

NFPA 72

National Fire Alarm Code

1993 EDITION

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**National Fire Protection
Association**

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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.

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1993 Edition

Reference: 1-5.2.3 Note, 1-5.2.6 (1) (2) (3), 1-5.2.9.2(a), 1-5.2.10.1 Exception, 1-5.2.10.5, 1-7.2.2.2.1, 3-6.2 Exception, 3-8.14.1, 3-8.15.3, 4-2.3.1.2, etc.

The Committee on National Fire Alarm Code notes the following errors in the 1993 edition of NFPA 72, *National Fire Alarm Code*.

1. *In 1-5.2.3 Note, the fifth line, change reference from "1-5.2.6" to "1-5.2.5".*
2. *In 1-5.2.6 (1) (2) (3), change references from "1-5.2.6" to "1-5.2.5".*
3. *In 1-5.2.9.2(a), the fifth line, change reference from "1-5.2.6" to "1-5.2.5".*
4. *In 1-5.2.10.1 Exception, the second line, change the reference from "1-5.2.6(b) and (c)" to "1-5.2.5(b) and (c)".*
5. *In 1-5.2.10.5, the second line, change the reference from "1-5.2.6" to "1-5.2.5".*
6. *Move 1-7.2.2.2.1 to the Appendix and renumber it A-1-7.2.2. Also renumber the paragraphs (a), (b), (c), (d), and (e) as 1 through 5 respectively. Change the word "shall" to "should" throughout the section. Add an asterisk to 1-7.2.2.*
7. *In 3-6.2 Exception, change reference from "1-5.7.4" to "1-5.7.6".*
8. *In 3-8.14.1 change "service" to "systems".*
9. *In 3-8.15.3, change the word "panel" to "unit".*
10. *In 4-2.3.1.2, change the reference in the eighth line from "4-3.4.5" to "4-2.4.2".*
11. *In Table 4-2.3.1.4, change the first entry under Type 3 from "56" to "256".*

12. In 4-2.3.5.4.2, first paragraph, change reference from "4-3.4.5" to "4-2.4.2".
13. In 4-6.7.1.2, change the last word from "percent" to "circuits".
14. Move and renumber "5-1.2.3" to "5-4.1.1.1".
15. Move and renumber "5-1.2.4" to "5-4.1.1.2".
16. In 5-3.5.8.2, the second line, change "30 ft" to "3 ft (0.9 m)."
17. In 5-4.2.1, wavelength, change the symbol for angstroms from " $^{\circ}$ " to " $\text{\AA}$ ".
18. In Table 7-2.2, Item 8, the fourth line, change "serve" to "severe".
19. Correct the spelling of Hazard in the heading in Figure 7-5.1 to read "Special Hazard Systems".
20. In A-3-2.4(a)1, the third line, correct the first occurrence of the word "or" to "on".
21. In A-3-8.14.1, delete the words "fire alarm" in the fourth line.
22. Renumber Figure A-5-2.5.1(a) to A-5-2.5.1.
23. Renumber Figure A-5-2.5.1(b) to Figure A-5-2.7.1(a) and renumber Figures A-5-2.7.1 thru A-5-2.7.1(d) as A-5-2.7.1(b) through (f).

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NFPA 72

National Fire Alarm Code

1993 Edition

This edition of NFPA 72, *National Fire Alarm Code*, was prepared by the Technical Committees on Fundamentals of Signaling Systems, Household Fire Warning Equipment Signaling Systems, Initiating Devices for Signaling Systems, Notification Appliances for Signaling Systems, Off-Premises Signaling Systems, Protected Premises Signaling Systems, and Testing and Maintenance of Signaling Systems; released by the Correlating Committee on Signaling Systems; and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 24-27, 1993, in Orlando, FL. It was issued by the Standards Council on July 23, 1993, with an effective date of August 20, 1993, and supersedes all previous editions.

The 1993 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 72

This standard is a consolidation of NFPA 71 - 1989, *Standard for the Installation, Maintenance, and Use of Signaling Systems for Central Station Service*; NFPA 72 - 1990, *Standard for the Installation, Maintenance, and Use of Protective Signaling Systems*; NFPA 72E - 1990, *Standard on Automatic Fire Detectors*; NFPA 72G - 1989, *Guide for the Installation, Maintenance, and Use of Notification Appliances for Protective Signaling Systems*; NFPA 72H - 1988, *Guide for Testing Procedures for Local, Auxiliary, Remote Station, and Proprietary Protective Signaling Systems*; and NFPA 74 - 1989, *Standard for the Installation, Maintenance, and Use of Household Fire Warning Equipment*. Many of the requirements of the standards are the same or very similar. The recommendations taken from the guides (NFPA 72G and NFPA 72H) have been changed into mandatory requirements. Cross-references to previous editions are provided at the end of each paragraph and at the end of the code for the user.

NFPA's signaling standards date back to 1898. This reconsolidation recognizes improvements in the state of the art of the various types of signaling systems that have evolved in recent years.

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Committee Scope. Responsible for preparing documents on the installation and operation of initiating devices for signaling systems, including automatic fire detection devices, sprinkler waterflow detectors, manually activated fire alarm stations, supervisory signaling initiating devices, and guard's tour stations.

Technical Committee on Notification Appliances for Signaling Systems

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Committee Scope. Responsible for preparing documents on the installation and operation of notification appliances for signaling systems.

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Committee Scope. Responsible for preparing documents on the installation and operation of off-premises signaling systems including the signal receiving facility and the communications between the protected premises and the off-premises signal receiving facility.

Technical Committee on Protected Premises Signaling Systems

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Committee Scope. Responsible for preparing documents on the installation and operation of protected premises signaling systems, including the interconnection with initiating devices, notification appliances, and other related building control equipment, within the protected premises.

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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

Chapter 1 Fundamentals of Fire Alarm Systems . . .	72- 9	4-6 Public Fire Alarm Reporting Systems . . .	72-64
1-1 Scope	72- 9	4-7 Auxiliary Fire Alarm Systems	72-73
1-2 Purpose	72- 9	Chapter 5 Initiating Devices	72-75
1-3 General	72- 9	5-1 General	72-75
1-4 Definitions	72- 9	5-2 Heat-Sensing Fire Detectors	72-76
1-5 Fundamentals	72-17	5-3 Smoke-Sensing Fire Detectors	72-79
1-6 System Interfaces	72-24	5-4 Radiant Energy-Sensing Fire Detectors . .	72-83
1-7 Documentation	72-24	5-5 Gas-Sensing Fire Detectors	72-85
Chapter 2 Household Fire Warning		5-6 Other Fire Detectors	72-87
Equipment	72-29	5-7 Sprinkler Waterflow Alarm-Initiating	
2-1 General	72-29	Devices	72-88
2-2 Basic Requirements	72-29	5-8 Detection of the Operation of Other Automatic	
2-3 Power Supplies	72-30	Extinguishing Systems	72-88
2-4 Equipment Performance	72-31	5-9 Manually Actuated Alarm-Initiating	
2-5 Installation	72-32	Devices	72-88
2-6 Maintenance and Tests	72-34	5-10 Supervisory Signal-Initiating Devices . . .	72-90
2-7 Markings and Instructions	72-34	5-11 Smoke Detectors for Control of Smoke	
Chapter 3 Protected Premises Fire Alarm Systems .	72-34	Spread	72-90
3-1 Scope	72-34	Chapter 6 Notification Appliances for Fire Alarm	
3-2 General	72-34	Systems	72-93
3-3 Applications	72-35	6-1 Scope	72-93
3-4 Performance of Initiating Device, Notification		6-2 General	72-93
Appliance, and Signaling Line Circuits . .	72-35	6-3 Audible Characteristics	72-94
3-5 Performance and Capacities of Initiating Device		6-4 Visible Characteristics, Public Mode	72-95
Circuits (IDC)	72-35	6-5 Visible Characteristics, Private Mode. . . .	72-96
3-6 Performance and Capacities of Signaling Line		6-6 Supplementary Visible Signaling	
Circuits (SLC)	72-37	Method	72-97
3-7 Notification Appliance Circuits (NAC) . .	72-37	6-7 Coded Appliance Characteristics	72-97
3-8 System Requirements	72-37	6-8 Textual Audible Appliances	72-97
3-9 Fire Safety Control Functions	72-42	6-9 Textual Visible Appliances	72-97
3-10 Suppression System Actuation	72-43	Chapter 7 Inspection, Testing, and Maintenance .	72-97
3-11 Interconnected Fire Alarm Control		7-1 General	72-97
Units	72-43	7-2 Test Methods	72-98
3-12 Emergency Voice/Alarm		7-3 Inspection and Testing Frequency	72-98
Communications	72-44	7-4 Maintenance	72-107
3-13 Special Requirements for Low Power Radio		7-5 Records	72-110
(Wireless) Systems	72-46	Chapter 8 Referenced Publications	72-116
Chapter 4 Supervising Station Fire Alarm		Appendix A Explanatory Material	72-117
Systems	72-47	Appendix B Engineering Guide for Automatic	
4-1 Scope	72-47	Fire Detector Spacing	72-156
4-2 Communication Methods for Off-Premises Fire		Appendix C Referenced Publications	72-241
Alarm Systems	72-47	Cross Reference List	72-243
4-3 Fire Alarm Systems for Central Station		Index	72-265
Service	72-57		
4-4 Proprietary Supervising Station			
Systems	72-60		
4-5 Remote Supervising Station Fire Alarm			
Systems	72-63		

NFPA 72**National Fire Alarm Code****1993 Edition**

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Information on referenced publications can be found in Chapter 8 and Appendix C.

Chapter 1 Fundamentals of Fire Alarm Systems

1-1 Scope. This code deals with the application, installation, performance, and maintenance of fire alarm systems and their components.

[From NFPA 72 - 1990, 1-1 modified]

1-2 Purpose.

1-2.1* The purpose of this code is to define the means of signal initiation, transmission, notification, and annunciation; the levels of performance; and the reliability of the various types of fire alarm systems. This code defines the features associated with these systems, and also provides the information necessary to modify or upgrade an existing system to meet the requirements of a particular system classification. It is the intent of this code to establish the required levels of performance, extent of redundancy, and quality of installation, but not the methods by which these requirements are to be achieved.

[From NFPA 72, 1-2.1 modified]

1-2.2 Any reference or implied reference to a particular type of hardware is for the purpose of clarity and shall not be interpreted as an endorsement.

[From NFPA 72, 1-2.2]

1-3 General.

1-3.1 This code classifies fire alarm systems as follows:

- (a) Household fire warning systems
- (b) Protected premises fire alarm systems
 - 1. Local fire alarm systems
- (c) Off-premises fire alarm systems
 - 1. Auxiliary fire alarm systems
 - (i) Local energy type
 - (ii) Parallel telephone type
 - (iii) Shunt type
 - 2. Remote station fire alarm systems
 - 3. Proprietary fire alarm systems
 - 4. Central station fire alarm systems
 - 5. Municipal fire alarm systems.

1-3.2 A device or system having materials or forms different from those detailed in this code shall be permitted to be examined and tested according to the intent of the code and, if found equivalent, shall be approved.

[From NFPA 72 - 1990, 1-3.2, and NFPA 71, 1-1.3 modified]

1-3.3 The intent and meaning of the terms used in this code are, unless otherwise defined herein, the same as those of NFPA 70, *National Electrical Code*.®

[From NFPA 72 - 1990, 1-3.3]

1-4 Definitions. For the purposes of this code, the following terms have the meanings shown below:

[From NFPA 72 - 1990]

Active Multiplex System. A multiplexing system in which transponders are employed to transmit status signals of each initiating device or initiating device circuit within a prescribed time interval.

[From NFPA 71 modified]

Active Signaling Element. A component within a circuit interface such as a transistor, silicon controlled rectifier, or relay whose function is to impress a signal on the multiplexed signaling line circuit.

[From NFPA 71 modified]

Addressable Device. A fire alarm system component with discreet identification that can have its status individually identified or that is used to individually control other functions.

[New paragraph]

Adverse Condition. Any occurrence to a communications or transmission channel that interferes with the proper transmission and/or interpretation of status change signals at the supervising station. (*See also Trouble Signal.*)

[From NFPA 71 modified]

Air Sampling-Type Detector. A detector that consists of a piping or tubing distribution network from the detector to the area(s) to be protected. An aspiration fan in the detector housing draws air from the protected area back to the detector through air sampling ports, piping, or tubing. At the detector, the air is analyzed for fire products.

[From NFPA 72E - 1990, 2-2.2.3]

Alarm. A warning of fire danger.

[New paragraph]

Alarm Service. The service required following the receipt of an alarm signal.

[From NFPA 71]

Alarm Signal. A signal indicating an emergency requiring immediate action, such as a signal indicative of fire.

[From NFPA 72 - 1990 and NFPA 71 modified]

Alarm Verification Feature. A feature of automatic fire detection and alarm systems to reduce unwanted alarms wherein smoke detectors must report alarm conditions for a minimum period of time, or confirm alarm conditions within a given time period, after being reset to be accepted as a valid alarm initiation signal.

[From NFPA 72 - 1990 modified]

Alert Tone. An attention-getting signal to alert occupants of the pending transmission of a voice message.

[From NFPA 72 - 1990]

Analog Initiating Device (Sensor). An initiating device that transmits a signal indicating varying degrees of condition as contrasted with a conventional initiating device, which can only indicate an on/off condition.

[New paragraph]

Annunciator. A unit containing two or more indicator lamps, alpha-numeric displays, or other equivalent means in which each indication provides status information about a circuit, condition, or location.

[From NFPA 72 - 1990 modified]

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.

[From NFPA 72 - 1990, NFPA 71, NFPA 72E, NFPA 72G, NFPA 72H, and NFPA 74]

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

[From NFPA 72 - 1990, NFPA 71, NFPA 72E, NFPA 72G, NFPA 72H, and NFPA 74]

Automatic Extinguishing System Operation Detector. A device that detects the operation of an extinguishing system by means appropriate to the system employed.

Automatic Extinguishing System Supervision. Devices that respond to abnormal conditions that could affect the proper operation of an automatic sprinkler system or other fire extinguishing system, including but not limited to con-

trol valves; pressure levels; liquid agent levels and temperatures; pump power and running, engine temperature and overspeed; and room temperature.

[New paragraphs]

Automatic Fire Detectors. Fire is a phenomenon that occurs when a substance reaches a critical temperature and reacts chemically with oxygen (for example) to produce heat, flame, light, smoke, water vapor, carbon monoxide, carbon dioxide, or other products and effects.

An automatic fire detector is a device designed to detect the presence of fire and initiate action. For the purpose of this code, automatic fire detectors are classified as listed below.

[NFPA 72E - 1990, 2-1, 2-2.1 modified]

Fire-Gas Detector. A device that detects gases produced by a fire.

[From NFPA 72E - 1990, 2-2.1.4]

Heat Detector. A device that detects abnormally high temperature or rate-of-temperature rise.

[From NFPA 74 and NFPA 72E]

Other Fire Detectors. Devices that detect a phenomenon other than heat, smoke, flame, or gases produced by a fire.

[From NFPA 72E - 1990, 2-2.1.5]

Radiant Energy Sensing Fire Detector. A device that detects radiant energy (such as ultraviolet, visible, or infrared) that is emitted as a product of combustion reaction and obeys the laws of optics.

[From NFPA 72E - 1990, 2-2.1.3]

Smoke Detector. A device that detects visible or invisible particles of combustion.

[From NFPA 74]

Auxiliary Box. A fire alarm box that can be operated from one or more remote actuating devices.

[From NFPA 1221 modified]

Auxiliary Fire Alarm System. A system connected to a municipal fire alarm system for transmitting an alarm of fire to the public fire service communication center. Fire alarms from an auxiliary fire alarm system are received at the public fire service communication center on the same equipment and by the same methods as alarms transmitted manually from municipal fire alarm boxes located on streets.

(a) *Local Energy Type.* An auxiliary system that employs a locally complete arrangement of parts, initiating devices, relays, power supply, and associated components to automatically trip a municipal transmitter or master box over electric circuits that are electrically isolated from the municipal system circuits.

(b) *Parallel Telephone Type.* An auxiliary system connected by a municipally controlled individual circuit to the protected property to interconnect the initiating devices at the protected premises and the municipal fire alarm switchboard.

(c) *Shunt Auxiliary Type.* An auxiliary system electrically connected to an integral part of the municipal alarm system extending the municipal circuit into the protected premises to interconnect the initiating devices, which, when operated, open the municipal circuit shunted around the trip coil of the municipal transmitter or master box, which is thereupon energized to start transmission without any assistance whatsoever from a local source of power.

[From NFPA 72 - 1990 modified]

Box Battery. The battery supplying power for an individual fire alarm box where radio signals are used for the transmission of box alarms.

[From NFPA 1221 modified]

Bridging Point. The location where the distribution of signaling line circuits to trunk facilities or leg facilities, or both, occurs.

[From NFPA 71 modified]

Carrier. High frequency energy that can be modulated by voice or signaling impulses.

[From NFPA 72 - 1990]

Carrier System. A means of conveying a number of channels over a single path by modulating each channel on a different carrier frequency and demodulating at the receiving point to restore the signals to their original form.

[From NFPA 71]

Ceiling. The upper surface of a space, regardless of height. Areas with a suspended ceiling would have two ceilings, one visible from the floor and one above the suspended ceiling.

Ceiling Height. The height from the continuous floor of a room to the continuous ceiling of a room or space.

[From NFPA 72E]

Ceiling Surfaces. Ceiling surfaces referred to in conjunction with the locations of initiating devices are as follows:

[From NFPA 72E - 1990, 2-4 and 2-4.1]

(a) *Beam Construction.* Ceilings having solid structural or solid nonstructural members projecting down from the ceiling surface more than 4 in. (100 mm) and spaced more than 3 ft (0.9 m), center to center.

[From NFPA 72E - 1990, 2-4.1.1]

(b) *Girders.* Girders support beams or joists and run at right angles to the beams or joists. When the top of girders are within 4 in. (100 mm) of the ceiling, they are a factor in determining the number of detectors and are to be considered as beams. When the top of the girder is more than 4 in. (100 mm) from the ceiling, it is not a factor in detector location.

[From NFPA 72E - 1990, 2-4.1.2]

Central Station. A supervising station that is listed for central station service.

[From NFPA 71, 1-3 modified]

Central Station Fire Alarm System. A system or group of systems in which the operations of circuits and devices

are transmitted automatically to, recorded in, maintained by, and supervised from a listed central station having competent and experienced servers and operators who, upon receipt of a signal, take such action as required by this code. Such service is to be controlled and operated by a person, firm, or corporation whose business is the furnishing, maintaining, or monitoring of supervised fire alarm systems.

[From NFPA 71 modified and TIA 304 revised, SC 90-44]

Central Station Service. The use of a system or a group of systems in which the operations of circuits and devices at a protected property are signaled to, recorded in, and supervised from a listed central station having competent and experienced operators who, upon receipt of a signal, take such action as required by this code. Related activities at the protected property such as equipment installation, inspection, testing, maintenance, and runner service are the responsibility of the central station or a listed fire alarm service - local company. Central station service is controlled and operated by a person, firm, or corporation whose business is the furnishing of such contracted services or whose properties are the protected premises.

Certificate of Completion. A document that acknowledges the features of installation, operation (performance), service, and equipment with representation by the property owner, system installer, system supplier, service organization, and the authority having jurisdiction.

[From NFPA 72 modified]

Certification. A systematic program using randomly selected follow-up inspections of the certified systems installed under the program, which allows the listing organization to verify that a fire alarm system complies with all the requirements of this code. A system installed under such a program is identified by the issuance of a certificate and is designated as a certificated system.

[From NFPA 71 modified]

Certification of Personnel. A formal program of related instruction and testing as provided by a recognized organization or the authority having jurisdiction.

NOTE: This definition applies only to municipal fire alarm systems.

[From NFPA 1221 modified]

Channel. A path for voice or signal transmission utilizing modulation of light or alternating current within a frequency band.

[From NFPA 71, NFPA 72 - 1990, and NFPA 1221 modified]

Circuit Interface. A circuit component that interfaces initiating devices and/or control circuits, indicating appliances and/or circuits, system control outputs, and other signaling line circuits to a signaling line circuit.

[New paragraph]

Combination Detector. A device that either responds to more than one of the fire phenomenon or employs more

than one operating principle to sense one of these phenomenon. Typical examples are a combination of a heat detector with a smoke detector or a combination rate-of-rise and fixed-temperature heat detector.

[From NFPA 72E]

Combination Fire Alarm and Guard's Tour Box. Manually operated box for separately transmitting a fire alarm signal and a distinctive guard patrol tour supervisory signal.

[From NFPA 72 - 1990]

Combination System. A local fire alarm system for fire alarm, supervisory, or guard's tour supervisory service, or a household fire warning system whose components may be used in whole or in part in common with a nonfire signaling system, such as a paging system, a burglar alarm system, or a process monitoring supervisory system, without degradation of or hazard to the fire alarm system.

[From NFPA 72 - 1990 and NFPA 74 modified]

Communication Channel. A circuit or path connecting subsidiary station(s) to supervising station(s) over which signals are carried.

[From NFPA 71 modified]

Compatibility Listed. A specific listing process that applies only to two-wire devices (such as smoke detectors) designed to operate with certain control equipment.

Compatible (Equipment). Equipment that interfaces mechanically or electrically together as manufactured without field modification.

Control Unit. A system component that monitors inputs and controls outputs through various types of circuits.

[New paragraphs]

Delinquency Signal. A signal indicating the need of action in connection with the supervision of guards or system attendants.

[From NFPA 71 and NFPA 72 - 1990 modified]

Derived Channel. A signaling line circuit that uses the local leg of the public switched network as an active multiplex channel, while simultaneously allowing that leg's use for normal telephone communications.

[From NFPA 71]

Digital Alarm Communicator Receiver (DACR). A system component that will accept and display signals from digital alarm communicator transmitters (DACTs) sent over the public switched telephone network.

[From NFPA 72 - 1990 and NFPA 71 modified]

Digital Alarm Communicator System (DACS). A system in which signals are transmitted from a digital alarm communicator transmitter (DACT) located at the protected premises through the public switched telephone network to a digital alarm communicator receiver (DACR).

