple fire agency jurisdictions. A telephone company does not limit or separate services on the basis of municipal boundaries. The continued expansion of service areas of a telephone exchange causes one operator or group of operators to handle calls from several communities. A citizen dialing the operator to report a fire is not assured that the operator will be able to transmit the alarm to the proper fire agency.

Fire agencies and other public safety services recognize the need for citizens to be able to reach them quickly, no matter where they are when an emergency arises. In January 1968, a proposal was made to implement throughout the country a single universal emergency telephone number which citizens could use to reach the police, fire department, and other emergency agencies from wherever they might be. The number "911" was chosen. The "911" system is an easy to remember, three-digit telephone number used to provide the general public with direct access to the emergency service resources. Some areas in the country are already being served by "911." The state of California has implemented a statewide "911" system. It is likely that other states will follow suit.

The call for help terminates at a PSAP (Public Safety Answering Point) where responsive action can be initiated. This point serves all kinds of emergency services — fire, police, medical, etc. The selection of a point to receive emergency calls raises the problem of jurisdiction because telephone exchange boundaries often include several communities or large areas. For this reason, some multi-jurisdictional areas are employing enhanced "911" telephone features such as Selective Routing, Automatic Number Identification (ANI), and Automatic Location Identification (ALI). Selective Routing automatically routes an emergency call to the proper answering point serving its community, irrespective of municipal and telephone boundary conflicts. ANI and ALI are features that automatically identify and display the telephone number and location of the emergency call. These enhanced "911" features can result in the overall reduction of emergency response time.

After a call for help has been received at a PSAP, there are several methods by which it may be handled. These are:

(a) *Direct Dispatch Method.* The dispatch personnel at the central answering point perform all call answering and dispatching of an appropriate emergency service unit upon the receipt of a telephone request.

(b) *Relay Method.* A telephone request for emergency services is relayed to appropriate safety agencies for dispatch of an emergency service unit.

(c) *Transfer Method.* A telephone request for emergency service is directly transferred to an appropriate safety agency.

(d) *Referral Method.* The requesting party is provided with the telephone number of the appropriate safety agency in nonemergencies.

5-2 Summoning Volunteers. Fire agencies with volunteers or paid-call fire fighters have the problem of summoning their personnel at any hour of the day or night. This problem can be solved by the use of the telephone or radio, supplementing siren or horns by which an outside alarm is given. Fire calls may be telephoned to the central telephone office where the operator may start a siren or operate an air horn, indicating that there is a fire. In rural areas where a fire alarm headquarters or communications center is not attended 24 hours a day, telephone companies may provide

a special telephone line which connects to special telephones located in places of business or residences selected by the town. The fire chief then arranges to have reports of fire acted upon. In agencies which have a fire station desk attendant, the telephone central operator may call the station and the attendant sounds the outside alarm to call volunteers. If there is a code-sounding siren or air horn, coded signals can be sent. Usually a transmitting apparatus is used to send out the code.

If radio equipment is used, a receiver with selective calling equipment can be placed in the home of each volunteer or call fire fighter. Selective signaling is accomplished on a group-called principle, permitting the volunteer or call forces to be divided into several groups, and these units can be summoned as a whole, or as individual groups, to take care of a particular fire. Pocket pagers are in common use for this purpose since they are lighter, cheaper, and can easily be carried anywhere. These units may include either a tone alarm or a receiver, or both.

5-3 Fireground or Other Incident Communications. The first unit to arrive at a fire or other emergency incident should notify the headquarters communications center by radio of its arrival, and give a brief description of the conditions visible and the precise location of the incident. The responding officer should report arrival and should establish the communications center or initial command post at the fire or other emergency. As soon as conditions allow, the officer in charge should report supplementary information to the headquarters communications center, and should make additional progress reports if operations keep the fire units at the emergency beyond a few minutes. An extended or complex emergency incident may require the use of a communications van for effective coordination, command, and control.

The assignment of a communications officer to incidents that are more complex will ensure that adequate communication is achieved, utilizing both available telephone and radio systems, and that the availability of existing frequencies or networks is maximized and system overloading minimized. An assigned communications officer can be particularly important and useful on multi-agency fires and other incidents. It may be necessary to establish specific nets and monitoring systems to guarantee communications in some situations. In complex incidents, communications discipline is most important to avoid system overloading.

The National Interagency Incident Management System (NIIMS) is the result of efforts by the National Wildfire Coordinating Group (NWCG) to develop a basic fire suppression management system that all fire protection agencies can use in an emergency. The system, develped by representatives from a broad spectrum of the fire services, provides commonality of organization, procedures, terminology, qualifications of personnel, and standards for equipment. It makes possible the effective exchange and use of fire fighters locally, regionally, and nationally. The system is designed to be used in response to any type of emergency.