[From NFPA 72 - 1990 and NFPA 71 modified]

Digital Alarm Communicator Transmitter (DACT). A system component at the protected premises to which initiating devices or groups of devices are connected.

The DACT will seize the connected telephone line, dial a preselected number to connect to a DACR, and transmit signals indicating a status change of the initiating device.

[From NFPA 72 - 1990 and NFPA 71 modified]

Digital Alarm Radio Receiver (DARR). A system component composed of two subcomponents: one that receives and decodes radio signals, the other that annunciates the decoded data. These two subcomponents can be coresident at the central station or separated by means of a data transmission channel.

[From NFPA 71]

Digital Alarm Radio System (DARS). A system in which signals are transmitted from a digital alarm radio transmitter (DART) located at a protected premises through a radio channel to a digital alarm radio receiver (DARR).

[From NFPA 71 modified]

Digital Alarm Radio Transmitter (DART). A system component connected to or an integral part of a DACT that is used to provide an alternate radio transmission channel.

[From NFPA 71]

Display. The visual representation of output data other than printed copy.

[From NFPA 72 - 1990]

Dual Control. The use of two primary trunk facilities over separate routes or different methods to control one communication channel.

[From NFPA 71]

Evacuation. The withdrawal of occupants from a building.

NOTE: Evacuation does not include relocation of occupants within a building.

[From NFPA 72 - 1990]

Evacuation Signal. Distinctive signal intended to be recognized by the occupants as requiring evacuation of the building.

[From NFPA 72 - 1990]

Exit Plan. Plan for the emergency evacuation of the premises.

Family Living Unit. That structure, area, room, or combination of rooms in which a family (or individual) lives. This is meant to cover living area only and not common usage areas in multifamily buildings such as corridors, lobbies, basements, etc.

[From NFPA 74]

Fire Alarm Control Unit (Panel). A system component that receives inputs from automatic and manual fire alarm devices and may supply power to detection devices and transponder(s) or off-premises transmitter(s). The control unit may also provide transfer of power to the notification appliances and transfer of condition to relays or devices

connected to the control unit. The fire alarm control unit can be a local fire alarm control unit or master control unit.

[New paragraph]

Fire Alarm/Evacuation Signal Tone Generator. A device that, upon command, produces a fire alarm/evacuation tone.

[From NFPA 72 - 1990 modified]

Fire Alarm Signal. A signal initiated by a fire alarm initiating device such as a manual fire alarm box, automatic fire detector, waterflow switch, or other device whose activation is indicative of the presence of a fire or fire signature.

Fire Alarm System. A system or portion of a combination system consisting of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal initiating devices and to initiate appropriate response to those signals.

[New paragraphs]

Fire Command Center. The principal manned or unmanned location where the status of the detection, alarm communications, and control systems is displayed and from which the system(s) can be manually controlled.

[From NFPA 72 - 1990 modified]

Fire Rating. The classification indicating in time (hours) the ability of a structure or component to withstand fire conditions.

Fire Safety Function Control Device. The fire alarm system component that directly interfaces with the control system that controls the fire safety function.

Fire Safety Functions. Building and fire control functions that are intended to increase the level of life safety for occupants or to control the spread of harmful effects of fire.

[New paragraphs]

Fire Warden. Building staff or tenant trained to perform assigned duties in the event of a fire emergency.

[From NFPA 72 - 1990]

Guard Signal. A supervisory signal monitoring the performance of guard patrols.

Guard's Tour Supervision. Devices that are manually or automatically initiated to indicate the route being followed and the timing of a guard's tour.

[New paragraphs]

Household. The family living unit in single-family detached dwellings, single-family attached dwellings, multifamily buildings, and mobile homes.

[From NFPA 74]

Household Fire Alarm System. A system of devices that produces an alarm signal in the household for the purpose of notifying the occupants of the presence of a fire so they may evacuate the premises.

[From NFPA 74 modified]

Hunt Group. A group of associated telephone lines within which an incoming call is automatically routed to an idle (not busy) telephone line for completion.

[From NFPA 72 - 1990 and NFPA 71]

Initiating Device. A system component that originates transmission of a change of state condition, such as a smoke detector, manual fire alarm box, supervisory switch, etc.

Initiating Device Circuit. A circuit to which automatic or manual initiating devices are connected where the signal received does not identify the individual device operated.

[From NFPA 72 - 1990]

Integrated System. A computer-based control system, listed for use as a fire alarm system, in which certain components are common to nonfire monitoring and control functions.

[New paragraph]

Intermediate Fire Alarm or Fire Supervisory Control Unit. A control unit used to provide area fire alarm or area fire supervisory service that, when connected to the proprietary fire alarm system, becomes a part of that system.

[From NFPA 72 - 1990 modified]

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.

[From NFPA 71, NFPA 72 - 1990, NFPA 72G, NFPA 74, and NFPA 1221]

Leg Facility. That portion of a communication channel that connects not more than one protected premises to a primary or secondary trunk facility. The leg facility includes the portion of the signal transmission circuit from its point of connection with a trunk facility to the point where it is terminated within the protected premises at one or more transponders.

[From NFPA 71 and NFPA 72 - 1990 modified]

Level Ceilings. Those ceilings that are actually level or have a slope of 1½ in. or less per ft (41.7 mm per m).

[From NFPA 72E - 1990, 2-3.1.1]

Line-Type Detector. A device in which detection is continuous along a path. Typical examples are rate-of-rise pneumatic tubing detectors, projected beam smoke detectors, and heat-sensitive cable.

[From NFPA 72E - 1990, 2-2.2.1]

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.

[From NFPA 71, NFPA 72 - 1990, NFPA 72G, NFPA 74, and NFPA 1221]

Loading Capacity. The maximum number of discrete elements of fire alarm systems permitted to be used in a particular configuration.

Local Control Unit (Panel). A control unit that serves the protected premises or a portion of the protected premises and indicates the alarm via notification appliances inside the protected premises.

[New paragraphs]

Local Fire Alarm System. A local system sounding an alarm at the protected premises as the result of the manual operation of a fire alarm box or the operation of protection equipment or systems, such as water flowing in a sprinkler system, the discharge of carbon dioxide, the detection of smoke, or the detection of heat.

[From NFPA 72 - 1990 modified]

Local Supervisory System. A local system arranged to supervise the performance of guard's tours, or the operative condition of automatic sprinkler systems or other systems for the protection of life and property against a fire hazard.

[From NFPA 72 - 1990]

Local System. A system that produces a signal at the premises protected.

Loss of Power. The reduction of available voltage at the load below the point at which equipment will function as designed.

[From NFPA 71]

Low Power Radio Transmitter. Any device that communicates with associated control/receiving equipment by some kind of low power radio signals.

[From NFPA 72 - 1990 modified]

Maintenance. Repair service, including periodically recurrent inspections and tests, required to keep the fire alarm system and its component parts in an operative condition at all times, together with replacement of the system or of its components, when for any reason they become undependable or inoperable.

[From NFPA 71 and NFPA 72 - 1990]

Manual Fire Alarm Box. A manually operated device used to initiate an alarm signal.

[New paragraph]

Master Box. A municipal fire alarm box that may also be operated by remote means.

[From NFPA 72 - 1990]

Master Control Unit (Panel). A control unit that serves the protected premises or portion of the protected premises as a local control unit and accepts inputs from other fire alarm control units.

[New paragraph]

Multiple Station Alarm Device. Two or more single-station alarm devices that may be interconnected so that actuation of one causes all integral or separate audible alarms to operate. It may also consist of one single-station alarm device having connections for other detectors or manual fire alarm box.

[From NFPA 74 modified]

Multiplexing. A signaling method characterized by simultaneous or sequential transmission, or both, and reception of multiple signals on a signaling line circuit or a communication channel including means for positively identifying each signal.

[From NFPA 71 modified]

Municipal Fire Alarm Box (Street Box). An enclosure housing a manually operated transmitter used to send an alarm to the public fire service communication center.

[From NFPA 72 - 1990 modified]

Municipal Fire Alarm System. A system of alarm initiating devices, receiving equipment, and connecting circuits (other than a public telephone network) used to transmit alarms from street locations to the public fire service communication center.

[From NFPA 1221 modified]

Municipal Transmitter. A transmitter that can only be tripped remotely, used to send an alarm to the public fire service communication center.

[From NFPA 72 - 1990 modified]

Nonrestorable Initiating Device. A device whose sensing element is designed to be destroyed in the process of operation.

[From NFPA 72E - 1990, 2-2.3.1]

Notification Appliance. A fire alarm system component such as a bell, horn, speaker, strobe, printer, etc., that provides an audible or visible output, or both.

[New paragraph]

Notification Appliance Circuit. A circuit or path directly connected to a notification appliance(s).

[From NFPA 71, NFPA 72 - 1990, and NFPA 72H modified]

Off-Hook. To make connection with the public switched telephone network in preparation to dial a telephone number.

On-Hook. To disconnect from the public switched telephone network.

[From NFPA 72 - 1990 and NFPA 71]

Ownership. Any property, building, contents, etc., under legal control by occupant, by contract, or by holding of title or deed.

[New paragraph]

Paging System. A system intended to page one or more persons such as by means of voice over loudspeaker, by means of coded audible signals or visible signals, or by means of lamp annunciators.

[From NFPA 72 - 1990 modified]

Parallel Telephone System. A telephone system in which an individually wired circuit is used for each fire alarm box.

[From NFPA 72 - 1990 and NFPA 1221 modified]

Permanent Visual Record (Recording). Immediately readable, not easily alterable, print, slash, punch, etc., listing all occurrences of status change.

[From NFPA 72 - 1990]

Plant. One or more buildings under the same ownership or control on a single property.

[From NFPA 71]

Positive Alarm Sequence. An automatic sequence that results in an alarm signal, even if manually delayed for investigation, unless the system is reset.

Power Supply. A source of electrical operating power including the circuits and terminations connecting it to the dependent system components.

Primary Battery (Dry Cell). A nonrechargeable battery requiring periodic replacement.

[New paragraphs]

Primary Trunk Facility. That part of a transmission channel connecting all leg facilities to a supervising or subsidiary station.

[From NFPA 71, 1-3 modified]

Prime Contractor. The one company contractually responsible for providing central station services to a subscriber as required by this code. This may be either a listed central station or a listed fire alarm service - local company.

[New paragraph - TIA 304 revised, SC 90-44]

Private Radio Signaling. A radio system under control of the proprietary supervising station.

Proprietary Fire Alarm System. An installation of fire alarm systems that serve contiguous and noncontiguous properties under one ownership from a proprietary supervising station located at the protected property, where trained, competent personnel are in constant attendance. This includes the proprietary supervising station; power supplies; signal initiating devices; initiating device circuits; signal notification appliances; equipment for the automatic, permanent visual recording of signals; and equipment for initiating the operation of emergency building control services.

[From NFPA 72 - 1990 modified]

Proprietary Supervising Station. A location to which alarm or supervisory signaling devices on proprietary fire alarm systems are connected and where personnel are in attendance at all times to supervise operation and investigate signals.

Protected Premises. The physical location protected by a fire alarm system.

[New paragraphs]

Public Fire Service Communication Center. The building or portion of the building used to house the central operating part of the fire alarm system; usually the place where the necessary testing, switching, receiving, transmitting, and power supply devices are located.

[From NFPA 72 - 1990]

Public Switched Telephone Network. An assembly of communications facilities and central office equipment operated jointly by authorized common carriers that provides the general public with the ability to establish communications channels via discrete dialing codes.

[From NFPA 71]

Radio Alarm Central Station Receiver (RACSR). A system component that receives data and annunciates that data at the central station.

[From NFPA 71 modified]

Radio Alarm Satellite Station Receiver (RASSR). A system component that receives radio signals. This component is resident at a satellite station, located at a remote receiving location.

Radio Alarm System (RAS). A system in which signals are transmitted from a radio alarm transmitter (RAT) located at a protected premises through a radio channel to two or more radio alarm satellite station receivers (RASSR), and that are annunciated by a radio alarm central station receiver (RACSR) located at the central station.

Radio Alarm Transmitter (RAT). A system component at the protected premises to which initiating devices or groups of devices are connected. The RAT transmits signals indicating a status change of the initiating devices.

[From NFPA 71]

Radio Channel. A band of frequencies of a width sufficient to permit its use for radio communications.

NOTE: The width of the channel depends on the type of transmissions and the tolerance for the frequency of emission. Normally allocated for radio transmission in a specified type for service by a specified transmitter.

[From NFPA 1221, 1-3]

Record Drawings. Drawings (as-built) that document the location of all devices, appliances, wiring sequences, wiring methods, and connections of the components of the fire alarm system as installed.

[From NFPA 72H modified]

Relocation. The movement of occupants from a fire zone to a safe area within the same building.

Remote Station Fire Alarm System. A system installed in accordance with this code to transmit alarm, supervisory, and trouble signals from one or more protected premises to a remote location at which appropriate action is taken.

[From NFPA 72 - 1990]

Repeater Facility. Equipment needed to relay signals between supervisory stations, subsidiary stations, and protected premises.

[From NFPA 72 - 1990 modified]

Repeater Station. The location of the equipment needed for a repeater facility.

[From NFPA 71 modified]

Restorable Initiating Device. A device whose sensing element is not ordinarily destroyed in the process of operation. Restoration may be manual or automatic.

[From NFPA 72E - 1990, 2-2.3.2]

Runner. A person other than the required number of operators on duty at central, supervising, or runner stations (or otherwise in contact with these stations) available for prompt dispatching, when necessary, to the protected premises.

Runner Service. The service provided by a runner at the protected premises, including resetting and silencing of all equipment transmitting fire alarm or supervisory signals to the off-premise location.

[New paragraphs]

Satellite Trunk. A circuit or path connecting a satellite to its central or proprietary supervising station.

[From NFPA 72 - 1990 modified]

Scanner. Equipment located at the telephone company wire center that monitors each local leg and relays status changes to the alarm center. Processors and associated equipment may also be included.

[From NFPA 71]

Secondary Trunk Facility. That part of a transmission channel connecting two or more, but less than all, leg facilities to a primary trunk facility.

[From NFPA 71, 1-3]

Separate Sleeping Area. The area or areas of the family living unit in which the bedrooms (or sleeping rooms) are located. For the purpose of this code, bedrooms (or sleeping rooms) separated by other use areas, such as kitchens or living rooms (but not bathrooms), shall be considered as separate sleeping areas.

[From NFPA 74 modified]

Shall. Indicates a mandatory requirement.

[From NFPA 72 - 1990, NFPA 71, NFPA 74, and NFPA 1221]

Shapes of Ceilings. The shapes of ceilings are classified as follows:

[From NFPA 72E - 1990, 2-3 and 2-3.1]

Sloping Ceilings. Those having a slope of more than 1 1/2 in. per ft (41.7 mm per m). Sloping ceilings are further classified as follows:

(a) *Sloping-Peaked Type.* Those in which the ceiling slopes in two directions from the highest point. Curved or domed ceilings may be considered peaked with the slope figured as the slope of the chord from highest to lowest point. (See Figure A-5-2.7.4.1.)

(b) *Sloping-Shed Type.* Those in which the high point is at one side with the slope extending toward the opposite side. (See Figure A-5-2.7.4.2.)

[From NFPA 72E - 1990, 2-3.1.2]

Smooth Ceiling. A surface uninterrupted by continuous projections, such as solid joists, beams, or ducts, extending more than 4 in. (100 mm) below the ceiling surface.

NOTE: Open truss constructions are not considered to impede the flow of fire products unless the upper member in continuous contact with the ceiling projects below the ceiling more than 4 in. (100 mm).

[From NFPA 72E - 1990, 2-4.1.4]

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

[From NFPA 72 - 1990, NFPA 72G, NFPA 72H, NFPA 71, NFPA 74, and NFPA 1221]

Signal. A status indication communicated by electrical or other means.

[New paragraph]

Signal Transmission Sequence. A DACT that obtains dial tone, dials the number(s) of the DACR, obtains verification that the DACR is ready to receive signals, transmits the signals, and receives acknowledgment that the DACR has accepted that signal before disconnecting (going on-hook).

[From NFPA 71]

Signaling Line Circuit. A circuit or path between any combination of circuit interfaces, control units, or transmitters over which multiple system input signals or output signals, or both, are carried.

[From NFPA 72 - 1990, NFPA 71, and NFPA 72H modified]

Signaling Line Circuit Interface. A system component that connects a signaling line circuit to any combination of initiating devices, initiating device circuits, notification appliances, notification appliance circuits, system control outputs, and other signaling line circuits.

[From NFPA 72 - 1990 and NFPA 72H modified]

Single Station Alarm Device. An assembly incorporating the detector, control equipment, and the alarm-sounding device in one unit operated from a power supply either in the unit or obtained at the point of installation.

[From NFPA 74]

Solid Joist Construction. Ceilings having solid structural or solid nonstructural members projecting down from the ceiling surface a distance of more than 4 in. (100 mm) and spaced at intervals 3 ft (0.9 m) or less, center to center.

[From NFPA 72E - 1990, 2-4.1.3]

Spacing. A horizontally measured dimension relating to the allowable coverage of fire detectors.

[From NFPA 72E]

Spot-Type Detector. A device whose detecting element is concentrated at a particular location. Typical examples are bimetallic detectors, fusible alloy detectors, certain pneumatic rate-of-rise detectors, certain smoke detectors, and thermoelectric detectors.

[From NFPA 72E - 1990, 2-2.2.2]

Story. The portion of a building included between the upper surface of a floor and upper surface of the floor or roof next above.

[From NFPA 74]

Subscriber. The recipient of contractual supervising station signal service(s). In case of multiple, noncontiguous properties having single ownership, the term "subscriber" refers to each protected premises or its local management.

[From NFPA 71, 1-3 modified]

Subsidiary Station. A subsidiary station is a normally unattended location, remote from the supervising station and linked by communication channel(s) to the supervising station. Interconnection of signal-receiving equipment or communication channel(s) from protected buildings with channel(s) to the supervising station is accomplished at this location.

[From NFPA 71 and NFPA 72 - 1990 modified]

Supervising Station. A facility that receives signals and where personnel are in attendance at all times to respond to these signals.

[New paragraph]

Supervisory Service. The service required to monitor performance of guard tours and the operative condition of fixed suppression systems or other systems for the protection of life and property.

Supervisory Signal. A signal indicating the need of action in connection with the supervision of guard tours, fire suppression systems or equipment, or with the maintenance features of related systems.

[From NFPA 71 and NFPA 72 - 1990 modified]

Supplementary. As used in this code, supplementary refers to equipment or operations not required by this code and designated as such by the authority having jurisdiction.

[From NFPA 71 and NFPA 72 - 1990]

Switched Telephone Network. An assembly of communications facilities and central office equipment operated jointly by authorized service providers, which provide the general public with the ability to establish transmission channels via discrete dialing.

[From NFPA 71, 1-3 modified]

System Unit. The active subassemblies at the central station utilized for signal receiving, processing, display, or recording of status change signals; a failure of one of these subassemblies would cause the loss of a number of alarm signals by that unit.

[From NFPA 71]

Transmission Channel. A circuit or path connecting transmitters to supervising stations or subsidiary stations on which signals are carried.

[New paragraph]

Transmitter. A system component that provides an interface between signaling line circuits, initiating device circuits, or control units and the transmission channel.

[From NFPA 71 modified]

Transponder. A multiplex alarm transmission system functional assembly located at the protected premises.

[From NFPA 71]

Trouble Signal. A signal initiated by the fire alarm system, indicative of a fault in a monitored circuit or component.

[From NFPA 71, NFPA 72 - 1990, NFPA 74, and NFPA 1221 modified]

Trunk Facility. That part of a transmission channel connecting two or more leg facilities to the central supervising station or subsidiary station.

[From NFPA 72 - 1990 modified]

Trunk Primary Facility. That part of a transmission channel connecting all leg facilities to a central or proprietary supervising station or subsidiary station.

Trunk Secondary Facility. That part of a transmission channel connecting two or more, but less than all, leg facilities to a primary trunk facility.

[From NFPA 71 modified]

WATS (Wide Area Telephone Service). Telephone company service allowing reduced costs for certain telephone call arrangements; may be in-WATS or 800-number service where calls can be placed from anywhere in the continental U.S. to the called party at no cost to the calling party, or out-WATS, a service whereby, for a flat-rate charge, dependent on the total duration of all such calls, a subscriber may make an unlimited number of calls within a prescribed area from a particular telephone terminal without the registration of individual call charges.

[From NFPA 71]

Zone. A defined area within the protected premises. A zone may define an area from which a signal can be received, an area to which a signal can be sent, or an area in which a form of control can be executed.

[From NFPA 72 - 1990]

1-5 Fundamentals.

1-5.1 Common System Fundamentals. The provisions of this chapter shall apply to Chapters 3 through 7.

1-5.1.1 The provisions of this chapter cover the basic functions of a complete fire alarm system. These systems are primarily intended to provide notification of fire alarm, supervisory, and trouble conditions, alert the occupants, summon appropriate aid, and control fire safety functions.

1-5.1.2 Equipment. Equipment constructed and installed in conformity with this code shall be listed for the purpose for which it is used.

[New paragraphs]

1-5.2 Power Supplies.

1-5.2.1 Scope. The provisions of this section apply to power supplies used for fire alarm systems.

[From NFPA 72 - 1990, 5-1, and NFPA 71, 2-2.1.1 modified]

1-5.2.2 Code Conformance. All power supplies shall be installed in conformity with the requirements of NFPA 70, *National Electrical Code*, for such equipment, and with the requirements indicated in this section.

[From NFPA 72 - 1990, 5-2; NFPA 71, 2-2.1.3 modified; and NFPA 1221, 4-1.5.1.1 modified]

1-5.2.3 Power Sources. Fire alarm systems shall be provided with at least two independent and reliable power supplies, one primary and one secondary (standby), each of which shall be of adequate capacity for the application.

[New paragraph]

Exception No. 1: Where the primary power is supplied by a dedicated branch circuit of an emergency system in accordance with NFPA 70, National Electrical Code, Article 700, or a legally required standby system in accordance with NFPA 70, National Electrical Code, Article 701, a secondary supply is not required.

Exception No. 2: Where the primary power is supplied by a dedicated branch circuit of an optional standby system in accordance with NFPA 70, National Electrical Code, Article 702, which also meets the performance requirements of Article 700 or Article 701, a secondary supply is not required.

NOTE to Exceptions No. 1 and No. 2: A trouble signal is not required where operating power is being supplied by either of the two sources of power indicated in Exceptions No. 1 and No. 2 above, if they are capable of providing the hours of operation required by 1-5.2.5 and loss of primary power is otherwise indicated (e.g., by loss of building lighting).

[From NFPA 72 - 1990, 5-3, 5-3.1; NFPA 71, 2-2.1.1, par. 2 modified; and NFPA 1221, 4-1.5.2 modified]

Where dc voltages are employed they shall be limited to no more than 350 volts above earth ground.

[From NFPA 71, 2-2.1.1 par. 3]

1-5.2.4 Primary Supply. The primary supply shall have a high degree of reliability, shall have adequate capacity for the intended service, and shall consist of one of the following:

(a) Light and power service arranged in accordance with 1-5.2.8,

(b) Engine-driven generator or equivalent arranged in accordance with 1-5.2.10.

[From NFPA 72 - 1990, 5-3.2; NFPA 71, 2-2.1.4 modified; and NFPA 1221, 4-1.5.2(a) modified]

1-5.2.5 Secondary Supply Capacity and Sources. The secondary supply shall automatically supply the energy to the system within 30 seconds and without loss of signals, wherever the primary supply is incapable of providing the minimum voltage required for proper operation. The secondary (standby) power supply shall supply energy to the system in the event of total failure of the primary (main) power supply or when the primary voltage drops to a level insufficient to maintain functionality of the control equipment and system components. Under maximum normal load, the secondary supply shall have sufficient capacity to operate a local, central station or proprietary system for 24 hours, or an auxiliary or remote station system for 60 hours; and then, at the end of that period, operate all

alarm notification appliances used for evacuation or to direct aid to the location of an emergency for 5 minutes. The secondary power supply for emergency voice/alarm communications service shall be capable of operating the system under maximum normal load for 24 hours and then be capable of operating the system during a fire or other emergency condition for a period of 2 hours. Fifteen minutes of evacuation alarm operation at maximum connected load shall be considered the equivalent of 2 hours of emergency operation.

The secondary supply shall consist of one of the following:

(a) A storage battery arranged in accordance with 1-5.2.9.

(b) An automatic starting engine-driven generator arranged in accordance with 1-5.2.10 and storage batteries with 4 hours capacity arranged in accordance with 1-5.2.9.

(c) Multiple engine-driven generators, one of which is arranged for automatic starting, arranged in accordance with 1-5.2.10, capable of supplying the energy required herein with the largest generator out of service. It shall be permitted for the second generator to be pushbutton start.

Operation on secondary power shall not affect the required performance of a fire alarm system. The system shall produce the same alarm, supervisory, and trouble signals and indications (excluding the ac power indicator) when operating from the standby power source as produced when the unit is operating from the primary power source.

[From NFPA 72 - 1990, 5-3.3; NFPA 71, 2-2.1.5 modified, 2-2.2 modified; and NFPA 1221, 4-1.5.2(c) modified]

1-5.2.6 Continuity of Power Supplies.

(a) Where signals could be lost on transfer of power between the primary and secondary sources, rechargeable batteries of sufficient capacity to operate the system under maximum normal load for 15 minutes shall assume the load in such a manner that no signals are lost if either of the following conditions exists:

1. Secondary power is supplied in accordance with 1-5.2.5(a) or 1-5.2.5(b), and the transfer is made manually; or

2. Secondary power is supplied in accordance with 1-5.2.5(c).

(b) Where signals will not be lost due to transfer of power between the primary and secondary sources, one of the following arrangements shall be made:

1. The transfer shall be automatic.

2. Special provisions shall be made to allow manual transfer within 30 seconds of loss of power.

3. The transfer shall be arranged in accordance with 1-5.2.5(a).

(c)* Where a computer system of any kind or size is used to receive or process signals, an uninterruptible power supply (UPS) with sufficient capacity to operate the system for at least 15 minutes, or until the secondary sup-

ply is capable of supplying the UPS input power requirements, shall be required if either of the following conditions apply:

1. Status of signals previously received will be lost upon loss of power.
2. The computer system cannot be restored to full operation within 30 seconds of loss of power.

[From NFPA 71, 2-2.1.6]

1-5.2.6.1* Uninterruptible Power System Bypass. A positive means for disconnecting the input and output of the UPS system while maintaining continuity of power supply to the load shall be provided.

[From NFPA 71, 2-2.1.8]

1-5.2.7 Power Supply for Remotely Located Control Equipment. Additional power supplies, where provided for control units, circuit interfaces, or other equipment essential to system operation, located remote from the main control unit, shall be comprised of a primary and secondary power supply that shall meet the same requirements as for 1-5.2.1 through 1-5.2.8

[From NFPA 72 - 1990, 5-3.5]

1-5.2.7.1 Power supervisory devices shall be arranged so as not to impair the receipt of fire alarm or supervisory signals.

[New paragraph]

1-5.2.8 Light and Power Service.

[From NFPA 72 - 1990, 5-4, and NFPA 71, 2-2.4 modified]

1-5.2.8.1 A light and power service employed to operate the system under normal conditions shall have a high degree of reliability and capacity for the intended service. This service shall consist of one of the following:

(a) *Two-Wire Supplies.* A two-wire supply circuit may be used for either the primary operating power supply or the trouble signal power supply of the signaling system.

(b) *Three-Wire Supplies.* A three-wire ac or dc supply circuit having a continuous unfused neutral conductor, or a polyphase ac supply circuit having a continuous unfused neutral conductor where interruption of one phase does not prevent operation of the other phase, may be used with one side or phase for the primary operating power supply and the other side or phase for the trouble signal power supply of the fire alarm system.

[From NFPA 72 - 1990, 5-4.1]

1-5.2.8.2 Connections to the light and power service shall be on a dedicated branch circuit. The circuit and connections shall be mechanically protected. The circuit disconnecting means shall have a red marking, be accessible only to authorized personnel, and be identified as "FIRE ALARM CIRCUIT CONTROL." The location of the circuit disconnecting means shall be permanently identified at the fire alarm control unit.

[From NFPA 71, 2-2.4.1 modified; NFPA 72 - 1990, 5-4.2 modified; and NFPA 1221, 4-1.5.1.2, 4-1.5.1.4 modified]

1-5.2.8.3 Overcurrent Protection. An overcurrent protective device of suitable current-carrying capacity and capable of interrupting the maximum short-circuit current to which it may be subject shall be provided in each ungrounded conductor. The overcurrent protective device shall be enclosed in a locked or sealed cabinet located immediately adjacent to the point of connection to the light and power conductors.

[From NFPA 71, 2-2.4.2]

1-5.2.8.4 Circuit breakers or engine stops shall not be installed in such a manner as to cut off the power for lighting or for operating elevators.

[From NFPA 72 - 1990, 5-4.3]

1-5.2.9* Storage Batteries.

[From NFPA 72 - 1990, 5-5]

1-5.2.9.1 Location. Storage batteries shall be so located that the fire alarm equipment, including overcurrent devices, are not adversely affected by battery gases and shall conform to the requirements of NFPA 70, *National Electrical Code*, Article 480. Cells shall be suitably insulated against grounds and crosses and shall be substantially mounted in such a manner as not to be subject to mechanical injury. Racks shall be suitably protected against deterioration.

[From NFPA 71, 2-2.3.1, 2-2.3.2 modified, 2-2.3.3; NFPA 72 - 1990, 5-5.2; and NFPA 1221, 4-1.5.6.1 modified, 4-1.5.6.3, 4-1.5.6.2]

1-5.2.9.2 Battery Charging.

(a) Adequate facilities shall be provided to automatically maintain the battery fully charged under all conditions of normal operation and, in addition, to recharge batteries within 48 hours after fully charged batteries have been subject to a single discharge cycle as specified in 1-5.2.5. Upon attaining a fully charged condition, the charge rate shall not be so excessive as to result in battery damage.

(b) A reliable source of power shall be provided for charging the batteries.

(c) Central stations shall maintain spare parts or units available and employed to restore failed charging capacity prior to the consumption of one-half of the capacity of the batteries for the central station equipment.

(d)* Batteries shall be either trickle or float charged.

(e) A rectifier employed as a battery charging source of supply shall be of adequate capacity. A rectifier employed as a charging means shall be energized by an isolating transformer.

[From NFPA 71, 2-2.3.4, and NFPA 72 - 1990, 5-5.1]

1-5.2.9.3 Overcurrent Protection. The batteries shall be protected against excessive load current by overcurrent devices having a rating not less than 150 percent and not more than 250 percent of the maximum operating load in the alarm condition. The batteries shall be protected from excessive charging current by overcurrent devices or by automatic current-limiting design of the charging source.

[From NFPA 71, 2-2.3.5, and NFPA 72 - 1990, 5-5.4 modified]

1-5.2.9.4 Metering. The charging equipment shall provide either integral meters or readily accessible terminal facilities for the connection of portable meters by which the battery voltage and charging current can be determined.

1-5.2.9.5 Under-Voltage Detection. An under-voltage detection device shall be provided to detect a failure of the charging source and initiate a trouble signal.

[From NFPA 71, 2-2.3.6, and NFPA 72 - 1990, 5-5.3 modified]

1-5.2.10 Engine-Driven Generator.

[From NFPA 71, 2-2.6 modified; NFPA 72 - 1990, 5-6; and NFPA 1221, 4-1.5.5 modified]

1-5.2.10.1 An engine-driven generator shall be used only where a person specifically trained in its operation is on duty at all times.

Exception: Where acceptable to the authority having jurisdiction and where the requirements of 1-5.2.5(b) and (c) are met, a person specifically trained in the operation of a generator dedicated to the fire alarm system shall not be required to be on duty at all times.

[From NFPA 71, 2-2.6.1 without Exception, and NFPA 72 - 1990, 5-6.1]

1-5.2.10.2 The installation of such units shall conform to the provisions of NFPA 110, *Standard for Emergency and Standby Power Systems*, except as restricted by the provisions of this section.

[From NFPA 71, 2-2.6.2; NFPA 72 - 1990, 5-6.2 modified; and NFPA 1221, 4-1.5.5.2 modified]

1-5.2.10.3 Capacity. The unit shall be of a capacity sufficient to operate the system under the maximum normal load conditions in addition to all other demands placed upon the unit, such as those of emergency lighting.

[From NFPA 71, 2-2.6.4, and NFPA 1221, 4-1.5.5.6 modified]

1-5.2.10.4 Fuel. Fuel shall be stored in outside underground tanks whenever possible, and gravity feed shall not be used. Gasoline deteriorates with age. Where gasoline-driven generators are used, fuel shall be supplied from a frequently replenished "working" tank, or other means provided, to ensure that gasoline will always be fresh.

[From NFPA 71, 2-2.6.3; NFPA 72 - 1990, 5-6.3; and NFPA 1221, 4-1.5.5.4 modified]

1-5.2.10.5 Sufficient fuel shall be available in storage for 6 months of testing plus the capacity specified in 1-5.2.5. For public fire alarm reporting systems, refer to 4-6.7.3.4.

Exception No. 1: If a reliable source of supply is available at any time on 2-hour notice, sufficient fuel shall be in storage for 12 hours of operation at full load.

Exception No. 2: Fuel systems using natural or manufactured gas supplied through reliable utility mains shall not be required to have fuel storage tanks unless located in seismic risk zone 3 or greater as defined in ANSI A-58.1, *Building Code Requirements for Minimum Design Loads in Buildings and Other Structures*.

[From NFPA 72 - 1990, 5-6.4, and NFPA 1221, 4-1.5.5.4, 4-1.5.5.5 modified]

1-5.2.10.6 A separate storage battery and separate automatic charger shall be provided for starting the engine-driven generator and shall not be used for any other purpose.

[From NFPA 71, 2-2.6.5; NFPA 72 - 1990, 5-6.5; and NFPA 1221, 4-1.5.5.7 modified]

1-5.2.11* Primary Batteries.

1-5.2.11.1 Location. Primary batteries shall be located in a clean, dry place accessible for servicing and where the ambient air temperature will not be less than 40°F (4.4°C) and not more than 100°F (37.8°C).

[From NFPA 71, 2-2.5.1]

1-5.2.11.2 Separation of Cells. Primary batteries shall be housed in a locked, substantial enclosure or otherwise suitably protected against movement, injury, and moisture. Reliable separation between cells shall be provided to prevent contact between terminals of adjacent cells and between battery terminals and other metal parts, which may result in depletion of the battery or other deterioration. Battery cells having containers constructed of other than suitable electrical insulating material shall be located on insulating supports.

[From NFPA 71, 2-2.5.2]

1-5.2.11.3 Capacity. A primary battery shall have sufficient capacity to supply 125 percent of the maximum normal load for not less than one year.

[From NFPA 71, 2-2.5.4]

1-5.3 Compatibility.

1-5.3.1 All initiating devices, notification appliances, and control equipment constructed and installed in conformity with this code shall be listed for the purpose for which they are intended.

[From NFPA 71, 1-4.2 modified; NFPA 72, 2-1.2 modified; NFPA 72E, 2-5.1 modified; and NFPA 1221, 4-1.1.2, 4-1.3.1]

1-5.3.2 All fire detection devices that receive their power from the initiating device circuit or signaling line circuit of a fire alarm control unit shall be listed for use with the control unit.

[From NFPA 72E, 2-5.1.1 modified]

1-5.4 System Functions.

[New title]

1-5.4.1 Local Fire Safety Functions. Fire safety functions shall be permitted to be performed automatically. The performance of automatic fire safety functions shall not interfere with power for lighting or for operating elevators. This does not preclude the combination of fire alarm services with other services requiring monitoring of operations.

[From NFPA 72, 3-7.1 modified]

1-5.4.2 Alarm Signals.

[From NFPA 71, 6-2.1.2 modified, and NFPA 72, 2-4.3]

1-5.4.2.1* Coded Alarm Signal. A coded alarm signal shall consist of not less than three complete rounds of the

number transmitted, and each round shall consist of not less than three impulses.

[From NFPA 71, 6-2.1.1 modified, and NFPA 72, 2-4.3]

1-5.4.3 Supervisory Signals.

1-5.4.3.1 Coded Supervisory Signal. A coded supervisory signal shall be permitted to consist of two rounds of the number transmitted to indicate a supervisory off-normal condition, and one round of the number transmitted to indicate the restoration of the supervisory condition to normal.

[From NFPA 72 - 1990, 2-4.4]

1-5.4.3.2 Combined Coded Alarm and Supervisory Signal Circuits. Where both coded sprinkler supervisory signals and coded fire or waterflow alarm signals are transmitted over the same signaling line circuit, provision shall be made either to obtain alarm signal precedence or sufficient repetition of the alarm signal to prevent the loss of an alarm signal.

[From NFPA 72 - 1990, 2-4.5]

1-5.4.4 Fire alarms, supervisory signals, and trouble signals shall be distinctively and descriptively annunciated.

[From NFPA 72 - 1990, 2-4.6.2]

1-5.4.5 Where status indicators are required to be provided for emergency equipment or fire safety functions, they shall be arranged to reflect accurately the actual status of the associated equipment or function.

[From NFPA 72 - 1990, 2-4.6.3]

1-5.4.6 Trouble Signal.

[From NFPA 71, 2-4.2, and NFPA 72 - 1990, 2-4.7]

1-5.4.6.1 General. Trouble signals and their restoration to normal shall be indicated within 200 seconds at the locations identified in 1-5.4.6.2 or 1-5.4.6.3. Trouble signals required to indicate at the protected premises shall be indicated by distinctive audible signals. These audible trouble signals shall be distinctive from alarm signals. If an intermittent signal is used, it shall sound at least once every 10 seconds with a minimum time duration of one-half second. An audible trouble signal may be common to several supervised circuits. The trouble signal(s) shall be located in an area where it is likely to be heard.

1-5.4.6.2 Visible and audible trouble signals and visible indication of their restoration to normal shall be indicated at the following locations:

(a) Control unit (central equipment) for local fire alarm systems

(b) Building fire command center for emergency voice/alarm communication systems

(c) Central station or remote station location for systems installed in compliance with Chapter 4.

[From NFPA 71, 2-4.2.1 modified, and NFPA 72, 2-4.7.1 modified]

1-5.4.6.3 Trouble signals and their restoration to normal shall be visibly and audibly indicated at the proprietary supervising station for systems installed in compliance with Chapter 4.

[From NFPA 72 - 1990, 9-8.3.3]

1-5.4.6.4 Audible Trouble Signal Silencing Switch.

[From NFPA 72 - 1990, 2-4.7.2]

1-5.4.6.4.1 A switch for silencing the trouble notification appliance(s) shall be permitted only if it transfers the trouble indication to a lamp or other acceptable visible indicator adjacent to the switch. The visible indication shall persist until the trouble has been corrected. The audible trouble signal shall sound if the switch is in its silence position and no trouble exists.

[From NFPA 72 - 1990, 2-4.7.2.1]

1-5.4.6.4.2 Where an audible trouble notification appliance is also used to indicate a supervisory condition, as permitted in 1-5.4.7(b), a trouble signal silencing switch shall not prevent subsequent sounding of supervisory signals.

[From NFPA 72 - 1990, 2-4.7.2.2]

1-5.4.7 Distinctive Signals. Audible alarm notification appliances for a fire alarm system shall produce signals that are distinctive from other similar appliances used for other purposes in the same area. The distinction among signals shall be as follows:

(a) Fire alarm signals shall be distinctive in sound from other signals and this sound shall not be used for any other purpose. (*See 3-7.2.*)

(b)* Supervisory signals shall be distinctive in sound from other signals. This sound shall not be used for any other purpose except that it may be employed to indicate a trouble condition. Where the same sound is used for both supervisory signals and trouble signals, distinction between signals shall be by other appropriate means such as visible annunciation.

(c) Fire alarm, supervisory, and trouble signals shall take precedence over all other signals.

[From NFPA 72 - 1990, 2-4.10 modified]

Exception: Signals from hold-up alarms or other life threatening signals shall be permitted to take precedence over supervisory and trouble signals if acceptable to the authority having jurisdiction.

[New paragraph]

1-5.4.8 Alarm Signal Deactivation. A means for turning off the alarm notification appliances shall be permitted only if it is key-operated, located within a locked cabinet, or arranged to provide equivalent protection against unauthorized use. Such a means shall be permitted only if a visible zone alarm indication or equivalent has been provided as specified in 1-5.7.1 and subsequent alarms on other initiating device circuits will cause the notification appliances to reactivate. A means that is left in the "off" position when there is no alarm shall operate an audible trouble signal until the means is restored to normal. Where automatically turning off the alarm notification appliances is permitted by the authority having jurisdiction, the alarm shall not be

turned off in less than 5 minutes unless otherwise permitted by the authority having jurisdiction.

[From NFPA 72A - 1990, 2-4.11 modified]

1-5.4.9 Supervisory Signal Silencing. A switch for silencing the supervisory signal sounding appliance(s) shall be permitted only if it is key-operated, located within a locked cabinet, or arranged to provide equivalent protection against unauthorized use. Such a switch shall be permitted only if it transfers the supervisory indication to a lamp or other visible indicator and subsequent supervisory signals from other zones will cause the supervisory signal indicating appliances to resound. A switch left in the "silence" position where there is no supervisory off-normal signal shall operate a visible signal silence indicator and cause the trouble signal to sound until the switch is restored to normal.

[From NFPA 72 - 1990, 2-4.12 modified]

1-5.4.10 Presignal Feature. Where permitted by the authority having jurisdiction, systems shall be permitted to have a feature where initial fire alarm signals will sound only in department offices, control rooms, fire brigade stations, or other constantly attended central locations and where human action is subsequently required to activate a general alarm, or a feature where the control equipment delays general alarm by more than one minute after the start of the alarm processing. Where there is a connection to a remote location, it shall activate upon initial alarm signal.

NOTE: A system provided with an alarm verification feature as permitted by 3-8.2.3 is not considered a presignal system since the delay in signal produced is 60 seconds or less and requires no human intervention.

[From NFPA 72 - 1990, 2-4.1]

1-5.5 Performance and Limitations.

[From NFPA 72 - 1990, 2-3]

1-5.5.1 Voltage, Temperature, and Humidity Variation. Unless otherwise listed, equipment shall be installed in locations where conditions do not exceed the following:

(a)* Eighty-five percent and at 110 percent of the nameplate primary (main) and secondary (standby) input voltage(s)

(b) Ambient temperatures of 32°F (0°C) and 120°F (49°C) for a minimum duration at each extreme of 3 hours

(c) Relative humidity of 85 percent $\pm$ 5 percent and an ambient temperature of 86°F $\pm$ 3°F (30°C $\pm$ 2°C) for a duration of at least 24 hours.

[From NFPA 72 - 1990, 2-3.1 modified, and NFPA 1221, 4-1.3.3 modified, 4-1.3.9]

1-5.5.2 Installation and Design.

[From NFPA 71, 1-5, and NFPA 72 - 1990, 2-1 modified]

1-5.5.2.1 All systems shall be installed in accordance with the specifications and standards approved by the authority having jurisdiction.

[From NFPA 71, 1-5.1, and NFPA 72 - 1990, 2-1.1 modified]

1-5.5.2.2 Devices and appliances shall be so located and mounted that accidental operation or failure will not be caused by vibration or jarring.

[From NFPA 71, 1-5.2, and NFPA 72, 2-1.3 modified]

1-5.5.2.3 All apparatus requiring rewinding or resetting to maintain normal operation shall be restored to normal as promptly as possible after each alarm and kept in normal condition for operation.

[From NFPA 71, 1-5.4 modified; NFPA 72, 2-5.6 modified; and NFPA 1221, 4-1.3.6 modified]

1-5.5.3 To reduce the possibility of damage by induced transients, circuits and equipment shall be properly protected in accordance with requirements as set forth in NFPA 70, *National Electrical Code*, Article 800.

[From NFPA 71, 1-5.5]

1-5.5.4* Wiring. The installation of all wiring, cable, and equipment shall be in accordance with NFPA 70, *National Electrical Code*, and specifically with Article 760, *Fire Protective Signaling Systems*; Article 770, *Optical Fiber Cables*; and Article 800, *Communication Circuits*, *National Electrical Code*, where applicable. Optical fiber cables shall be protected against mechanical injury in accordance with Article 760.