The common emergency organization, the Incident Command System (ICS), includes two important communications concepts:

(a) *Common Terminology.* All participating agencies use "clear text" radio and established standard terms and phrases. In multiple agency emergencies, it is extremely difficult to guarantee that all agency codes portray exactly the same meaning. To avoid any potential misunderstandings between cooperators, the ICS requires "clear text" or "plain language" for all radio messages. Although this is a significant departure from public safety agency tradition, it has been found to be very efficient in actual practice.

(b) *Integrated Incident Communications.* Participating agencies plan in advance for the use of integrated radio frequencies to tie together all tactical and support units on an incident. To assure the best possible use of all participating agency radios on major incidents, an Incident Radio Communications Plan matrix is developed. This matrix lists all available radio systems on an incident and aids in assigning them to provide Command, Tactical, and Logistical coverage for a complete operation. Preparation of the matrix requires some training (four hours) and a knowledge of cooperating agency frequencies and radio components. Use of the matrix is greatly enhanced by the existence of a frequency sharing agreement (*see Appendix B*).

The Federal Communications Commission (FCC) has no prohibition against public agencies sharing frequencies during emergencies provided that the responsible agency has granted permission to do so to assisting agencies. The agreement specifies the mutual permission of participating agencies to use other agencies' frequencies when assisting them. The agreement lists the terms and conditions of use by others and includes all frequencies that could be made available under critical conditions. Agreements such as this facilitate better multi-agency dispatching and incident communications and can be prepared by any groups or agencies who frequently work together.

5-4 Communications Center Operations. Fire agencies should adopt a standard procedure for handling messages. All members should complete a training course on use of communications equipment. The adoption of a standard use of words or code in voice communication is important to speed message transmission and avoid errors. With voice communication it is necessary to phrase messages so they will not be misunderstood. Code signals and standard messages are used not only to use the communications facilities efficiently, but also to make sure that the code or standard message can be defined. Voice communications in fire agency practice are generally haphazard. Better message procedures are needed in nearly every fire agency. The agency's standard procedures should define how persons originating a message shall identify themselves. A code word or code number is desirable even with voice communication to prevent the communications system being used for calls which should be handled over the regular commercial telephone system, and to prevent unauthorized persons communicating in the name of an officer. Radio logs, card systems, maps with appropriate symbols, and/or other aids and displays can be used to maintain resources and incident status.

An important person in the communications center operations is the dispatcher. This position is one of con-

trol and assistance, and is expected to promote an orderly and legal operating procedure. The dispatcher must know the capabilities and limitations of the communications systems that he/she is authorized to operate; must be familiar with the administrative organization of the agency so as to be able to route traffic properly and be aware of the equipment and resources available to the agency; and must be familiar with capabilities of cooperating agencies and with the rules and regulations of the FCC which are applicable.

Many calls from citizens are clearly of an emergency nature. Some calls are not of an emergency nature, reducing the need for priority handling. Some calls are not clearly in either the emergency or nonemergency category. A dispatcher or clerk must avoid the assumption that the call is not urgent, for the cost of an error in judgment may be high. All such doubtful calls must be treated as if they were urgent, representing true emergencies. Many calls to the fire emergency telephone number may be merely requests for information. The dispatcher or person answering the phone generally must handle all such routine questions, transferring the call to another person only if unable to answer the question. Citizens frequently supply information to the fire agency.

Dispatchers should possess the following basic qualifications:

(a) Ability to speak clearly and distinctly at all times.

(b) Ability to reduce rambling and disconnected material into concise and accurate messages.

(c) Ability to think and act promptly in emergencies.

(d) Ability to analyze a situation accurately and to take or suggest an effective course of action.

(e) Thorough understanding of the capabilities of the agency's own communications system and a working knowledge of cooperators' systems.

(f) Adequate understanding of the technical operation of the agency's own system to allow intelligent reporting of equipment failures.

(g) Physical and mental ability to work effectively under all conditions encountered.

(h) Knowledge of the FCC rules and regulations applying to operator's responsibilities.

5-5 Telephone Techniques. The telephone is the most available means of access the citizen has to obtain the services of the fire agency. It is the primary link between professional and nonprofessional communications. The telephone is also the fundamental method of communications within an agency and between agencies.

Agency personnel using the telephone should adhere to the following rules:

(a) *Answer Promptly.* Treat each call as an emergency. Every ring for the person who may be ill or suffering from fear or panic seems like an eternity. Try to answer within three rings.