[From NFPA 71, 2-1; NFPA 72 - 1990, 2-1.4 modified; and NFPA 1221, 4-1.3.11, 4-1.4.1.7]

1-5.5.5 Grounding. All systems shall test free of grounds.

Exception: Parts of circuits or equipment that are intentionally and permanently grounded to provide ground-fault detection, noise suppression, emergency ground signaling, and circuit protection grounding.

[From NFPA 71, 1-5.3; NFPA 72 - 1990, 2-1.5; and NFPA 1221, 4-1.3.10]

1-5.5.6 Initiating Devices.

[From NFPA 72 - 1990, 2-3.2]

1-5.5.6.1 Initiating devices of both the manual or automatic type shall be selected and installed as to minimize false alarms.

[From NFPA 72 - 1990, 2-3.2.1 modified]

1-5.5.6.2 Fire alarm boxes of the manually operated type shall comply with 3-8.1.

[From NFPA 72 - 1990, 2-3.2.2]

1-5.6 Protection of Control Equipment. In areas that are not continuously occupied, automatic smoke detection shall be provided at each control unit(s) location to provide notification of fire at that location.

Exception: Should ambient conditions prohibit installation of automatic smoke detection, automatic heat detection shall be permitted.

[From NFPA 72 - 1990, 2-1.6 modified]

1-5.7 Visible Indication (Annunciation).

[New title]

1-5.7.1 Visible Zone Alarm Indication. Where required, the location of an operated initiating device shall be visibly indicated by building, floor, fire zone, or other approved subdivision by annunciation, printout, or other approved means. The visible indication shall not be canceled by the operation of an audible alarm silencing means.

[From NFPA 72 - 1990, 2-4.6 modified]

1-5.7.1.1 The primary purpose of fire alarm system annunciation is to enable responding personnel to quickly and accurately identify the location of a fire, and to indicate the status of emergency equipment or fire safety functions that might affect the safety of occupants in a fire situation. All required annunciation means shall be readily accessible to responding personnel and shall be located as required by the authority having jurisdiction to facilitate an efficient response to the fire situation.

[From NFPA 72 - 1990, 2-4.6.1 modified]

1-5.7.1.2 Zone of Origin. Fire alarm systems serving two or more zones shall identify the zone of origin of the alarm initiation by annunciation or coded signal.

[From NFPA 72, 2-4.2]

1-5.7.2 Alarm annunciation at the fire command center shall be by means of audible and visible indicators.

[From NFPA 101, 7-6.7.2 modified]

1-5.7.3 For the purpose of alarm annunciation, each floor of the building shall be considered as a separate zone.

[From NFPA 101, 7-6.7.3]

1-5.7.4 A system supervisory signal shall be annunciated at the fire command center by means of an audible and visible indicator.

[From NFPA 101, 7-6.7.6 modified]

1-5.7.5 A system trouble signal shall be annunciated at the fire command center by means of an audible and visible indicator.

[From NFPA 101, 7-6.7.5 modified]

1-5.7.6 Where the system serves more than one building, each building shall be indicated separately.

[From NFPA 101, 7-6.7.7 modified]

1-5.8 Monitoring Integrity of Installation Conductors and Other Signaling Channels.

[From NFPA 72 - 1990, 4-2, and NFPA 71, 2-4 modified]

1-5.8.1 All means of interconnecting equipment, devices, and appliances and wiring connections shall be monitored for the integrity of the interconnecting conductors or equivalent path so that the occurrence of a single open or a single ground fault condition in the installation conductors or other signaling channels and their restoration to normal shall be automatically indicated within 200 seconds.

NOTE: The provisions of a double loop or other multiple path conductor or circuit to avoid electrical monitoring is not acceptable.

[From NFPA 72 - 1990, 6-3, 4-2.1 modified, 4-3 modified; and NFPA 71, 2-4.1 modified]

Exception No. 1: Styles of initiating device circuits, signaling line circuits, and notification appliance circuits tabulated in Tables 3-5.1, 3-6.1, and 3-7.1 that do not have an "X" under "Trouble" for the abnormal condition indicated.

[From NFPA 72 - 1990, 4-2.1 Exception No. 1]

Exception No. 2: Shorts between conductors, except as required by 1-5.8.3, 1-5.8.4, 1-5.8.5.2, Tables 3-5.1, 3-6.1, and 3-7.1, are not covered by this code.

[From NFPA 72 - 1990, 4-2.1 Exception No. 2]

Exception No. 3: A noninterfering shunt circuit, provided that a fault circuit condition on the shunt circuit wiring results only in the loss of the noninterfering feature of operation.

[From NFPA 72 - 1990, 4-2.1 Exception No. 7]

Exception No. 4: Connections to and between supplementary system components, provided that single open, ground, or short circuit conditions of the supplementary equipment and/or interconnecting means does not affect the required operation of the fire alarm system.

[From NFPA 72 - 1990, 4-2.1 Exception No. 5]

Exception No. 5: The circuit of an alarm notification appliance installed in the same room with the central control equipment, provided that the notification appliance circuit conductors are installed in conduit or equivalently protected against mechanical injury.

[From NFPA 72 - 1990, 4-2.1 Exception No. 8]

Exception No. 6: A trouble signal circuit.

[From NFPA 72 - 1990, 4-2.1 Exception No. 9]

Exception No. 7: Interconnection between equipment within a common enclosure.

NOTE: This code does not have jurisdiction over monitoring integrity of conductors within equipment, devices, or appliances.

[From NFPA 71, 2-4.1 Exception No. 13, and NFPA 72-1990, 4-2.1 Exception No. 10]

Exception No. 8: Interconnection between enclosures containing control equipment located within 20 ft (6 m) when the conductors are installed in conduit or equivalently protected against mechanical injury.

[From NFPA 72 - 1990, 4-2.1 Exception No. 11]

Exception No. 9: Conductors for ground detection, where a single ground does not prevent the required normal operation of the system.

[From NFPA 72 - 1990, 4-2.1 Exception No. 12]

Exception No. 10: Central station circuits serving notification appliances within a central station.

[New paragraph]

Exception No. 11: Pneumatic rate-of-rise systems of the continuous line type in which the wiring terminals of such devices are connected in multiple across electrically supervised circuits.

[From NFPA 71, 2-4.1 Exception No. 12]

1-5.8.2 Interconnection means shall be arranged so that a single break or single ground fault will not cause an alarm signal.

[From NFPA 72 - 1990, 4-2.2]

1-5.8.3 An open, ground, or short circuit fault on the installation conductors of one alarm notification appliance circuit shall not affect the operation of any other alarm notification circuit.

[From NFPA 72 - 1990, 4-2.3]

1-5.8.4 The occurrence of a wire-to-wire short circuit fault on any alarm notification appliance circuit shall result in a trouble signal at the protected premises.

[New paragraph]

Exception No. 1: A circuit employed to produce a supplementary local alarm signal, provided that the occurrence of a short circuit on the circuit in no way affects the required operation of the fire alarm system.

[From NFPA 71, 2-4.1 Exception No. 11]

Exception No. 2: The circuit of an alarm notification appliance installed in the same room with the central control equipment, provided that the notification appliance circuit conductors are installed in conduit or equivalently protected against mechanical injury.

[From NFPA 72, 4-2.1 Exception No. 8]

Exception No. 3: Central station circuits serving notification appliances within a central station.

[From NFPA 71, 2-4.1 Exception No. 8 modified]

1-5.8.5 Monitoring Integrity of Emergency Voice/Alarm Communication Systems.

[New title]

1-5.8.5.1* Monitoring Integrity of Speaker Amplifier and Tone-Generating Equipment. Where speakers are used to produce audible fire alarm signals, the following shall apply:

(a) Failure of any audio amplifier shall result in an audible trouble signal.

(b) Failure of any tone-generating equipment shall result in an audible trouble signal.

Exception: Tone-generating and amplifying equipment enclosed as integral parts and serving only a single listed loudspeaker need not be monitored.

[From NFPA 72 - 1990, 4-4]

1-5.8.5.2 Where a two-way telephone communication circuit is provided, its installation wires shall be monitored for a short circuit fault that would make the telephone communication circuit inoperative.

[From NFPA 72 - 1990, 10-2.2]

1-5.8.6 Monitoring Integrity of Power Supplies.

[From NFPA 72 - 1990, 4-5]

1-5.8.6.1 All primary and secondary power supplies shall be monitored for the presence of voltage at the point of connection to the system.

[NFPA 72 - 1990, 4-5.1 modified, 4-5.2 modified]

Exception No. 1: A power supply for supplementary equipment.

[From NFPA 72 - 1990, 4-5.1 modified]

Exception No. 2: The neutral of a three-, four-, or five-wire ac or dc supply source.

[From NFPA 71, 2-4.1 Exception No. 5, and NFPA 72 - 1990, 4-2.1 Exception No. 6 modified]

Exception No. 3: In a central station, the main power supply, if the fault condition is otherwise so indicated as to be obvious to the operator on duty.

[From NFPA 71, 2-4.1 Exception No. 9]

Exception No. 4: The output of an engine-driven generator that is part of the secondary power supply, if the generator is tested weekly per Chapter 7.

[New paragraph]

1-5.8.6.2 Power supply sources and electrical supervision for digital alarm communications systems shall be in accordance with 1-5.2 and 1-5.8.1.

NOTE: Since digital alarm communicator systems establish communications channels between the protected premises and the central station via the public switched telephone network, the requirement to supervise circuits between the protected premises and the central station (see 1-5.8.1) is considered met when the communications channel is periodically tested in accordance with 4-2.3.2.1.10.

[From NFPA 71, 5-4.1]

1-5.8.6.3 The primary power failure trouble signal for the DACT shall not be transmitted until the actual battery capacity is depleted at least 25 percent, but not more than 50 percent.

[From NFPA 71, 5-4.2]

1-6 System Interfaces. The requirements by which fire alarm systems interface with other fire protective systems and fire safety functions can be found in Chapter 3.

[New paragraph]

1-7 Documentation.

[From NFPA 72 - 1990, 2-2]

1-7.1 Approval and Acceptance.

[New title]

1-7.1.1 The authority having jurisdiction shall be notified prior to installation or alteration of equipment or wiring. At its request, complete information regarding the system or system alterations, including specifications, wiring diagrams, battery calculation, and floor plans shall be submitted for approval.

[From NFPA 71, 1-4.1; NFPA 72, 2-2.1; and NFPA 72E, 2-5.1.2 modified]

1-7.1.2 Before requesting final approval of the installation, where required by the authority having jurisdiction the installing contractor shall furnish a written statement to the effect that the system has been installed in accordance with approved plans and tested in accordance with the manufacturer's specifications and the appropriate NFPA requirements.

[From NFPA 72E, 2-5.1.3 modified]

1-7.2 Certificate of Completion.

[New title]

1-7.2.1* A certificate (*see Figure 1-7.2.1*) shall be prepared for each system. Parts 1, 2, and 4 through 10 shall be completed after the system is installed and the installation wiring has been checked. Part 3 shall be completed after the operational acceptance tests have been completed. A preliminary copy of the certificate shall be given to the system owner and, when requested, to other authorities having jurisdiction after completion of the installation wiring tests, and a final copy after completion of the operational acceptance tests.

[From NFPA 72, 2-2.2 modified, and NFPA 71, 1-4.3 modified]

1-7.2.2* Every system shall include the following documentation, which shall be delivered to the owner or the owner's representative upon final acceptance of the system.

(a)* An owner's manual and installation instructions covering all system equipment, and

(b) Record drawings.

[From NFPA 72 - 1990, 2-2.3 modified and A-2-2.2.3(a)]

1-7.2.3 Central Station Fire Alarm Systems. It shall be conspicuously indicated by the prime contractor (*see Chapter 4*) that the fire alarm system providing service at a protected premises complies with all applicable requirements of this code by providing a means of verification as specified in either 1-7.2.3.1 or 1-7.2.3.2.

[From NFPA 71, 1-2.3 modified]

1-7.2.3.1 The installation shall be certificated.

[From NFPA 71, 1-2.3.1]

1-7.2.3.1.1 Central station fire alarm systems providing service that complies with all requirements of this code shall be certificated by the organization that has listed the prime contractor, and a document attesting to this certification shall be located on or near the fire alarm system

control unit or, if no control unit exists, on or near a fire alarm system component.

[From NFPA 71, 1-2.3.1.1 modified]

1-7.2.3.1.2 A central repository of issued certification documents, accessible to the authority having jurisdiction, shall be maintained by the organization that has listed the central station.

[From NFPA 71, 1-2.3.1 modified]

1-7.2.3.2 The installation shall be placarded.

[From NFPA 71, 1-2.3.2]

1-7.2.3.2.1 Central station fire alarm systems providing service that complies with all requirements of this code shall be conspicuously marked by the prime contractor to indicate compliance. The marking shall be by one or more securely affixed placards.

[From NFPA 71, 1-2.3.2.1 modified]

1-7.2.3.2.2 The placard(s) shall be 20 sq in. (130 cm²) or larger, shall be located on or near the fire alarm system control unit or, if no control unit exists, on or near a fire alarm system component, and shall identify the central station and, if applicable, the prime contractor by name and telephone number.

[From NFPA 71, 1-2.3.2.2 modified]

1-7.3 Records. A complete unalterable record of the tests and operations of each system shall be kept for at least 2 years. The record shall be available for examination and, where required, reported to the authority having jurisdiction. Archiving of records by any means shall be permitted if hard copies of the records can be provided promptly when requested.

[From NFPA 71, 1-4.5 modified, and NFPA 72 - 1990, 2-5.7 modified]

Exception: Where off-premises monitoring is provided, records of all signals, tests, and operations recorded at the supervising station shall be maintained for not less than one year.

[New paragraph]

Certificate of Completion

Name of Protected Property: _____

Address: _____

Rep. of Protected Prop. (name/phone): _____

Authority Having Jurisdiction: _____

Address/Phone Number: _____

1. Type(s) of System or Service:

_____ NFPA 72, Chapter 3 — Local

If alarm is transmitted to location(s) off premise, list where received:

_____ NFPA 72, Chapter 3 — Emergency Voice/Alarm Service

Quantity of voice/alarm channels: _____ Single: _____ Multiple: _____

Quantity of speakers installed: _____ Quantity of speaker zones: _____

Quantity of telephones or telephone jacks included in system: _____

_____ NFPA 72, Chapter 4 — Auxiliary

Indicate type of connection:

Local energy, _____ Shunt, _____ Parallel telephone

Location and telephone number for receipt of signals: _____

_____ NFPA 72, Chapter 4 — Remote Station

Alarm: _____

Supervisory: _____

_____ NFPA 72, Chapter 4 — Proprietary

If alarms are retransmitted to public fire service communications center or others, indicate location and telephone number of the organization receiving alarm:

Indicate how alarm is retransmitted: _____

_____ NFPA 72, Chapter 4 — Central Station

The Prime Contractor: _____

Central Station Location: _____

Means of transmission of signals from the protected premise to the central station:

_____ McCulloh _____ Multiplex _____ One-Way Radio

_____ Digital Alarm Communicator _____ Two-Way Radio _____ Others

Means of transmission of alarms to the public fire service communications center:

1. _____

2. _____

System Location: _____

	Organization Name/Phone	Representative Name/Phone
Installer	_____	_____
Supplier	_____	_____
Service Organization	_____	_____

Figure 1-7.2.1 Certificate of Completion.

[From NFPA 72 - 1990, 2-2.2 modified, and NFPA 71, 1-4.3 modified]

Location of Record (As-Built) Drawings:

Location of Owners Manuals:

Location of Test Reports:

A contract, dated _____, for test and inspection in accordance with NFPA standard(s) No.(s) _____, dated _____, is in effect.

2. Certification of System Installation

(Fill out after installation is complete and wiring checked for opens, shorts, ground faults, and improper branching, but prior to conducting operational acceptance tests.)

This system has been installed in accordance with the NFPA standards as listed below, was inspected by _____ on _____, includes the devices listed below and has been in service since _____

_____ NFPA 72, Chapters 1 3 4 5 6 7 (circle all that apply)

_____ NFPA 70, *National Electrical Code*, Article 760

_____ Manufacturer's Instructions

_____ Other (specify): _____

Signed: _____ Date: _____

Organization: _____

3. Certification of System Operation

All operational features and functions of this system were tested by _____ on _____ and found to be operating properly in accordance with the requirements of:

_____ NFPA 72, Chapters 1 3 4 5 6 7 (circle all that apply)

_____ NFPA 70, *National Electrical Code*, Article 760

_____ Manufacturer's Instructions

_____ Other (specify): _____

Signed: _____ Date: _____

Organization: _____

4. Alarm Initiating Devices and Circuits (Use blanks to indicate quantity of devices.)

MANUAL

a) _____ Manual Stations _____ Noncoded, Activating _____ Transmitters _____ Coded

b) _____ Combination Manual Fire Alarm and Guard's Tour Coded Stations

AUTOMATIC

Coverage: Complete: _____ Partial: _____

a) _____ Smoke Detectors _____ Ion _____ Photo

b) _____ Duct Detectors _____ Ion _____ Photo

c) _____ Heat Detectors _____ FT _____ RR _____ FT/RR _____ RC

d) _____ Sprinkler Water Flow Switches: _____ Noncoded, activating _____ Transmitters _____ Coded

e) _____ Other (list): _____

5. Supervisory Signal Initiating Devices and Circuits (Use blanks to indicate quantity of devices.)

GUARD'S TOUR

a) _____ Coded Stations

b) _____ Noncoded Stations Activating _____ Transmitters

c) _____ Compulsory Guard Tour System Comprised of _____ Transmitter Stations and _____ Intermediate Stations

Note: Combination devices recorded under 4(b) and 5(a).

SPRINKLER SYSTEM

a) _____ Coded Valve Supervisory Signaling Attachments
Valve Supervisory Switches Activating _____ Transmitters

b) _____ Building Temperature Points

c) _____ Site Water Temperature Points

d) _____ Site Water Supply Level Points

Figure 1-7.2.1 Certificate of Completion. (cont.)

[From NFPA 72 - 1990, 2-2.2 modified, and NFPA 71, 1-4.3 modified]

Frequency of routine tests and inspections, if other than in accordance with the referenced NFPA standard(s):

System deviations from the referenced NFPA standard(s) are:

(signed) for Central Station or Alarm Service Company

(title)

(date)

Upon completion of the system(s) satisfactory test(s) witnessed (if required by the authority having jurisdiction):

(signed) representative of the authority having jurisdiction

(title)

(date)

Figure 1-7.2.1 Certificate of Completion. (cont.)

[From NFPA 72 - 1990, 2-2.2 modified, and NFPA 71, 1-4.3 modified]

Chapter 2* Household Fire Warning Equipment

2-1 General.

[New title]

2-1.1* Scope. This chapter contains minimum requirements for the selection, installation, operation, and maintenance of fire warning equipment for use within family living units. The requirements of the other chapters do not apply except as specifically indicated.

[From NFPA 74 - 1989, 1-1 modified]

2-1.2 General Provisions.

[From NFPA 74 - 1989, 1-2]

2-1.2.1 This code is primarily concerned with life safety, not with protection of property. It presumes that the family has an exit plan.

[From NFPA 74 - 1989, 1-2.1]

2-1.2.2 A control and associated equipment, multiple or single station alarm device(s), or any combination thereof shall be permitted to be used as a household fire warning system, provided the requirements of 2-1.3.1 are met.

[From NFPA 74 - 1989, 1-2.2 modified]

2-1.2.3 Detection and alarm systems for use within the protected household are covered by this chapter.

[From NFPA 74 - 1989, 1-2.3 modified]

2-1.2.4 Supplementary functions, including the extension of an alarm beyond the household, shall be permitted and shall not interfere with the performance requirements of this chapter.

[From NFPA 74 - 1989, 1-2.4 modified]

2-1.2.5 Where the authority having jurisdiction requires a household fire warning system to comply with the requirements of Chapter 4 or any other chapters of this code, the requirements of Section 2.2 shall still apply.

[From NFPA 74 - 1989, 1-2.5 modified]

2-1.2.6 Definitions of Chapter 1 shall apply.

2-1.2.7 This chapter does not exclude the use of fire alarm systems complying with other chapters of this code in household applications, provided all of the requirements of this chapter are met or exceeded.

[New paragraphs]

2-1.3 Approval.

[From NFPA 74 - 1989, 1-3]

2-1.3.1 All devices, combination of devices, and equipment to be installed in conformity with this chapter shall be approved or listed for the purposes for which they are intended.

[From NFPA 74 - 1989, 1-3.1.1 modified]

2-1.3.2 A device or system of devices having materials or forms different from those detailed in the chapter may be examined and tested according to the intent of the chapter and, if found equivalent, may be approved.

[From NFPA 74 - 1989, 1-3.1.2 modified]

2-1.3.3 Equivalency. Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code, provided technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency and the system, method, or device is approved for the intended purpose.

[New paragraph]

2-2 Basic Requirements.

[From NFPA 74 - 1989, Chap. 2]

2-2.1 Required Protection.

[From NFPA 74 - 1989, 2-1]

2-2.1.1* This code requires the following detectors within the family living unit.

[From NFPA 74 - 1989, 2-1.1]

2-2.1.1.1 Smoke detectors shall be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms and on each additional story of the family living unit, including basements and excluding crawl spaces and unfinished attics. In new construction a smoke detector also shall be installed in each sleeping room.

[From NFPA 74 - 1989, 2-1.1.1 modified]

2-2.1.1.2* For family living units with one or more split levels (i.e., adjacent levels with less than one full story separation between levels), a smoke detector required by 2-2.1.1.1 shall suffice for an adjacent lower level, including basements. (See Figure A-2-2.1.1.2.)

Exception: Where there is an intervening door between one level and the adjacent lower level, a smoke detector shall be installed on the lower level.

[From NFPA 74 - 1989, 2-1.1.2]

2-2.1.1.3 Automatic sprinkler systems provided in accordance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes*, or NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height*, shall be interconnected to sound alarm notification appliances throughout the dwelling when a fire warning system is provided.

2-2.2* Alarm Notification Appliances. Each detection device shall cause the operation of an alarm that shall be clearly audible in all bedrooms over background noise levels with all intervening doors closed. The tests of audibility level shall be conducted with all household equipment that may be in operation at night in full operation.