(b) *Identify Yourself and Your Agency.* This assures the caller that the call was placed properly.

(c) *Speak Directly into the Mouthpiece.* This ensures that you will be understood and will not waste time repeating information.

(d) *Observe Telephone Courtesy.* Use a calm, competent, decisive voice in a courteous manner.

(e) *Take Charge of the Conversation.* After the initial exchange, lead the call into meaningful context by asking questions as to who, what, where, and when. Be courteous but firm.

(f) *Take All Information.* Write it down. Never leave anything to memory.

(g) *Explain Waits.* Explain why it will take time to check for information and that you will call back. A party waiting on a "dead" phone may become irritable and uncooperative.

(h) *Avoid Jargon or Slang.*

(i) *Show Interest in the Person's Call.* The person calling has or needs information and feels it is important.

(j) *Use Caller's Name when Possible.* This makes the caller feel that you have a personal interest in the call.

(k) *Try to Visualize the Caller.* The telephone is an impersonal thing and we tend to be curt or less courteous or to lose our temper more easily than if we were meeting the party in person.

(l) *Make Sure the Information Gets to the Proper Person.* Never give the caller misinformation, never guess, but refer the call to the proper party even if it means transferring the call. If requested information is not immediately available, obtain the caller's name and number and return the call.

(m) *Advise when You Leave Your Telephone.* Let your co-workers know of your whereabouts when leaving your position.

(n) *Place and Receive Your Own Calls.* This provides far better harmony with the citizen than letting someone else do the calling.

(o) *List Frequently Called Numbers.* Place such numbers, as well as all other important numbers, within view of the operating position.

(p) *Do Not Say "Who's Calling?"* You will receive a better response if you simply say, "May I tell _____ who called?"

(q) *Transfer Calls Only when Necessary.* When it is necessary to transfer a call, tell the caller what your are going to do.

(r) *Terminate Calls Positively and Courteously.*

5-6 Radio Techniques. FCC rules and regulations govern the operation of fire services radio, and a copy of the rules must be maintained on the premises of the agency. In addition, certain rules should be observed which are based on common courtesy and achieving maximum efficiency from the system. Good radio practices include the following:

Always be courteous.

Use proper language. The use of profanity is prohibited by the FCC. This rule is enforced. Violations can and do result in fines, imprisonment, or loss of license.

Answer radio calls promptly.

Think through your message before starting to transmit. Be brief and to the point. Radio channels are crowded. Use code or brief phrases whenever possible to condense your messages.

When using a car radio, the driver should slow down or briefly stop except during emergencies. If radio "dead spots" or interference are encountered, move the vehicle and try again. Sometimes only a few feet can make a considerable difference. Many vehicles have directional radio patterns, either toward the front or rear, depending on location of the antenna. Changing vehicle direction can sometimes assist in getting a signal to the base station.

If others are using the air, wait until they are through unless your message is of an emergency nature. If it is, break in on the conversation and request a clear frequency for emergency traffic. Always listen first to be sure the channel is clear before you attempt to transmit.

Pronounce your words distinctly and rather slowly. Talk into the microphone; use a normal tone of voice. Shouting or yelling into the microphone will cause an extremely distorted signal and must be avoided, even when it is extremely noisy from the engine or nearby activities. It is also essential that your voice maintain a constant volume which does not trail off. Do not become excited.

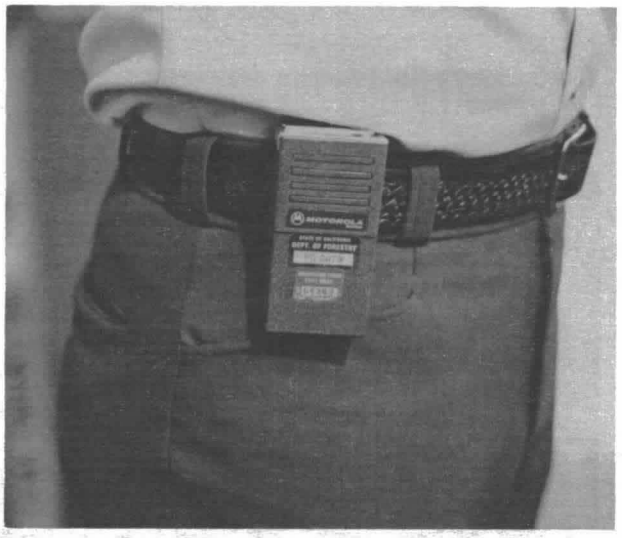
In transmitting messages, always give the call number or name of the station or person you are calling first, followed by your call number. When you are through transmitting (message given and reply received) terminate the conversation by giving your call number. This indicates that the air is clear for communications by others.

Do not carry on discussions unrelated to agency activity. Only pertinent communications are permitted. FCC rules do not permit transmission of messages for unlicensed parties (except in emergency situations) or the transmission of music or commercial messages.

Learn how to use radio equipment correctly. Correct use permits proper understanding of your message and results in prompt action. Delays mean loss of minutes, and minutes count in fire suppression work.

A radio transmitter should not be used within 300 feet of electric blasting. Do not carry electric blasting caps in radio-equipped cars or trucks.

"911" placard on fire department pickup.

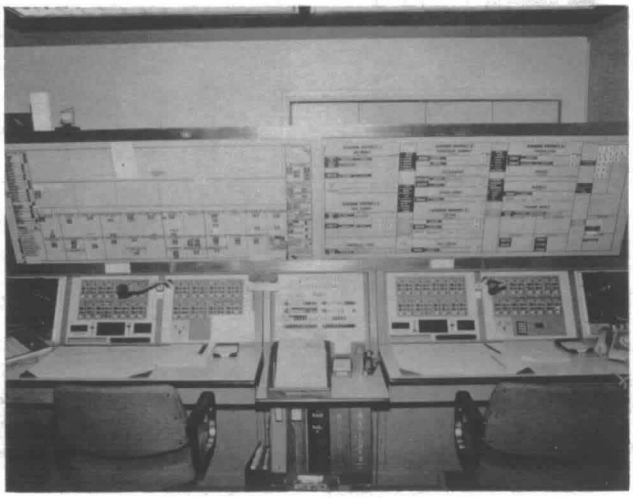


Pager carried on belt.

Incident communications and resource situation/status unit, Southern California FIRESCOPE Project.

Mobile Incident Command/Communications Unit.

Radio operator's desk with cooperating agency's radio, tone encoder, and portable base station as installed in Mobile Incident Command/Communications Unit.



Two-position dispatch and communications console with resource directories, tone encoder, tape recorder, and resource/situation display.

Chapter 6 Referenced Publications

6-1 The following documents or portions thereof are referenced within this guide and shall be considered part of the requirements of this document. The edition indicated for each reference is current as of the date of the NFPA issuance of this document. These references are listed separately to facilitate updating to the latest edition by the user.

6-1.1 FCC Publication. U.S. Government Printing Office, Washington, DC.

FCC Rules and Regulations — Land Mobile Service (FCC Part 90), November 22, 1978.

Appendix A Public Safety Communication Languages

This Appendix is not a part of the requirements of this NFPA guide, but is included for information purposes only.

There is a need for inter-communication between agencies in the Public Safety Radio Services. The most efficient service rendered to the public in a given area exists when all the resources of public safety can be coordinated. Communication is a vital link in this coordination process, be it by radio, telephone, or other means. It is essential that the operator of one system be able to understand the language of other systems. The only efficient and accurate method of reaching understanding is for these operators to speak the same language.

An acceptable method of providing a common language is through the use of a universal brevity code.

In the past it was common for public safety agencies to use the "ten code." Many agencies still do and typically the APCO Ten Code is chosen. However, there is a system of standard plain-language phrases that offers a means to improve the understanding between agencies using different codes. In addition, use of a Phrase/Word Brevity Code for local operations can reduce misunderstandings from numerical code misuse and permit new personnel to be rapidly integrated into system communications. For these reasons, NFPA recommends the Phrase/Word Brevity Code.

Phrase/Word Brevity Code

Phrase/Word	Meaning	APCO Ten Code
Use Caution	Caution: dangerous condition is suspected to exist.	10-30
Unreadable	Radio signal is too weak to receive.	10-1
Out of Service	Unit, vehicle, or person is not working.	10-7
In Service	Unit, vehicle, or person is working but not necessarily "available" or "on radio."	10-8
Available	Unit is in service ready to accept assignment, not necessarily by radio.	10-24
Not Available	Unit cannot accept another assignment, but may be "on radio."	10-7A
Prepare to Copy	Dispatcher is about to give lengthy message.	10-14
Go Ahead	You have been given clearance to transmit your message.	N/A
Roger (Received)	Message received and understood.	10-4
Say Again (Repeat)	Repeat your message.	10-9
Stand By	Stop transmitting and wait for further instructions.	10-12
Disregard (Recall)	Cancel your present assignment.	10-22
Off Radio	Unit is not capable of being contacted by radio, but may be "available."	10-7B
On Radio	Unit is capable of being contacted by radio, but is not necessarily "available."	10-11