Examples of such equipment are window air conditioners and room humidifiers. (See A-2-2.2 for additional information.)

[From NFPA 74 - 1989, 2-2]

2-2.2.1 In new construction, where more than one smoke detector is required by 2-2.1, they shall be so arranged that operation of any smoke detector shall cause the alarm in all smoke detectors within the dwelling to sound.

Exception: Configurations that provide equivalent distribution of the alarm signal.

[From NFPA 74 - 1989, 2-2.1]

2-2.2.2* Standard Signal. Alarm notification appliances used with a household fire warning system and single and multiple station smoke detectors shall produce the audible emergency evacuation signal described in ANSI S3.41, *Audible Emergency Evacuation Signals*. This requirement shall become effective on July 1, 1996.

2-2.3 Alarm Notification Appliances for the Hearing Impaired. In a household occupied by one or more hearing impaired persons, each initiating device shall cause the operation of visible alarm signal(s) in accordance with 2-4.4.2. Since hearing deficits are often not apparent, the responsibility to advise appropriate persons shall rest with the hearing impaired party. The responsibility for compliance shall rest with the occupants of the family living unit.

Exception: A listed tactile signal shall be permitted to be employed.

[New paragraphs]

2-3 Power Supplies.

2-3.1 General.

[From NFPA 74 - 1989, Chap. 3]

2-3.1.1 All power supplies shall have sufficient capacity to operate the alarm signal(s) for at least 4 continuous minutes.

[From NFPA 74 - 1989, 3-1.1]

2-3.1.2 For electrically powered detectors, an ac primary power source shall be utilized in all new construction. In existing households, ac primary power is preferred; however, where such is not practical, a monitored battery primary power source is permitted.

[From NFPA 74 - 1989, 3-1.1.1]

2-3.2 Primary Power Supply — AC.

[From NFPA 74 - 1989, 3-2]

2-3.2.1 An ac primary (main) power source shall be a dependable commercial light and power supply source. A visible "power on" indicator shall be provided.

[From NFPA 74 - 1989, 3-2.1]

2-3.2.2 All electrical systems designed to be installed by other than a qualified electrician shall be powered from a source not in excess of 30 volts that meets the requirements for power limited fire alarm circuits as defined in NFPA 70, *National Electrical Code*, Article 760.

[From NFPA 74 - 1989, 3-2.2]

2-3.2.3 A restraining means shall be used at the plug-in of any cord connected installation.

[From NFPA 74 - 1989, 3-2.3]

2-3.2.4 AC primary (main) power shall be supplied either from a dedicated branch circuit or the unswitched portion of a branch circuit also used for power and lighting. Operation of a switch (other than a circuit breaker) or a ground fault circuit interrupter shall not cause loss of primary (main) power.

[From NFPA 74 - 1989, 3-2.4 modified]

Exception No. 1: Detectors with a supervised rechargeable standby battery that provides at least 4 months' operation with a fully charged battery.

[From NFPA 74 - 1989, TIA 89-1]

Exception No. 2: Where a ground-fault circuit interrupter serves all electrical circuits within the household.

[New paragraph]

2-3.2.5 Neither loss nor restoration of primary (main) power shall cause an alarm signal in excess of 2 seconds within nor any alarm signal outside the living unit.

[From NFPA 74 - 1989, 3-2.5 modified]

2-3.2.6 Where a secondary (standby) battery is provided, the primary (main) power supply shall be of sufficient capacity to operate the system under all conditions of loading with any secondary (standby) battery disconnected or fully discharged.

[From NFPA 74 - 1989, 3-2.7]

2-3.3 Primary Power Supply — Monitored Battery.

[From NFPA 74 - 1989, 3-3]

2-3.3.1 Household fire warning equipment shall be permitted to be powered by a battery, provided that the battery is monitored to ensure that the following conditions are met:

[From NFPA 74 - 1989, 3-3.1]

(a) All power requirements are met for at least 1 year's life, including monthly testing.

[From NFPA 74 - 1989, 3-3.1(a) modified]

(b) A distinctive audible trouble signal is given before the battery is incapable of operating (from aging, terminal corrosion, etc.) the device(s) for alarm purposes.

[From NFPA 74 - 1989, 3-3.1(b)]

(c) For a unit employing a lock-in alarm feature, automatic transfer is provided from alarm to a trouble condition.

[From NFPA 74 - 1989, 3-3.1(c)]

(d) The unit is capable of producing an alarm signal for at least 4 minutes at the battery voltage at which a trouble signal is normally obtained, followed by not less than 7 days of trouble signal operation.

[From NFPA 74 - 1989, 3-3.1(d)]

(e) The audible trouble signal is produced at least once every minute for 7 consecutive days.

[From NFPA 74 - 1989, 3-3.1(e)]

(f) Acceptable replacement batteries are clearly identified by manufacturer's(s') name and model number(s) on the unit near the battery compartment.

[From NFPA 74 - 1989, 3-3.1(f)]

(g) A readily noticeable visible indication shall be displayed when a primary battery is removed from the unit.

[From NFPA 74 - 1989, 3-3.1(g)]

(h) Any unit that uses a nonrechargeable battery as a primary power supply that is capable of a 10-year or greater service life, including testing, and meets the requirements of (b) thru (e) above, shall not be required to have a replaceable battery.

2-3.4 Secondary (Standby) Power Supply.

2-3.4.1 Removal or disconnection of a battery used as a secondary (standby) power source shall cause a distinctive audible or visible trouble signal.

2-3.4.2 Acceptable replacement batteries shall be clearly identified by manufacturer's(s') name and model number(s) on the unit near the battery compartment.

2-3.4.3 If required by law for disposal reasons, rechargeable batteries shall be removable.

2-3.4.4 Automatic recharging shall be provided where a rechargeable battery is used as the secondary (standby) supply. The supply shall be capable of operating the system for at least 24 hours in the normal condition, followed by not less than 4 minutes of alarm. Loss of the secondary (standby) source shall sound an audible trouble signal at least once every minute.

2-3.4.4.1 The battery shall be recharged within 4 hours if power is provided from a circuit that can be switched on or off other than by a circuit breaker, or within 48 hours when power is provided from a circuit that cannot be switched on or off other than by a circuit breaker.

2-3.4.5 Where automatic recharging is not provided, the battery shall be monitored to ensure that the following conditions are met:

(a) All power requirements are met for at least 1 year's life.

(b) A distinctive audible trouble signal is given before the battery capacity has been depleted below the level required to produce an alarm signal for 4 minutes.

[New paragraphs and title]

2-3.5 Primary Power — Nonelectrical. A suitable spring-wound mechanism shall provide power for the non-electrical portion of a listed single station detector. A visible indication shall be provided to show that sufficient operating power is not available.

[From NFPA 74 - 1989, 3-4 modified]

2-4 Equipment Performance.

[From NFPA 74 - 1989, Chap. 4]

2-4.1 General. The failure of any nonreliable or short-life component that renders the detector inoperable shall be readily apparent to the occupant of the living unit without the need for test.

[From NFPA 74 - 1989, 4-1]

2-4.2 Smoke Detectors.

[From NFPA 74 - 1989, 4-2]

2-4.2.1 Each smoke detector shall detect abnormal quantities of smoke that may occur in a dwelling, shall properly operate in the normal environmental conditions of a household, and shall be in compliance with ANSI/UL 268, *Smoke Detectors for Fire Protective Signaling Systems*, or ANSI/UL 217, *Single and Multiple Station Smoke Detectors*.

[From NFPA 74 - 1989, 4-2.1]

2-4.3* Heat Detectors. Each heat detector, including a heat detector integrally mounted on a smoke detector, shall detect abnormally high temperature or rate-of-temperature rise, and all such detectors shall be listed or approved for not less than 50-ft (15-m) spacing.

[From NFPA 74 - 1989, 4-3 modified]

2-4.3.1* Fixed-temperature detectors shall have a temperature rating at least 25°F (14°C) above the normal ambient temperature and shall not exceed 50°F (28°C) higher than the maximum anticipated ambient temperature in the room or space where installed.

[From NFPA 74 - 1989, 4-3.1]

2-4.4 Alarm Signaling Intensity.

[From NFPA 74 - 1989, 4-4 modified]

2-4.4.1 All alarm-sounding appliances shall have a minimum rating of 85 dBA at 10 ft (3 m).

Exception: An additional sounding appliance intended for use in the same room as the user, such as a bedroom, may have a sound pressure level as low as 75 dBA at 10 ft (3 m).

[From NFPA 74 - 1989, 4-4.1]

2-4.4.2 Visible notification appliances used in rooms where hearing impaired person(s) sleep shall have a minimum rating of 177 candela for a maximum room size of 14 ft by 16 ft (4.27 m by 4.88 m). For larger rooms, the visible notification appliance shall be located within 16 ft (4.88 m) of the pillow. Visible notification appliances in other areas shall have a minimum rating of 15 candela.

Exception: Where a visible notification appliance in a sleeping room is mounted more than 24 in. below the ceiling, a minimum rating of 110 candela shall be permitted.

[New paragraphs]

2-4.5 Control Equipment.

[From NFPA 74 - 1989, 4-5]

2-4.5.1 The control equipment shall be automatically restoring on restoration of electrical power.

[From NFPA 74 - 1989, 4-5.1]

2-4.5.2 The control equipment shall be of a type that "locks in" on an alarm condition. Smoke detection circuits need not lock in.

[From NFPA 74 - 1989, 4-5.2]

2-4.5.3 If a reset switch is provided, it shall be a self-restoring type.

[From NFPA 74 - 1989, 4-5.3]

2-4.5.4 An alarm-silencing switch or an audible trouble-silencing switch shall not be provided unless its silenced position is indicated by a readily apparent signal.

[From NFPA 74 - 1989, 4-5.4]

2-4.5.5 Each electrical fire warning system and each single station smoke detector shall have an integral test means to permit the householder to check the system and sensitivity of the detector(s).

[From NFPA 74 - 1989, 4-5.5]

2-4.6 Monitoring Integrity of Installation Conductors.

2-4.6.1 All means of interconnecting initiating devices or notification appliances shall be monitored for the integrity of the interconnecting pathways up to the connections to the device or appliance so that the occurrence of a single open or single ground fault, which prevents normal operation of the system, will be indicated by a distinctive trouble signal.

Exception No. 1: Conductors connecting multiple-station detectors, provided a single fault on the wiring will not prevent single-station operation of any of the interconnected detectors.

Exception No. 2: Circuits extending from single- or multiple-station detectors to required remote notification appliances provided operation of the test feature on any detector will cause all connected appliances to activate.

[New paragraphs]

2-4.7 Combination System.

[From NFPA 74 - 1989, 4-7]

2-4.7.1 Where common wiring is employed for a combination system, the equipment for other than the fire warning signaling system shall be connected to the common wiring of the system so that short circuits, open circuits, grounds, or any fault in this equipment or interconnection between this equipment and the fire warning system wiring shall not interfere with the supervision of the fire warning system, or prevent alarm or trouble signal operation.

[From NFPA 74 - 1989, 4-7.1]

2-4.7.2 In a fire/burglar system, the operation shall be as follows:

(a) A fire alarm signal shall take precedence or be clearly recognizable over any other signal even when the nonfire alarm signal is initiated first.

(b) Distinctive alarm signals shall be obtained between fire alarms and other functions such as burglar alarms. The use of a common sounding appliance for fire and burglar alarms is acceptable if distinctive signals are obtained. (See 2-2.2.2.)

[From NFPA 74 - 1989, 4-7.2]

2-4.8 Low Power Wireless Systems. Household fire warning systems utilizing low power wireless transmission of signals within the protected household shall comply with the requirements of Section 3-13, except for 3-13.4.5.

2-4.9 Digital Alarm Communicators.

2-4.9.1 Household fire warning systems that employ off-premises transmission of signals via digital alarm communicators shall comply with the provisions of section 4-2.3.2 with the following exceptions:

(a) For 4-2.3.2.1.6 only one telephone line shall be required for one- and two-family residences.

(b) For 4-2.3.2.1.8 each DACT need only be programmed to call a single DACR number.

(c) For 4-2.3.2.1.10 each DACT serving a one- or two-family residence shall transmit a test signal to its associated receiver at least once a month.

[New paragraphs and title]

2-5 Installation.

[From NFPA 74 - 1989, Chap. 5]

2-5.1 General.

[From NFPA 74 - 1989, 5-1]

2-5.1.1 General Provisions.

[From NFPA 74 - 1989, 5-1.1]

2-5.1.1.1 All equipment shall be installed in a workman-like manner.

[From NFPA 74 - 1989, 5-1.1.1]

2-5.1.1.2 All devices shall be so located and mounted that accidental operation will not be caused by jarring or vibration.

[From NFPA 74 - 1989, 5-1.1.2]

2-5.1.1.3 All installed household fire warning equipment shall be mounted so as to be supported independently of its attachment to wires.

[From NFPA 74 - 1989, 5-1.1.3]

2-5.1.1.4 All equipment shall be restored to normal as promptly as possible after each alarm or test.

[From NFPA 74 - 1989, 5-1.1.4]

2-5.1.1.5 The supplier or installing contractor shall provide the owner with:

(a) An instruction booklet illustrating typical installation layouts

(b) Instruction charts describing the operation, method and frequency of testing, and proper maintenance of household fire warning equipment

(c) Printed information for establishing a household emergency evacuation plan

(d) Printed information to inform owners where they may obtain repair or replacement service, and where and how parts requiring regular replacement (such as batteries or bulbs) may be obtained within two weeks.

[From NFPA 74 - 1989, 5-1.1.5]

2-5.1.2 Multiple-Station Detector Interconnection.

[From NFPA 74 - 1989, 5-1.2]

(a) Where the interconnected wiring is unsupervised, no more than 18 detectors shall be interconnected in a multiple station configuration.

(b) Where the interconnecting wiring is supervised, the number of interconnected detectors shall be limited to 64.

[New paragraphs]

2-5.1.2.1* Interconnection that causes other detectors to sound shall be limited to an individual family living unit. Remote annunciation from single- or multiple-station detectors shall be permitted.

[From NFPA 74 - 1989, 5-1.2.1 modified]

2-5.1.2.2 No more than 12 smoke detectors may be interconnected in a multiple-station connection.

[New paragraph]

2-5.2* Detector Location and Spacing.

[From NFPA 74 - 1989, 5-2]

2-5.2.1* Smoke Detectors.

[From NFPA 74 - 1989, 5-2.1]

2-5.2.1.1 Smoke detectors in rooms with ceiling slopes greater than 1 ft rise per 8 ft (1 m rise per 8 m) horizontally shall be located at the high side of the room.

[From NFPA 74 - 1989, 5-2.1.1]

2-5.2.1.2 A smoke detector installed in a stairwell shall be so located as to ensure that smoke rising in the stairwell cannot be prevented from reaching the detector by an intervening door or obstruction.

[From NFPA 74 - 1989, 5-2.1.2]

2-5.2.1.3 A smoke detector installed to detect a fire in the basement shall be located in close proximity to the stairway leading to the floor above.

[From NFPA 74 - 1989, 5-2.1.3]

2-5.2.1.4 A smoke detector installed to protect a sleeping area in accordance with 2-2.1.1.1 shall be located outside of the bedrooms but in the immediate vicinity of the sleeping area.

[From NFPA 74 - 1989, 5-2.1.4]

2-5.2.1.5 The smoke detector installed to comply with 2-2.1.1.1 on a story without a separate sleeping area shall be located in close proximity to the stairway leading to the floor above.

[From NFPA 74 - 1989, 5-2.1.5]

2-5.2.1.6* Smoke detectors shall be mounted on the ceiling at least 4 in. (102 mm) from a wall or on a wall with the top of the detector not less than 4 in. (102 mm) nor more than 12 in. (305 mm) below the ceiling.

Exception: Where the mounting surface might become considerably warmer or cooler than the room, such as a poorly insulated ceiling below an unfinished attic or an exterior wall, the detectors shall be mounted on an inside wall.

2-5.2.1.7 Smoke detectors shall not be located within kitchens or garages, or in other spaces where temperatures can fall below 32°F (0°C) or exceed 100°F (38°C). Smoke detectors shall not be located closer than 3 ft (0.9 m) from:

(a) The door to a kitchen or a bathroom containing a tub or shower

(b) Supply registers of a forced air heating or cooling system.

Exception: Detectors specifically listed for the application.

[New paragraphs]

2-5.2.2* Heat Detectors.

[From NFPA 74 - 1989, 5-2.2]

2-5.2.2.1 On smooth ceilings, heat detectors shall be installed within the strict limitations of their listed spacing.

[From NFPA 74 - 1989, 5-2.2.1]

2-5.2.2.2 For sloped ceilings having a rise greater than 1 ft in 8 ft (1 m in 8 m) horizontally, the detector shall be located on or near the ceiling at or within 3 ft (0.9 m) of the peak. The spacing of additional detectors, if any, shall be based on a horizontal distance measurement, not on a measurement along the slope of the ceiling.

[From NFPA 74 - 1989, 5-2.2.2]

2-5.2.2.3* Heat detectors shall be mounted on the ceiling at least 4 in. (102 mm) from a wall or on a wall with the top of the detector not less than 4 in. (102 mm) nor more than 12 in. (305 mm) below the ceiling.

Exception: Where the mounting surface might become considerably warmer or cooler than the room, such as a poorly insulated ceiling below an unfinished attic or an exterior wall, the detectors shall be mounted on an inside wall.

[New paragraphs]

2-5.2.2.4 In rooms with open joists or beams, all ceiling-mounted detectors shall be located on the bottom of such joists or beams.

[From NFPA 74 - 1989, 5-2.2.4]

2-5.2.2.5* Detectors installed on an open-joisted ceiling shall have their smooth ceiling spacing reduced where this spacing is measured at right angles to solid joists; in the case of heat detectors, this spacing shall not exceed one-half of the listed spacing.

[From NFPA 74 - 1989, 5-2.2.5]

2-5.3 Wiring and Equipment. The installation of wiring and equipment shall be in accordance with the requirements of NFPA 70, *National Electrical Code*, Article 760.

[From NFPA 74 - 1989, 5-3]

2-6 Maintenance and Tests.

[From NFPA 74 - 1989, Chap. 6]

2-6.1* Maintenance. If batteries are used as a source of energy, they shall be replaced in accordance with the recommendations of the alarm equipment manufacturer.

[From NFPA 74 - 1989, 6-1]

2-6.2* Tests.

2-6.2.1 Single- and Multiple-Station Smoke Detectors. Homeowners shall inspect and test smoke detectors and all connected appliances in accordance with the manufacturer's instructions at least once a month.

[From NFPA 74 - 1989, 6-2 modified]

2-6.2.2 Fire Alarm Systems. Homeowners shall test systems in accordance with the manufacturer's instructions and shall have every residential fire alarm system tested by a qualified service technician at least every 3 years. This test shall be conducted according to the methods of Chapter 7.

[New paragraph]

2-7 Markings and Instructions. All household fire warning equipment or systems shall be plainly marked with the following information on the unit:

[From NFPA 74 - 1989, 7-1.1.1]

(a) Manufacturer's or listee's name, address, and model number

[From NFPA 74 - 1989, 7-1.2.1]

(b) A mark or certification that the unit has been approved or listed by a testing laboratory

[From NFPA 74 - 1989, 7-1.2.2]

(c) Electrical rating (if applicable)

[From NFPA 74 - 1989, 7-1.2.3]

(d) Temperature rating (if applicable)

[From NFPA 74 - 1989, 7-1.2.4]

(e) Spacing rating (if applicable)

[From NFPA 74 - 1989, 7-1.2.5]

(f) Operating instructions

[From NFPA 74 - 1989, 7-1.2.6]

(g) Test instructions

[From NFPA 74 - 1989, 7-1.2.7]

(h) Maintenance instructions

[From NFPA 74 - 1989, 7-1.2.8]

(i) Replacement and service instructions.

Exception: When space limitations prohibit inclusion of 2-7.1(g), 2-7.1(h), and 2-7.1(i), a permanent label or plaque suitable for permanent attachment within the living unit shall be provided with the equipment and referenced on the equipment. In the case of a household fire warning system, the required information shall be prominently displayed at the control panel.

[From NFPA 74 - 1989, 7-1.2.9]

Chapter 3 Protected Premises Fire Alarm Systems

3-1 Scope. This chapter provides requirements for the application, installation, and performance of fire alarm systems, including fire alarm and supervisory signals, within protected premises.

3-2 General. The systems covered in this chapter are intended to be used for the protection of life by automatically indicating the necessity for evacuation of the building or fire area, and for the protection of property through the automatic notification of responsible persons and for the automatic activation of fire safety functions. The requirements of the other chapters shall also apply except where they conflict with the requirements of this chapter.

[New paragraphs]

Exception: For household fire warning equipment protecting a single living unit, see Chapter 2.

[From NFPA 72 - 1990, 6-1 modified]

3-2.1 Systems requiring transmission of signals to continually manned locations providing supervising station service (e.g., central station, proprietary, remote station) shall also comply with the applicable requirements of Chapter 4.

3-2.2 All protected premises fire alarm systems shall be maintained and tested in accordance with Chapter 7.

3-2.3 Fire alarm systems provided for evacuation of occupants shall have one or more notification appliances listed for the purpose on each floor of the building, so located that they shall have the characteristics for public mode described in Chapter 6.

[New paragraphs]

3-2.4* The system shall be so designed and installed that attack by fire:

(a) in an evacuation zone, causing loss of communications to this evacuation zone, shall not result in loss of communications to any other evacuation zone.

(b) causing failure of equipment or a fault on one or more installation wiring conductors of one communications path shall not result in total loss of communications to any evacuation zone.

[From NFPA 72 - 1990, 10-3.1 modified]

Exception No. 1 to (a) and (b): Systems that, on alarm, automatically sound evacuation signals throughout the protected premises.

Exception No. 2 to (a) and (b): Where there is a separate means acceptable to the authority having jurisdiction for voice communications to each floor or evacuation zone.

Exception No. 3 to (b): The fire command station and the central control equipment.

Exception No. 4 to (b): Where the installation wiring is enclosed in a 2-hour rated enclosure, other than a stairwell.

[From NFPA 72 - 1990, 10-3.1]

Exception No. 5 to (b): Where the installation wiring is enclosed within a 2-hour rated stairwell in a fully sprinklered building in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.

[From NFPA 72 - 1990, 10-3.1 modified]

Exception No. 6 to (b): When the evacuation zone is directly attacked by fire within the zone.

[From NFPA 72 - 1990, 10-3.1]

3-3 Applications. Protected premises fire alarm systems include one or more of the following features:

- (a) Manual alarm signal initiation
- (b) Automatic alarm signal initiation
- (c) Monitoring of abnormal conditions in fire suppression systems
- (d) Activation of fire suppression systems
- (e) Activation of fire safety functions
- (f) Activation of alarm notification appliances
- (g) Emergency voice/alarm communications
- (h) Guard's tour supervisory service
- (i) Process monitoring supervisory systems
- (j) Activation of off-premises signals
- (k) Combination systems
- (l) Integrated systems.

[From NFPA 72 - 1990, 3-1 modified]

3-4 Performance of Initiating Device, Notification Appliance, and Signaling Line Circuits.

3-4.1* Circuit Designations. Initiating device, notification appliance, and signaling line circuits shall be designated by class or style, or both, depending on the circuits' capability of being able to continue to operate during specified fault conditions.

3-4.1.1 Class. Initiating device, notification appliance, and signaling line circuits shall be permitted to be designated as either Class A or Class B, depending on the capability of the circuit to transmit alarm and trouble signals during nonsimultaneous single circuit fault conditions as specified by the following:

(a) Circuits capable of transmitting an alarm signal during a single open or a nonsimultaneous single ground fault on a circuit conductor shall be designated as Class A.

(b) Circuits not capable of transmitting an alarm beyond the location of the fault conditions specified in (a) above shall be designated as Class B.

Faults on both Class A and Class B circuits shall result in a trouble condition on the system in accordance with the requirements of 1-5.8.

3-4.1.2 Style. Initiating device, notification appliance, and signaling line circuits shall be permitted to also be des-

ignated by style depending on the capability of the circuit to transmit alarm and trouble signals during specified simultaneous multiple circuit fault conditions in addition to the single circuit fault conditions considered in the designation of the circuits by class.

(a) An initiating device circuit shall be permitted to be designated as either Style A, B, C, D, or E, depending on its ability to meet the alarm and trouble performance requirements shown in Table 3-5.1, during a single open, single ground, wire-to-wire short, or loss of carrier fault condition.

(b) A notification appliance circuit shall be permitted to be designated as either Style W, X, Y, or Z, depending on its ability to meet the alarm and trouble performance requirements shown in Table 3-7.1, during a single open, single ground, or wire-to-wire short fault condition.

(c) A signaling line circuit shall be permitted to be designated as either Style 0.5, 1, 2, 3, 3.5, 4, 4.5, 5, 6, or 7, depending on its ability to meet the alarm and trouble performance requirements shown in Table 3-6.1, during a single open, single ground, wire-to-wire short, simultaneous wire-to-wire short and open, simultaneous wire-to-wire short and ground, simultaneous open and ground, and loss of carrier fault conditions.

3-4.2* All styles of Class A circuits using physical conductors (metallic, optical fiber) shall be installed such that the outgoing and return conductors, exiting from and returning to the control unit respectively, are routed separately. The outgoing and return (redundant) circuit conductors shall not be run in the same cable assembly (multiconductor cable), enclosure, or raceway.

Exception No. 1: For a distance not to exceed 10 ft (3 m) where the outgoing and return conductors enter or exit initiating device, notification appliance, or control unit enclosures; or

[New paragraphs]

Exception No. 2: Where the vertically run conductors are enclosed (installed) in a 2-hour rated enclosure other than a stairwell; or

Exception No. 3: Where the vertically run conductors are enclosed (installed) in a 2-hour rated stairwell in a building fully sprinklered in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.

[From NFPA 72 - 1990, 2-6 modified]

Exception No. 4: Where looped conduit/raceway systems are provided, single conduit/raceway drops to individual devices or appliances shall be permitted.

Exception No. 5: Where looped conduit/raceway systems are provided, single conduit/raceway drops to multiple devices or appliances installed within a single room not exceeding 1000 sq ft (92.9 m²) in area shall be permitted.

[New paragraphs]

3-5 Performance and Capacities of Initiating Device Circuits (IDC).

[From NFPA 72 - 1990, 2-6 modified]

3-5.1* The assignment of class designations, style designations, or both to initiating device circuits shall be based on their performance capabilities under abnormal (fault) conditions in accordance with the requirements of Table 3-5.1.

Table 3-5.1 Performance and Capacities of Initiating Device Circuits (IDC)

Class	B			B			B			A			A		
Style	A			B			C			D			E α		
G = Systems with ground detection shall indicate systems trouble with a single ground. R = Required capability. X = Indication required at protected premises and as required by Chapter 4. α = Style exceeds minimum requirements for Class A. * = See A-3-5.1.	Alarm	Trouble	Alarm Receipt Capability During Abnormal Condition	Alarm	Trouble	Alarm Receipt Capability During Abnormal Condition	Alarm	Trouble	Alarm Receipt Capability During Abnormal Condition	Alarm	Trouble	Alarm Receipt Capability During Abnormal Condition	Alarm	Trouble	Alarm Receipt Capability During Abnormal Condition
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		X			X			X			X	X		X	X
		R			G	R		G	R		G	R		G	R
Abnormal Condition	X			X				X		X				X	
A. Single Open															
B. Single Ground															
C. Wire-to-Wire Short															
D. Loss of Carrier (If Used)/Channel Interface								X						X	
Note: The following sections apply only where signals are transmitted to a proprietary supervising station in accordance with Section 4-4.															
E. Maximum Quantity per Initiating Device Circuit															
1. Fire Alarm															
(a) Manual Fire Alarm Boxes	2			5			5			25			25		
(b) Water Flow Alarm Devices	1			2			2			5			5		
(c) Discharge Alarm from Other Fire Suppression Systems	1			2			2			5			5		
(d) Automatic Fire Detectors	*			*			*			*			*		
2. Fire Supervisory															
(a) Sprinkler Supervisory Devices	2			4			4			20			20		
(b) Other Fire Suppression Supervisory Devices	2			4			4			20			20		
3. Guard's Tour	1			1			1			1			1		
4. Process, Security, and Other Devices in Combination with 1, 2, and 3 Above	0			0			0			0			0		
5. Process, Security, and Other Devices Not Combined with 1, 2, and 3 Above	5			10			10			20			20		
6. Buildings	1			1			1			1			1		
7. Intermediate Fire Alarm or Fire Supervisory Control Unit	1			1			1			1			1		
F. Maximum Quantity of Initiating Device Circuits per Circuit Interface Between IDC & SLC															
1. Per Limits of E above	10			10			10			10			10		
2. With Following Limitations Fulfilled	10			20			20			50			50		
(a) One Water Flow per IDC															
(b) Maximum of Four Sprinkler Supervisory Devices															
(c) Maximum of Five Process, Security, and Other Devices on a Separate IDC															
(d) Maximum of One Intermediate Fire Alarm or Fire Supervisory Control Unit per IDC															

[From NFPA 72 - 1990, 2-6.2 modified]

3-5.2 The loading of initiating device circuits on systems connected to a proprietary supervising station shall not exceed the capacities listed in Table 3-5.1 for their assigned style designations. The loading of initiating device circuits designated only as Class A or Class B (without a style designation) shall not exceed the capacities for the style with the lowest capacities in their class (Style A for Class B circuits, and Styles D or E for Class A circuits).

NOTE: Though Styles D and E have been assigned the same capacities, the choice between the two styles depends on the desired system performance. Style D circuits transmit an alarm signal, while Style E circuits only transmit a trouble signal on the occurrence of a wire-to-wire short on the circuit. A similar distinction exists between Class B, Styles B and C, which have also been assigned the same capacities.

[New paragraphs]

3-5.3 Numbered initiating device groups listed in Table 3-5.1, Section E, shall not be combined on the same initiating device circuit.

Exception No. 1: When implementing 3-8.1.2, manual means and automatic means shall be permitted to be combined on the same initiating device circuit.

Exception No. 2: Where only one fire alarm box is required, it shall be permitted to be connected to the waterflow initiating device circuit.

[From NFPA 72 - 1990, 2-6.3]

3-6 Performance and Capacities of Signaling Line Circuits (SLC).

[From NFPA 72 - 1990, 2-7 modified]

3-6.1* The assignment of class designations or style designations, or both, to signaling line circuits shall be based on their performance capabilities under abnormal (fault) conditions in accordance with the requirements of Table 3-6.1.

[New paragraph]

3-6.2 The loading of signaling line circuits shall not exceed the capacities listed in Table 3-6.1 for their assigned style designation. The loading of signaling line circuits designated only as Class A or Class B (without a style designation) shall not exceed the capacities for the style with the lowest capacities in their class (Styles 0.5 or 1 for Class B circuits, and Style 2 for Class A circuits).

NOTE: Sections H and I of Table 3-6.1 provide information regarding capacities where protected premises fire alarm equipment, as covered in this chapter, is used in a proprietary fire alarm system. For information regarding proprietary supervisory stations, see Section 4-4.

Exception: Where a Class A signaling line circuit is so arranged that a single open or ground fault, or short circuit between wires of the same signaling line circuit does not cause the loss of fire alarm signals from more than a single zone as defined in 1-5.7.3 and 1-5.7.6, the maximum number of initiating devices per signaling line circuit shall be unlimited.

3-7 Notification Appliance Circuits (NAC).

3-7.1 Performance. The assignment of class designations or style designations, or both, to notification appliance circuits shall be based on their performance capabilities

under abnormal (fault) conditions in accordance with the requirements of Table 3-7.1.

[New paragraphs and title]

3-7.2 Distinctive Evacuation Signal.

(a)* Section 1-5.4.7 requires that fire alarm signals be distinctive in sound from other signals and that this sound not be used for any other purpose. To meet this requirement, the fire alarm signal used to notify building occupants of the need to evacuate (leave the building) shall be ANSI S3.41, *American National Standard Audible Emergency Evacuation Signal*. This requirement shall become effective July 1, 1996.

(b) The use of the American National Standard Audible Emergency Evacuation Signal shall be restricted to situations where it is desired to have all occupants hearing the signal evacuate the building immediately. It shall not be used where, with the approval of the authority having jurisdiction, the planned action during a fire emergency is not evacuation, but relocation of the occupants from the affected area to a safe area within the building, or their protection in place (e.g., high rise buildings, health care facilities, penal institutions, etc.).

3-8 System Requirements. (See also Section 5-9.)

3-8.1 Manual Fire Alarm Signal Initiation.

[New paragraphs and titles]

3-8.1.1 Fire alarm boxes shall be listed for the intended application, installed in accordance with Chapter 5, and tested in accordance with Chapter 7.

[From NFPA 71 and 72, 3-2.2 modified]

3-8.1.2 For fire alarm systems employing automatic fire detectors or waterflow detection devices, at least one fire alarm box shall be provided to initiate a fire alarm signal. This fire alarm box shall be located where required by the authority having jurisdiction.

[From NFPA 72 - 1990, 3-2.4 modified]

Exception: Fire alarm systems dedicated to elevator recall control and supervisory as permitted in 3-8.15.1.

[From NFPA 71 - 1989, 3-3.2.1 modified]

3-8.1.3 Where signals from fire alarm boxes and other fire alarm initiating devices within a building are transmitted over the same signaling line circuit, there shall be no interference with fire alarm box signals when both types of initiating devices are operated at or near the same time. Provision of the shunt noninterfering method of operation shall be acceptable for this performance.

[From NFPA 72 - 1990, 3-2.5]

3-8.2 Automatic Fire Alarm Signal Initiation.

[From NFPA 72 - 1990, 3-3 modified]

3-8.2.1 Automatic alarm initiating devices shall be listed for the intended application and installed in accordance with Chapter 5.

[From NFPA 72 - 1990, 3-3.1 modified]

Table 3-6.1 Performance and Capacities of Signaling Line Circuits (SLC)

Class	B		B		A		B		B		B		B		A		A		A											
Style	0.5		1		2 α		3		3.5		4		4.5		5 α		6 α		7 α											
G = Systems with ground detection shall indicate system trouble with a single ground. M = May be capable of alarm with wire-to-wire short. R = Required capability. X = Indication required at protected premises and as required by Chapter 4. α = Style exceeds minimum requirements for Class A.	Alarm	Trouble	Alarm	Trouble	Alarm	Trouble	Alarm	Trouble	Alarm	Trouble	Alarm	Trouble	Alarm	Trouble	Alarm	Trouble	Alarm	Trouble	Alarm	Trouble										
	Alarm Receipt Capability During Abnormal Condition		Alarm Receipt Capability During Abnormal Condition		Alarm Receipt Capability During Abnormal Condition		Alarm Receipt Capability During Abnormal Condition		Alarm Receipt Capability During Abnormal Condition		Alarm Receipt Capability During Abnormal Condition		Alarm Receipt Capability During Abnormal Condition		Alarm Receipt Capability During Abnormal Condition		Alarm Receipt Capability During Abnormal Condition		Alarm Receipt Capability During Abnormal Condition											
Abnormal Condition	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A. Single Open		X			X			X	R		X			X			X			X	R		X	R		X	R		X	R
B. Single Ground		X			G	R		G	R		G	R		X			G	R		X		G	R		G	R		G	R	
C. Wire-to-Wire Short									M		X			X			X			X		X			X			X	R	
D. Wire-to-Wire Short & Open									M		X			X			X			X		X			X			X		
E. Wire-to-Wire Short & Ground									G	M		X		X			X			X		X			X			X		
F. Open and Ground								X	R		X			X			X			X		X			X	X		X	R	
G. Loss of Carrier (If Used)/ Channel Interface														X			X			X		X			X			X		
Note: The following sections apply only where signals are transmitted to a proprietary supervising station in accordance with Section 4-4.																														
H. Maximum quantity per Signaling Line Circuit ^B																														
1. Initiating Devices (All Types)	250		250		250		300		300		500		500		750		1000		unlimited											
2. Buildings	25		25		25		50		50		75		75		75		100		100											
I. Maximum Quantity per Proprietary Supervising Station (PSS)																														
1. Initiating Device Circuits	500		500		500		1000		1000		1000		1000		1500		2000		2000											
2. IDCs with Redundant PSS Control Equipment ¹	1000		1000		1000		2000		2000		2000		2000		3000		unlimited		unlimited											
3. Buildings	25		25		25		25		25		50		50		75		400		400											
4. Buildings with Redundant PSS Control Equipment ¹	25		25		25		50		50		100		100		150		unlimited		unlimited											

Note 1: When the supervisory station multiplex control unit is duplicated and a switchover can be accomplished in not more than 90 seconds with no loss of signals during this period, the capacity of the system is unlimited.

β = See the exception to 3-6.2.

[From NFPA 72 - 1990, 2-7.2 modified]

Table 3-7.1 Notification Appliance Circuits (NAC)

Class	B		B		B		A	
Style	W		X		Y		Z	
G = Systems with ground detection shall indicate system trouble with a single ground. X = Indication required at protected premises.	Trouble Indication at Protected Premises		Alarm Capability During Abnormal Conditions		Trouble Indication at Protected Premises		Alarm Capability During Abnormal Conditions	
	Alarm Capability During Abnormal Conditions		Trouble Indication at Protected Premises		Alarm Capability During Abnormal Conditions		Trouble Indication at Protected Premises	
Abnormal Condition	1	2	3	4	5	6	7	8
Single Open	X		X	X	X		X	X
Single Ground	X		X		G	X	G	X
Wire-to-Wire Short	X		X		X		X	

[From NFPA 72 - 1990, 6-4 modified]

3-8.2.2 Automatic alarm initiating devices having integral trouble contacts shall be wired on the initiating device circuit so that a trouble condition within a device does not impair the alarm transmission from any other initiating device.

NOTE: Though a trouble signal is required when a plug-in initiating device is removed from its base, it is not considered as a trouble condition within the device and the requirement of 3-8.2.2 does not apply.

[From NFPA 72 - 1990, 3-3.2]

3-8.2.3* Systems equipped with alarm verification features shall be permitted, provided:

(a) A smoke detector continuously subjected to a smoke concentration above alarm threshold magnitude initiates a system alarm within 1 minute.

(b) Actuation of an alarm initiating device other than a smoke detector shall cause a system alarm signal within 15 seconds.

[From NFPA 72 - 1990, 3-3.3 modified]

3-8.2.4 Where individual alarm initiating devices are used to control the operation of equipment as permitted by 1-5.4.1, this control capability shall remain operable even if all of the initiating devices connected to the same circuit are in an alarm state.

[From NFPA 72 - 1990, 3-3.4 modified]

3-8.2.5 Systems that require the operation of two automatic detection devices to initiate the alarm response shall be permitted, provided:

(a) They are not prohibited by the authority having jurisdiction.

(b) There are at least two automatic detection devices in each protected space.

(c) Automatic detection device area spacing is no more than one-half that determined by the application of Chapter 5.

(d) The alarm verification feature is not used.

[From NFPA 72 - 1990, 3-3.5 modified]

3-8.3 Positive Alarm Sequence.

3-8.3.1 Systems having positive alarm features complying with the following shall be permitted where approved by the authority having jurisdiction.

[From NFPA 72 - 1990, 3-3.6 modified]

3-8.3.1.1 The signal from an automatic fire detection device selected for positive alarm sequence operation shall be acknowledged at the control unit by trained personnel within 15 seconds of annunciation in order to initiate the alarm investigation phase. If the signal is not acknowledged within 15 seconds, all building and remote signals shall be activated immediately and automatically.

[From NFPA 72 - 1990, 3-3.6.1 modified]

3-8.3.1.2 Trained personnel shall have up to 180 seconds during the alarm investigation phase to evaluate the fire condition and reset the system. If the system is not reset during this investigation phase, all building and remote signals shall be activated immediately and automatically.

[From NFPA 72 - 1990, 3-3.6.2 modified]

3-8.3.2 If a second automatic fire detector selected for positive alarm sequence is actuated during the alarm investigation phase, all normal building and remote signals shall be activated immediately and automatically.

[From NFPA 72 - 1990, 3-3.6.3 modified]

3-8.3.3 If any other initiating device is actuated, all building and remote signals shall be activated immediately and automatically.

[From NFPA 72 - 1990, 3-3.6.4 modified]

3-8.3.4* The system shall provide means to bypass the positive alarm sequence.

[From NFPA 72 - 1990, 3-3.6.5]

3-8.4* Concealed Detectors. Where a remote alarm indicator is provided for an automatic fire detector in a concealed location, the location of the detector and the area protected by the detector shall be prominently indicated either at the remote alarm indicator by a permanently attached placard or by other approved means.

[From NFPA 72 - 1990, 3-3.7]

3-8.5 Automatic Drift Compensation. Where automatic drift compensation of sensitivity for a fire detector is provided, the control unit shall give an indication identifying the affected detector when the limit of compensation is reached.

[New paragraph]

3-8.6 Waterflow Alarm Signal Initiation.

[From NFPA 72 - 1990, 3-4.1 modified]

3-8.6.1 The provisions of 3-8.6 apply to sprinkler system signaling attachments that initiate an alarm indicating a flow of water in the system. Waterflow initiating devices shall be listed for the intended application and installed in accordance with Chapter 5.

[From NFPA 72 - 1990, 3-4.1.1 modified]

3-8.6.2 A dry-pipe or preaction sprinkler system that is supplied with water by a connection beyond the alarm initiating device of a wet-pipe system shall be equipped with a separate waterflow alarm initiating pressure switch or other approved means to initiate a waterflow alarm.

[From NFPA 72 - 1990, 3-4.1.4 modified]

3-8.6.3 The number of waterflow switches permitted to be connected to a single initiating device circuit shall not exceed five.

[From NFPA 72 - 1990, 6-2.2 modified, and NFPA 71, 6-4.1.2]

3-8.7 Supervisory Signal Initiation.

[From NFPA 72 - 1990, 3-4.2 modified]

3-8.7.1 General. The provisions of this section apply to the monitoring of sprinkler and other fire protection systems for the initiation of a supervisory signal indicating an off-normal condition that may adversely affect the performance of the system.

[From NFPA 72 - 1990, 3-4.2.1 modified]

3-8.7.1.1 Supervisory devices shall be listed for the intended application and installed in accordance with Chapter 5.

[New paragraph]

3-8.7.1.2 The number of supervisory devices permitted to be connected to a single initiating device circuit shall not exceed 20.

[From NFPA 71, 6-4.2 modified, and NFPA 72 - 1990, 6-2.3 modified]

3-8.7.2* Provisions shall be made for supervising the conditions that are essential for the proper operation of sprinkler and other fire suppression systems.

[From NFPA 72 - 1990, 3-4.2.2 modified]

Exception: Those conditions related to water mains, tanks, cisterns, reservoirs, and other water supplies controlled by a municipality or a public utility.

[From NFPA 72 - 1990, 3-4.2.2 Exception]

3-8.7.3 Signals shall distinctively indicate the particular function (such as valve position, temperature, pressure, etc.) of the system that is off-normal and also indicate its restoration to normal.

[From NFPA 72 - 1990, 3-4.2.3 modified]

NOTE: Cancellation of the off-normal signal is acceptable as a restoration signal except where separate recording of all changes of state is a specific requirement. (See Chapter 4.)

[From NFPA 72 - 1990, 3-4.2.5 modified]

3-8.7.4 A dry-pipe sprinkler system equipped for waterflow alarm signaling shall be supervised for off-normal system air pressure.

[From NFPA 72 - 1990, 3-4.2.4 modified]

3-8.7.5 A control valve shall be supervised to initiate a distinctive signal indicating movement of the valve from its normal position. The off-normal signal shall remain until the valve is restored to its normal position. The off-normal signal shall be obtained during the first two revolutions of the hand wheel or during one-fifth of the travel distance of the valve control apparatus from its normal position.

[From NFPA 72 - 1990, 3-4.2.5 modified]

3-8.7.6 An initiating device for supervising the position of a control valve shall not interfere with the operation of the valve, obstruct the view of its indicator, or prevent access for valve maintenance.

[New paragraph]

3-8.7.7 Pressure Supervision. Pressure sources shall be supervised to obtain two separate and distinct signals, one indicating that the required pressure has been increased or decreased, and the other indicating restoration of the pressure to its required value.

(a) A pressure supervisory signal initiating device for a pressure tank shall indicate both high and low pressure conditions. A signal shall be obtained where the required pressure is increased or decreased 10 psi (70 kPa) from the required pressure value.

(b) A pressure supervisory signal initiating device for a dry-pipe sprinkler system shall indicate both high and low pressure conditions. A signal shall be obtained when the required pressure is increased or decreased 10 psi (70 kPa) from the required pressure value.

(c) A steam pressure supervisory initiating device shall indicate a low pressure condition. A signal shall be obtained where the pressure is reduced to a value that is 110 percent of the minimum operating pressure of the steam operated equipment supplied.

(d) An initiating device for supervising the pressure of sources other than those specified above shall be provided as required by the authority having jurisdiction.

3-8.7.8 Water Temperature Supervision. Exposed water storage containers shall be supervised to obtain two separate and distinct signals, one indicating that the temperature of the water has been lowered to 40°F (4.4°C), and the other indicating restoration to a temperature above 40°F (4.4°C).

[From NFPA 71 - 1989]

3-8.8 Signal Annunciation. Protected premises fire alarm systems shall be arranged to annunciate alarm, supervisory, and trouble signals in accordance with 1-5.7.

[New paragraph]

3-8.9 Signal Initiation from Automatic Fire Suppression System Other Than Waterflow.

[From NFPA 71, 3-4.3]

3-8.9.1 The operation of an automatic fire suppression system installed within the protected premises shall be indicated on the protected premises fire alarm system.

[From NFPA 71, 3-4.3.1]

3-8.9.2 A supervisory signal shall indicate the off-normal condition and its restoration to normal appropriate to the system employed.

[From NFPA 71, 3-4.4.1 modified]

3-8.9.3 The integrity of each fire suppression system actuating device and its circuit shall be supervised in accordance with 1-5.8.1 and with other applicable NFPA standards.

[From NFPA 72 - 1990, 3-7.2.1 modified]

3-8.10 Pump Supervision. Automatic fire pumps and special service pumps shall be supervised in accordance with NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*, and the authority having jurisdiction.

[From NFPA 72 - 1990, 3-4.2.9 modified]

3-8.10.1 Supervision of electric power supplying the pump shall be made on the line side of the motor starter. All phases and phase reversal shall be supervised.

[From NFPA 71, 3-4.4.6 modified]

3-8.10.2 Where both sprinkler supervisory signals and pump running signals are transmitted over the same signaling circuits, provisions shall be made to obtain pump running signal preference unless the circuit is so arranged that no signals will be lost.

[From NFPA 72 - 1990, 3-4.2.9]

3-8.11 Tampering.

[From NFPA 72, 3-4.3]

3-8.11.1 Automatic fire suppression system alarm and supervisory signal initiating devices and their circuits shall be so designed and installed that they cannot be readily tampered with, opened, or removed without initiating a signal. This provision specifically includes junction boxes installed outside of buildings to facilitate access to the initiating device circuit.

[From NFPA 72 - 1990, 3-4.3.1 modified]

3-8.11.2* If a valve is installed in the connection between a signal attachment and the fire suppression system to which it is attached, such a valve shall be supervised in accordance with the requirements of Chapter 5.

[From NFPA 72 - 1990, 3-4.3.2]

3-8.12 Guard's Tour Supervisory Service.

[From NFPA 72 - 1990, 3-5 modified]

3-8.12.1 Guard's tour reporting stations shall be listed for the application.

[New paragraph]

3-8.12.2 The number of guard's tour reporting stations, their locations, and the route to be followed by the guard for operating the stations shall be approved for the particular installation in accordance with NFPA 601, *Standard on Guard Service in Fire Loss Prevention*.

[From NFPA 72 - 1990, 3-5.1.1 modified]

3-8.12.3 A permanent record indicating every time each signal-transmitting station is operated shall be made at the

main control unit. Where intermediate stations that do not transmit a signal are employed in conjunction with signal-transmitting stations, distinctive signals shall be transmitted at the beginning and end of each tour of a guard, and a signal-transmitting station shall be provided at intervals not exceeding ten stations. Intermediate stations that do not transmit a signal shall be capable of operation only in a fixed sequence.

[From NFPA 72 - 1990, 3-5.1.3 and 3-5.2.7]

3-8.13 Suppressed (Exception Reporting) Signal System.

[From NFPA 72 - 1990, 3-5.2]

3-8.13.1 The system shall comply with the provisions of 3-8.12.2.

[From NFPA 72 - 1990, 3-5.2.1, and NFPA 71, 3-2.2.1]

3-8.13.2 The system shall transmit a start signal to the signal-receiving location and shall be initiated by the guard at the start of continuous tour rounds.

[From NFPA 72 - 1990, 3-5.2.2 modified, and NFPA 71, 3-2.2.2]

3-8.13.3 The system shall automatically transmit a delinquency signal within 15 minutes after the predetermined actuation time if the guard fails to actuate a tour station as scheduled.

[From NFPA 72 - 1990, 3-5.2.3, and NFPA 71, 3-2.2.3]

3-8.13.4 A finish signal shall be transmitted within a predetermined interval after the guard completes each tour of the premises.

[From NFPA 72 - 1990, 3-5.2.4, and NFPA 71, 3-2.2.4]

3-8.13.5 For periods of over 24 hours, during which tours are continuously conducted, a start signal shall be transmitted at least every 24 hours.

[From NFPA 72 - 1990, 3-5.2.5, and NFPA 71, 3-2.2.6]

3-8.13.6 The start, delinquency, and finish signals shall be recorded at the signal-receiving location.

[From NFPA 72 - 1990, 3-5.2.6 modified, and NFPA 71, 3-2.2.7]

3-8.14 Combination Systems.

[From NFPA 72 - 1990, 3-6]

3-8.14.1* Fire alarm systems shall be permitted to share components, equipment, circuitry, and installation wiring with nonfire alarm systems.

[From NFPA 72 - 1990, 3-6.1 modified]

3-8.14.2 Where common wiring is employed for combination systems, the equipment for other than fire alarm systems shall be permitted to be connected to the common wiring of the system. Short circuits, open circuits, or grounds in this equipment or between this equipment and the fire alarm system wiring shall not interfere with the supervision of the fire alarm system or prevent alarm or supervisory signal transmissions.

[From NFPA 72 - 1990, 3-6.2 modified]

3-8.14.3 To maintain the integrity of fire alarm system functions, the removal, replacement, failure, or maintenance procedure on any hardware, software, or circuit not required to perform any of the fire alarm system functions shall not cause loss of any of these functions.

[From NFPA 72 - 1990, 3-6.3]

Exception: Where the hardware, software, and circuits are listed for fire alarm use.

3-8.14.4 Speakers used as alarm notification appliances on fire alarm systems shall not be used for nonemergency purposes.

[New paragraphs]

Exception: Where the fire command station is constantly attended by a trained operator, selective paging shall be permitted.

[From NFPA 72 - 1990, 3-6.4]

3-8.14.5 In combination systems, fire alarm signals shall be distinctive, clearly recognizable, and take precedence over any other signal even when a nonfire alarm signal is initiated first.

[From NFPA 72 - 1990, 3-6.5 modified]

3-8.15 Elevator Recall for Fire Fighters' Service.

[From NFPA 72 - 1990, 3-7.3]

3-8.15.1* System type smoke detectors located in elevator lobbies, elevator hoistways, and elevator machine rooms, which are used to initiate fire fighters' service recall, shall be connected to the building fire alarm system. In facilities without a building fire alarm system, these smoke detectors shall be connected to a dedicated fire alarm system control unit that shall be designated "Elevator Recall Control and Supervisory Panel" on the record drawings. Unless otherwise required by the authority having jurisdiction, only the elevator lobby, elevator hoistway, and the elevator machine room smoke detectors shall be used to recall elevators for fire fighters' service.

[From NFPA 72 - 1990, 3-7.3.1 modified]

3-8.15.2 Each elevator lobby, elevator hoistway, and elevator machine room smoke detector shall be capable of initiating elevator recall when all other devices on the same initiating device circuit have been manually or automatically placed in the alarm condition.

[From NFPA 72 - 1990, 3-7.3.2]

3-8.15.3 When actuated, each elevator lobby, elevator hoistway, and elevator machine room smoke detector shall initiate an alarm condition on the building fire alarm system and shall visibly indicate, at the control unit and required remote annunciators, the alarm initiation circuit or zone from which the alarm originated.

[From NFPA 72 - 1990, 3-7.3.3]

Exception: Where approved by the authority having jurisdiction, the elevator hoistway and machine room detectors shall be permitted to initiate a supervisory signal.

[New paragraph]

3-8.15.4* For each group of elevators within a building, two elevator control circuits shall be terminated at the designated elevator controller within the group's elevator

machine room(s). The operation of the elevators shall be in accordance with ANSI/ASME A17.1, *Safety Code for Elevators and Escalators*, Rules 211.3 through 211.8. The smoke detectors shall be connected to the two elevator control circuits as follows:

(a) The smoke detector located in the designated elevator recall lobby shall be connected to the first elevator control circuit.

[From NFPA 72 - 1990, 3-7.3.5]

(b) The smoke detectors in the remaining elevator lobbies, elevator hoistways, and the elevator machine room shall be connected to the second elevator control circuit except that when the elevator machine room is located at the designated landing, then that elevator machine room smoke detector shall be connected to the first elevator control circuit. In addition, where the elevator is equipped with front and rear doors, then the smoke detectors in both lobbies at the designated level shall be connected to the first elevator control circuit.

3-8.16 Elevator Shutdown.

3-8.16.1* Where heat detectors are used to shut down elevator power prior to sprinkler operation, the detector shall have both a lower temperature rating and a higher sensitivity [often characterized by a lower Response Time Index (RTI)] when compared to the sprinkler.

3-8.16.2 Where heat detectors are used for elevator power shutdown prior to sprinkler operation, they shall be placed within 2 feet of each sprinkler head and be installed in accordance with the requirements of Chapter 5. Alternatively, engineering methods (such as in Appendix B) shall be permitted to be used to select and place heat detectors to ensure response prior to any sprinkler head under a variety of fire growth rate scenarios.

3-8.16.3* Where pressure or waterflow switches are used to shut down elevator power immediately upon or prior to the discharge of water from sprinklers, the use of devices with time delays shall not be permitted.

3-9 Fire Safety Control Functions.

3-9.1 Scope. The provisions of this section apply to the minimum requirements for the interconnection of fire safety control functions (e.g., fan control, door control, etc.) to the fire alarm system. These fire safety functions are not intended to provide notification of alarm, supervisory, or trouble conditions; alert or control occupants; or summon aid.

3-9.2 General.

3-9.2.1 An auxiliary relay connected to the fire alarm system used to initiate control of fire safety functions shall be located within 3 ft (1 m) of the controlled circuit or device. The auxiliary relay shall function within the voltage and current limitations of the control unit. The installation wiring between the fire alarm system control unit and the auxiliary relay shall be monitored for integrity.

Exception: Control devices that operate on loss of power or on loss of power to the auxiliary relay shall be considered self-monitoring for integrity.

3-9.2.2 Fire safety functions shall not interfere with other operations of the fire alarm control system.

3-9.2.3 Transfer of data over listed serial communication ports shall be an acceptable means of interfacing between the fire alarm control unit and fire safety function control devices.

3-9.2.4 The fire safety function control devices shall be listed as compatible with the fire alarm control unit, so as not to interfere with the control unit's operation.

3-9.2.5 The interfaced systems shall be acceptance tested together in the presence of the authority having jurisdiction to ensure proper operation of the fire alarm system and the interfaced system(s).

3-9.2.6 Where manual controls for emergency control functions are required to be provided, they shall provide visible indication of the status of the associated control circuits.

3-9.3 Heating, Ventilation, and Air Conditioning (HVAC) Systems.

3-9.3.1 The provisions of 3-9.3 apply to the basic method by which a fire alarm system interfaces with the HVAC systems.

3-9.3.2 All detection devices used to cause the operation of smoke dampers, fire dampers, fan control, smoke doors, and fire doors shall be monitored for integrity in accordance with 1-5.8 where connected to the fire alarm system serving the protected premises.

3-9.3.3 Connections between fire alarm systems and the HVAC system for the purpose of monitoring and control shall operate and be monitored in accordance with applicable NFPA standards.

3-9.4 Door Release Service.

3-9.4.1 This section applies to the methods of connection of door hold release devices and to integral door hold release, closer, and smoke detection devices.

3-9.4.2 All detection devices used for door hold release service, whether integral or stand alone, shall be monitored for integrity in accordance with 1-5.8 where connected to the fire alarm system serving the protected premises.

3-9.4.3 All door hold release and integral door release and closure devices used for release service shall be monitored for integrity in accordance with 3-9.2.

3-9.5 Door Unlocking Devices.

3-9.5.1 Any device or system intended to effect the locking/unlocking of emergency exits shall be connected to the fire alarm system serving the protected premises.

3-9.5.2 All emergency exits connected in accordance with 3-9.5.1 shall unlock upon receipt of any fire alarm signal by the fire alarm system serving the protected premises.

3-9.5.3 All emergency exits connected in accordance with 3-9.5.1 shall unlock upon loss of the primary power to the fire alarm system serving the protected premises. The secondary power supply shall not be utilized to maintain these doors in the locked condition.

3-10 Suppression System Actuation.

3-10.1 Fire alarm systems listed for releasing service shall be permitted to provide automatic or manual actuation of fire suppression systems.

3-10.2 The integrity of each releasing device (e.g., solenoid, relay, etc.) shall be supervised in accordance with applicable NFPA standards.

3-10.3 The integrity of the installation wiring shall be monitored in accordance with the requirements of Chapter 1.

3-10.4 Fire alarm systems used for fire suppression releasing service shall be provided with a disconnect switch to permit system testing without activating the fire suppression systems. Operation of the disconnect switch shall cause a trouble signal at the fire alarm control unit.

3-10.5 Sequence of operation shall be consistent with the applicable suppression system standards.

3-10.6* Each space protected by an automatic fire suppression system actuated by the fire alarm system shall contain one or more automatic fire detectors installed in accordance with Chapter 5.

3-11* Interconnected Fire Alarm Control Units. Fire alarm systems shall be permitted to be either integrated systems combining all detection, notification, and auxiliary functions in a single system, or a combination of component subsystems. Fire alarm system components shall be permitted to share control equipment or be able to operate as stand alone subsystems, but shall in any case be arranged to function as a single system. All component subsystems shall be capable of simultaneous, full load operation without degradation of the required, overall system performance.

3-11.1 The method of interconnection of control units shall be by the following recognized means:

- (a) Properly rated electrical contacts
- (b) Compatible digital data interfaces
- (c) Other listed methods

and shall meet the monitoring requirements of 1-5.8 and the requirements of NFPA 70, *National Electrical Code*, Article 760.

3-11.2 Where approved by the authority having jurisdiction, interconnected control units providing localized detection, evacuation signaling, and auxiliary functions shall be permitted to be monitored by a fire alarm system as initiating devices.

3-11.2.1 Each interconnected control unit shall be separately monitored for alarm, trouble, and supervisory conditions.

3-11.2.2 Interconnected control unit alarm signals shall be permitted to be monitored by zone or combined as common signals as appropriate.

[New paragraphs and titles]

3-12 Emergency Voice/Alarm Communications.

[From NFPA 72 - 1990, Chap. 10]

3-12.1 Application. This section describes the requirements for emergency voice/alarm communications. The primary purpose is to provide dedicated manual and automatic facilities for the origination, control, and transmission of information and instructions pertaining to a fire alarm emergency to the occupants (including fire department personnel) of the building. It is the intent of this section to establish the minimum requirements for emergency voice/alarm communications.

3-12.2 Monitoring the integrity of speaker amplifiers, tone-generating equipment, and two-way telephone communications circuits shall be in accordance with 1-5.8.5.

3-12.3 Survivability.

3-12.3.1 The fire command station and the central control unit shall be located within a minimum 1-hour rated fire-resistive area and shall have a minimum 3-ft (1-m) clearance about the face of the fire command station control equipment.

Exception: Where approved by the authority having jurisdiction, the fire command station control equipment shall be permitted to be located in a lobby or other approved space.

[From NFPA 72 - 1990, 10-3.2 modified]

3-12.3.2 Where the fire command station control equipment is remote from the central control equipment, the wiring between the two shall be installed in conduit or other metal raceway that is routed through areas whose characteristics are at least equal to the limited combustible characteristics as defined in NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*. The maximum run of conduit or raceway shall not exceed 100 ft (30 m) or shall be enclosed in a 2-hour fire rated enclosure.

[From NFPA 72 - 1990, 10-3.3]

3-12.3.3 The primary power supply installation wiring between the central control equipment and the main service entrance shall also be routed through areas whose characteristics are at least equal to the limited combustible characteristics as defined in NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*.

[From NFPA 72 - 1990, 10-3.4]

3-12.3.4 The secondary (standby) power supply shall be provided in accordance with 1-5.2.5.

[From NFPA 72 - 1990, 10-3.5 modified]

3-12.4 Voice/Alarm Signaling Service.

[From NFPA 72 - 1990, 10-4]

3-12.4.1* General. The purpose of the voice/alarm signaling service is to provide an automatic response to the receipt of a signal indicative of a fire emergency. Subsequent manual control capability of the transmission and audible reproduction of evacuation tone signals, alert tone signals, and voice directions on a selective and all-call basis, as determined by the authority having jurisdiction, is also required from the fire command station.

Exception: Where the fire command station or remote monitoring location is constantly attended by trained operators, and operator acknowledgment of receipt of a fire alarm signal is received within 30 seconds, automatic response is not required.

[From NFPA 72 - 1990, 10-4.1]

3-12.4.2 Multichannel Capability. When required by the authority having jurisdiction, the system shall allow the application of an evacuation signal to one or more zones and, at the same time, shall permit voice paging to the other zones selectively or in any combination.

[From NFPA 72 - 1990, 10-4.2]

3-12.4.3 Functional Sequence.

[From NFPA 72 - 1990, 10-4.3]

3-12.4.3.1 In response to an initiating signal indicative of a fire emergency, the system shall automatically transmit, either immediately or after a delay acceptable to the authority having jurisdiction, the following:

[From NFPA 72 - 1990, 10-4.3.1]

(a) An alert tone of 3 to 10 seconds' duration followed by a message (or messages when multichannel capability is provided) shall be repeated at least three times to direct the occupants of the alarm signal initiation zone and other zones in accordance with the building's fire evacuation plan; or

(b) An evacuation signal to the alarm signal initiation zone and other zones in accordance with the building's fire evacuation plan.

[From NFPA 72 - 1990, 10-4.3.1 modified]

3-12.4.3.2 Failure of the message described by 3-12.4.3.1(a), where used, shall sound the evacuation signal automatically. Provisions for manual initiation of voice instructions or evacuation signal generation shall be provided.

Exception: Different functional sequences shall be permitted where approved by the authority having jurisdiction.

[From NFPA 72 - 1990, 10-4.3.2 modified]

3-12.4.3.3 Live voice instructions shall override all previously initiated signals on that channel.

[From NFPA 72 - 1990, 10-4.3.3]

3-12.4.3.4 Where provided, manual controls for emergency voice/alarm communications shall be arranged to provide visible indication of the on/off status for their associated evacuation zones.

[New paragraph]

3-12.4.4 Voice and Tone Devices. The alert tone preceding any message shall be permitted to be a part of the voice message or to be transmitted automatically from a separate tone generator.

[From NFPA 72 - 1990, 10-4.4.1]

3-12.4.5 Fire Command Station.

[From NFPA 72 - 1990, 10-4.5]

3-12.4.5.1 A fire command station shall be provided near a building entrance or other location approved by the

authority having jurisdiction. The fire command station shall provide a communications center for the arriving fire department and shall provide for control and display of the status of detection, alarm, and communications systems. The fire command station shall be permitted to be physically combined with other building operations and security centers as permitted by the authority having jurisdiction. Operating controls for use by the fire department shall be clearly marked.

[From NFPA 72 - 1990, 10-4.5.1]

3-12.4.5.2 The fire command station shall control the emergency voice/alarm communications signaling service and, where provided, the two-way telephone communications service.

[From NFPA 72 - 1990, 10-4.5.2]

3-12.4.6 Loudspeakers.

[From NFPA 72 - 1990, 10-4.6]

3-12.4.6.1 Loudspeakers and their enclosures shall be listed for voice/alarm signaling service and installed in accordance with Chapter 6.

[From NFPA 72 - 1990, 10-4.6.1 modified]

3-12.4.6.2* There shall be at least two loudspeakers in each paging zone of the building, so located that signals can be clearly heard regardless of the maximum noise level produced by machinery or other equipment under normal conditions of occupancy. (See Section 6-3.)

[From NFPA 72 - 1990, 10-4.6.2 modified]

3-12.4.6.3 Each elevator car shall be equipped with a single loudspeaker connected to the paging zone serving the elevator group in which the elevator car is located.

[From NFPA 72 - 1990, 10-4.6.3]

3-12.5 Evacuation Signal Zoning.

3-12.5.1 Where two or more evacuation signaling zones are provided, such zones shall be arranged consistent with the fire or smoke barriers within the protected premises. Undivided fire areas shall not be divided into multiple evacuation signaling zones.

NOTE: This section does not prohibit provision of multiple notification appliance circuits within a single evacuation signaling zone (i.e., separate circuits for audible and visible signals, redundant circuits provided to enhance survivability, or multiple circuits necessary to provide sufficient power/capacity).

Exception: Stairwells not exceeding two stories in height.

3-12.5.2 Where multiple notification appliance circuits are provided within an single evacuation signaling zone, all of the notification appliances within the zone shall be arranged to activate simultaneously, either automatically or by actuation of a common, manual control.

Exception: Where the different notification appliance circuits within an evacuation signaling zone perform separate functions (i.e., prealarm and general alarm signals, predischARGE and discharge signals, etc.).

[New paragraphs and title]

3-12.6 Two-Way Telephone Communications Service.

[From NFPA 72 - 1990, 10-5]

3-12.6.1 Two-way telephone communications equipment shall be listed for two-way telephone communications service and installed in accordance with 3-12.6.

[From NFPA 72 - 1990, 10-5.1 modified]

3-12.6.2 Two-way telephone communications service, where provided, shall be available for use by the fire service. Additional uses, where specifically permitted by the authority having jurisdiction, shall be permitted to include signaling and communication for a building fire warden organization, signaling and communication for reporting a fire and other emergencies, (i.e., voice call box service, signaling, and communication for guard's tour service) and other uses. Variation of equipment and system operation provided to facilitate additional use of the two-way telephone communications service shall not adversely affect performance when used by the fire service.

[From NFPA 72 - 1990, 10-5.2]

3-12.6.3* Two-way telephone communications service shall be capable of permitting the simultaneous operation of any five telephone stations in a common talk mode.

[From NFPA 72 - 1990, 10-5.3]

3-12.6.4 A notification signal at the fire command station, distinctive from any other alarm or trouble signal, shall indicate the off-hook condition of a calling telephone circuit. Where a selective talk telephone communications service is supplied, a distinctive visible indicator shall be furnished for each selectable circuit so that all circuits with telephones off-hook are continuously and visibly indicated.

[From NFPA 72 - 1990, 10-5.5]

3-12.6.5 A switch for silencing the audible call-in signal sounding appliance shall be permitted only if it is key operated, in a locked cabinet, or given equivalent protection from use by unauthorized persons. Such a switch shall be permitted only if it operates a visible indicator and sounds a trouble signal whenever the switch is in the silence position where there are no telephone circuits in an off-hook condition. Where a selective talk telephone system is used, such a switch shall be permitted only if subsequent telephone circuits going off-hook will operate the distinctive off-hook audible signal sounding appliance.

[From NFPA 72 - 1990, 10-5.6]

3-12.6.6 The minimum requirement for fire service use shall be common talk, i.e., a conference or party line circuit. The minimum requirement for fire warden use, where provided, shall be a selective talking system controlled at the fire command station. Either system shall be capable of operation with five telephone stations connected together. There shall be at least one fire service telephone station or jack per floor and at least one per exit stairway. Where provided, there shall be at least one fire warden station or jack to serve each fire paging zone.

[From NFPA 72 - 1990, 10-5.7]

3-12.6.7 Where the control equipment provided does not indicate the location of the caller (common talk systems), each telephone station or phone jack shall be clearly and permanently labeled to allow the caller to readily identify his location to the fire command station by voice.

3-12.6.8 Where telephone jacks are provided, a sufficient quantity of portable handsets, as determined by the authority having jurisdiction, shall be stored at the fire command station for distribution during an incident to responding personnel.

[New paragraphs]

3-13* Special Requirements for Low Power Radio (Wireless) Systems.

[From NFPA 72 - 1990, 6-5 modified]

3-13.1 Compliance with this section shall require the use of low power radio equipment specifically listed for the purpose.

NOTE: Equipment solely listed for household use does not comply with this requirement.

[From NFPA 72 - 1990, 6-5.1 modified]

3-13.2 Power Supplies. A primary battery (dry cell) shall be permitted to be used as the sole power source of a low power radio transmitter when all of the following conditions are met:

(a) Each transmitter shall serve only one device and shall be individually identified at the receiver/control unit.

(b) The battery shall be capable of operating the low power radio transmitter for not less than one year before the battery depletion threshold is reached.

(c) A battery depletion signal shall be transmitted before the battery has depleted to a level insufficient to support alarm transmission after 7 additional days of normal operation. This signal shall be distinctive from alarm, supervisory, tamper, and trouble signals; shall visibly identify the affected low power radio transmitter; and, if silenced, shall automatically resound at least once every 4 hours.

(d) Catastrophic (open or short) battery failure shall cause a trouble signal identifying the affected low power radio transmitter at its receiver/control unit. If silenced, the trouble signal shall automatically resound at least once every 4 hours.

(e) Any mode of failure of a primary battery in a low power radio transmitter shall not affect any other low power radio transmitter.

[From NFPA 72 - 1990, 6-5.2 modified]

3-13.3 Alarm Signals.

[From NFPA 72 - 1990, 6-5.3]

3-13.3.1 When actuated, each low power radio transmitter shall automatically transmit an alarm signal.

NOTE: This requirement is not intended to preclude verification and local test intervals prior to alarm transmission.

[From NFPA 72 - 1990, 6-5.3.1 modified]

3-13.3.2 Each low power radio transmitter shall automatically repeat alarm transmission at intervals not exceeding 60 seconds until the initiating device is returned to its normal condition.

[From NFPA 72 - 1990, 6-5.3.2 modified]

3-13.3.3 Fire alarm signals shall have priority over all other signals.

[From NFPA 72 - 1990, 6-5.3.3 modified]

3-13.3.4 The maximum allowable response delay from activation of an initiating device to receipt and display by the receiver/control unit shall be 90 seconds.

[From NFPA 72 - 1990, 6-5.3.4 modified]

3-13.3.5 An alarm signal from a low power radio transmitter shall latch at its receiver/control unit until manually reset and shall identify the particular initiating device in alarm.

[From NFPA 72 - 1990, 6-5.3.5 modified]

3-13.4 Supervision.

[From NFPA 72 - 1990, 6-5.4]

3-13.4.1 The low power radio transmitter shall be specifically listed as using a transmission method that shall be highly resistant to misinterpretation of simultaneous transmissions and to interference (e.g., impulse noise and adjacent channel interference).

[From NFPA 72 - 1990, 6-5.4.1 modified]

3-13.4.2 The occurrence of any single fault that disables transmission between any low power radio transmitter and the receiver/control unit shall cause a latching trouble signal within 200 seconds.

Exception: Where Federal Communications Commission (FCC) regulations prevent meeting the 200-second requirement, the time period for a low power radio transmitter with only a single alarm initiating device connected shall be permitted to be increased to four times the minimum time interval permitted for a one-second transmission up to:

(a) *Four hours maximum for a transmitter serving a single initiating device*

(b) *Four hours maximum for a re-transmission device (repeater) if disabling of the repeater or its transmission does not prevent the receipt of signals at the receiver/control unit from any initiating device transmitter.*

[From NFPA 72 - 1990, 6-5.4.2 modified]

3-13.4.3 A single fault on the signaling channel shall not cause an alarm signal.

[From NFPA 72 - 1990, 6-5.4.3]

3-13.4.4 The normal periodic transmission from a low power radio transmitter shall provide assurance of successful alarm transmission capability.

[From NFPA 72 - 1990, 6-5.4.4 modified]

3-13.4.5 Removal of a low power radio transmitter from its installed location shall cause immediate transmission of a distinctive supervisory signal that indicates its removal and individually identifies the affected device. Household fire warning systems do not need to comply with this requirement.

[From NFPA 72 - 1990, 6-5.4.5 modified]

3-13.4.6 Reception of any unwanted (interfering) transmission by a retransmission device (repeater) or by the main receiver/control unit, for a continuous period of 20 seconds or more, shall cause an audible and visible trouble indication at the main receiver/control unit. This indication shall identify the specific trouble condition present as an interfering signal.

[From NFPA 72 - 1990, 6-5.4.6 modified]

Chapter 4 Supervising Station Fire Alarm Systems

4-1 Scope. This chapter covers the requirements for the proper performance, installation, and operation of fire alarm systems between the protected premises and the continuously attended supervising station facility.

4-2 Communication Methods for Off-Premises Fire Alarm Systems.

NOTE: The requirements of Chapters 1, 3, 5, 6, and 7 shall apply to off-premises fire alarm systems unless they conflict with requirements of this section.

4-2.1 Scope. This section describes the requirements for the methods of communication between the protected premises and the supervising station. This includes the transmitter, transmission channel, and the signal receiving, processing, display, and recording equipment at the supervising station.

[New paragraphs and titles]

4-2.2 General.

[From NFPA 71, 4-1]

4-2.2.1 Applicable Requirements. The requirements of Sections 4-1, 4-3, 4-4, 4-5, 4-6, and 4-7 shall apply to active multiplex, including systems utilizing derived channels; digital alarm communicator systems, including digital alarm radio systems; McCulloh systems; two-way RF multiplex systems; and one-way radio alarm systems, except where they conflict with the requirements of this section.

[From NFPA 71, 4-1.1 modified, 5-1.1 modified, 6-1.1 modified, 7-1.1 modified, and 8-1.1 modified]

4-2.2.2 Equipment.

[From NFPA 71, 4-1.2]

4-2.2.2.1 Wiring, power supplies, and overcurrent protection shall comply with the requirements of 1-5.5.4 and 1-5.8.6.

[From NFPA 71, 4-1.2.1 modified, 7-1.2.1 modified, and 8-1.2.1 modified]

4-2.2.2.2 Exclusive of the transmission channel, grounding of fire alarm equipment shall be permitted.

[From NFPA 71, 4-1.2.2 modified]

4-2.2.2.3 Fire alarm system equipment and installations shall comply with Federal Communication Commission (FCC) rules and regulations, as applicable, concerning electromagnetic radiation; use of radio frequencies; and connection to the public switched telephone network of telephone equipment, systems, and protection apparatus.

[From NFPA 71, 5-1.3 modified, 8-1.1 modified, and NFPA 72, 8-7.1.3 modified]

4-2.2.2.4 Equipment shall be installed in compliance with NFPA 70, *National Electrical Code*, Article 810.

4-2.2.2.5 All external antennas shall be protected in order to minimize the possibility of damage by static discharge or lightning.

[From NFPA 71, 7-1.2.2 modified and 8-1.2.2 modified]

4-2.2.3 Adverse Conditions.

4-2.2.3.1 For active and two-way RF multiplex systems, the occurrence of an adverse condition on the transmission channel between a protected premises and the supervising station that will prevent the transmission of any status change signal shall be automatically indicated and recorded at the supervising station. This indication and record shall identify the affected portions of the system so that the supervising station operator can determine the location of the adverse condition by trunk or leg facility, or both.

[From NFPA 71, 4-3.1.2 modified, 7-3.1.2 modified, and 8-3.1.2 modified]

4-2.2.3.2 For a one-way radio alarm system, the system shall be supervised to ensure that at least two independent radio alarm repeater station receivers (RARSRs) are receiving signals for each radio alarm transmitter (RAT) during each 24-hour period. The occurrence of a failure to receive a signal by either RARSR shall be automatically indicated and recorded at the supervising station. The indication shall identify which RARSR has failed to receive such supervisory signals. It is not necessary for correctly received test signals to be indicated at the supervising station.

[From NFPA 71, 8-3.1.2 modified]

4-2.2.3.3 For active and two-way RF multiplex systems, restoration of normal service to the affected portions of the system shall be automatically recorded. When normal service is restored, the first status change of any initiating device circuit, or any initiating device directly connected to a signaling line circuit, or any combination that occurred at any of the affected premises during the service interruption shall also be recorded.

[From NFPA 71, 4-3.1.2 modified, 7-3.1.2 modified, and 8-3.1.2 modified]

Exception: This requirement does not apply to proprietary systems on contiguous properties.

[New paragraph]

4-2.2.4 Dual Control.

4-2.2.4.1 Dual control, where required, shall provide for redundancy in the form of a standby circuit or similar alternate means of transmitting signals over the primary trunk portion of a transmission channel. The same method of signal transmission shall be permitted to be used over separate routes, or different methods of signal transmission shall be permitted to be utilized. Public switched telephone network facilities shall be used only as the alternate method of transmitting signals.

4-2.2.4.2 Where utilizing facilities leased from a telephone company, that portion of the primary trunk facility between the supervising station and its serving wire center shall be permitted to be excepted from the separate routing requirement of the primary trunk facility. Dual control, where used, requires supervision as follows:

(a) Dedicated facilities, which are available full time and whose use is limited to signaling purposes as defined in this code, shall be exercised at least once every hour.

(b) Public switched telephone network facilities shall be exercised at least once every 24 hours.

[From NFPA 71, 4-3.1.3 modified and 7-3.1.3 modified]

4-2.3 Communication Methods.

4-2.3.1 Active Multiplex Transmission Systems.

[New titles]

4-2.3.1.1 The multiplex transmission channel terminates in a transmitter at the protected premises and in a system unit at the supervising station. The derived channel terminates in a transmitter at the protected premises and in derived channel equipment at a subsidiary station location or a telephone company wire center. The derived channel equipment at the subsidiary station location or a telephone company wire center selects or establishes the communication with the supervising station.

[From NFPA 71, 4-3.1 modified]

4-2.3.1.2* Operation of the transmission channel shall conform to the requirements of this code whether channels are private facilities, such as microwave, or leased facilities furnished by a communication utility company. Where private signal transmission facilities are utilized, the equipment necessary to transmit signals shall also comply with the requirements for duplicate equipment or replacement of critical components, as described in 4-2.4.2. The trunk transmission channels shall be dedicated facilities for the main channel. For Type 1 multiplex systems, the public switched telephone network facilities shall be permitted to be used for the alternate channel.

Exception: Derived channel scanners with no more than 32 legs shall be permitted to use the public switched telephone network for the main channel.

[From NFPA 71, 4-3.1.1 modified]

4-2.3.1.2.1 Derived channel signals shall be permitted to be transmitted over the leg facility, which shall be permitted to be shared by the telephone equipment under all normal on-hook and off-hook operating conditions.

[From NFPA 71, 4-3.1.1.1 modified]

4-2.3.1.2.2 Where used, the public switched telephone network shall be in compliance with the requirements of 4-2.3.2.

[From NFPA 71, 4-3.1.1.2 modified]

4-2.3.1.2.3 The maximum end-to-end operating time parameters allowed for an active multiplex system are as follows:

(a) The maximum allowable time lapse from the initiation of a single fire alarm signal until it is recorded at the supervising station shall not exceed 90 seconds. When any number of subsequent fire alarm signals occur at any rate, they shall be recorded at a rate no slower than one every 10 additional seconds.

(b)* The maximum allowable time lapse from the occurrence of an adverse condition in any transmission channel until recording of the adverse condition is started shall not exceed 90 seconds for Type 1 and Type 2 systems, and 200 seconds for Type 3 systems. (See 4-2.3.1.3.)

(c) In addition to the maximum operating time allowed for fire alarm signals, the requirements of one of the following paragraphs shall be met:

1. A system unit having more than 500 initiating device circuits shall be able to record not less than 50 simultaneous status changes in 90 seconds.

2. A system unit having fewer than 500 initiating device circuits shall be able to record not less than 10 percent of that total number of simultaneous status changes within 90 seconds.

[From NFPA 71, 4-2.1.3 modified]

4-2.3.1.3 System Classification. Active multiplex systems are divided into three categories based upon their ability to perform under adverse conditions of their transmission channels. System classifications are as follows:

(a) A Type 1 system shall have dual control as described in 4-2.2.4. An adverse condition on a trunk or leg facility shall not prevent the transmission of signals from any other trunk or leg facility, except those normally dependent on the portion of the transmission channel in which the adverse condition has occurred. An adverse condition limited to a leg facility shall not interrupt normal service on any trunk or other leg facility. The requirements of 4-2.2.1, 4-2.2.2, and 4-2.2.3 shall be met by Type 1 systems.

(b) A Type 2 system shall have the same requirements as a Type 1 system, except that dual control of the primary trunk facility shall not be required.

(c) A Type 3 system shall automatically indicate and record at the supervising station the occurrence of an adverse condition on the transmission channel between a protected premises and the supervising station. The requirements of 4-2.2, except for 4-2.2.4, shall be met.

[From NFPA 71, 4-3.1.4 modified]

4-2.3.1.4 System Loading Capacities. The capacities of active multiplex systems are based on the overall reliability of the signal receiving, processing, display, and recording equipment at the supervising and subsidiary stations, and the capability to transmit signals during adverse conditions of the signal transmission facilities. Table 4-2.3.1.4 establishes the allowable capacities.

[From NFPA 71, 4-4.1 modified]

4-2.3.1.5 Exceptions to Loading Capacities Listed in Table 4-2.3.1.4. Where the signal receiving, processing, display, and recording equipment is duplicated at the supervising station and a switch-over can be accomplished in not more than 30 seconds with no loss of signals during this period, the capacity of a system unit shall be unlimited.

[From NFPA 71, 4-4.2 modified]

4-2.3.2 Digital Alarm Communicator Systems.

[From NFPA 71, Chap. 5, and NFPA 72, 8-7]

4-2.3.2.1 Digital Alarm Communicator Transmitter (DACT).

[From NFPA 71, 5-2, and NFPA 72, 8-7.2]

4-2.3.2.1.1 A DACT shall be connected to the public switched telephone network upstream of any private telephone system at the protected premises. In addition, special attention is required to ensure that this connection shall be made only to a loop start telephone circuit and not to a ground start telephone circuit.

Exception: If public cellular telephone service is utilized as a secondary means of transmission, the requirements of this paragraph shall not apply.

[From NFPA 71, 5-2.1 modified, and NFPA 72, 8-7.2.1 modified]

Table 4-2.3.1.4

	System Type		
	Type 1	Type 2	Type 3
A. Trunks			
Maximum number of fire alarm service initiating device circuits per primary trunk facility	5120	1280	256
Maximum number of leg facilities for fire alarm service per primary trunk facility	512	128	64
Maximum number of leg facilities for all types of fire alarm service per secondary trunk facility*	128	128	128
Maximum number of all types of initiating device circuits per primary trunk facility in any combination*	10,240	2560	512
Maximum number of leg facilities for all types of fire alarm service per primary trunk facility in any combination*	1024	256	128
B. System Units at the Supervising Station			
Maximum number of all types of initiating device circuits per system unit*	10,240**	10,240**	10,240**
Maximum number of fire protecting buildings and premises per system unit	512**	512**	512**
Maximum number of fire alarm service initiating device circuits per system unit	5120**	5120**	5120**
C. Systems Emitting from Subsidiary Station	Same as B	Same as B	Same as B

*Includes every initiating device circuit, i.e., waterflow, fire alarm, supervisory, guard, burglary, hold-up, etc.

**Paragraph 4-2.3.1.5 applies.

[From NFPA 71, Table 4-4.1 modified]

4-2.3.2.1.2 All information exchanged between the DACT at the protected premises and the digital alarm communicator receiver (DACR) at the supervising or subsidiary station shall be by digital code or equivalent. Signal repetition, digital parity check, or some equivalent means of signal verification shall be used.

[From NFPA 71, 5-2.2 modified, and NFPA 72, 8-7.2.2 modified]

4-2.3.2.1.3* A DACT shall be capable of seizing the telephone line (going off-hook) at the protected premises, disconnecting an outgoing or incoming telephone call, and preventing its use for outgoing telephone calls until signal transmission has been completed. A DACT shall not be connected to a party line telephone facility.

[From NFPA 71, 5-2.3, and NFPA 72, 8-7.2.3]

4-2.3.2.1.4 A DACT shall have the means to satisfactorily obtain an available dial tone, dial the number(s) of the DACR, obtain verification that the DACR is ready to receive signals, transmit the signal, and receive acknowledgment that the DACR has accepted that signal. In no event shall the time from going off-hook to on-hook exceed 90 seconds per attempt.

[From NFPA 71, 5-2.4, and NFPA 72, 8-7.2.4]

4-2.3.2.1.5* A DACT shall have suitable means to reset and retry if the first attempt to complete a signal transmission sequence is unsuccessful. A failure to complete connection shall not prevent subsequent attempts to transmit an alarm if such alarm is generated from any other initiating device circuit or signaling line circuit, or both. Additional attempts shall be made until the signal transmission sequence has been completed to a minimum of five and a maximum of ten attempts.

If the maximum number of attempts to complete the sequence is reached, an indication of the failure shall be made at the premises.

[From NFPA 71, 5-2.5, and NFPA 72, 8-7.2.5]

4-2.3.2.1.6 A DACT shall be connected to two separate means of transmission at the protected premises. The DACT shall be capable of selecting the operable means of transmission in the event of failure of the other. The primary means of transmission shall be a telephone line (number) connected to the public switched network.

4-2.3.2.1.6.1 The secondary means of transmission shall be permitted to be one of the following:

(a) A one-way radio system utilized in accordance with 4-2.3.2.3.

(b) Public cellular telephone service. A verification signal shall be transmitted at least once a month.

(c) A telephone line (number).

[From NFPA 71, 5-2.6 modified, and NFPA 72, 8-7.2.6 modified]

4-2.3.2.1.6.2 The first transmission attempt shall utilize the primary means of transmission.

[New paragraph]

4-2.3.2.1.7* Failure of either of the telephone lines (numbers) at the protected premises shall be annunciated at the protected premises, and a trouble signal shall be transmitted to the supervising or subsidiary station over the other line (number). Transmission shall be initiated within 4 minutes of detection of the fault. If public cellular telephone service is used as the secondary means of transmission, loss of cellular service shall be considered a failure.

[From NFPA 71, 5-2.7 modified, and NFPA 72, 8-7.2.7 modified]

4-2.3.2.1.8 Each DACT shall be programmed to call a second DACR line (number) should the signal transmission sequence to the first called line (number) be unsuccessful.

[From NFPA 71, 5-2.8, and NFPA 72, 8-7.2.8]

4-2.3.2.1.9 If long distance telephone service (including WATS) is used, the second telephone number shall be provided by a different long distance service provider, where available.

[From NFPA 71, 5-2.8.1 modified]

4-2.3.2.1.10 Each DACT shall automatically initiate and complete a test signal transmission sequence to its associated DACR at least once every 24 hours. A successful signal transmission sequence of any other type within the same 24-hour period shall be considered sufficient to fulfill the requirement to verify the integrity of the reporting system, if signal processing is automated so that 24-hour delinquencies shall be individually acknowledged by supervising station personnel.

[From NFPA 71, 5-2.9, and NFPA 72, 8-7.2.9]

4-2.3.2.1.11* If DACTs are programmed to call a telephone line (number) that is call forwarded to the line (number) of the DACR, a means shall be implemented to verify the integrity of the call forwarding feature every 4 hours.

[New paragraph]

4-2.3.2.2 Digital Alarm Communicator Receiver (DACR).

[From NFPA 71, 5-3, and NFPA 72, 8-7.3]

4-2.3.2.2.1 Equipment.

[From NFPA 71, 5-3.1, and NFPA 72, 8-7.3.1]

4-2.3.2.2.1.1 Spare DACRs shall be provided in the supervising or subsidiary station and shall be able to be switched in place of a failed unit within 30 seconds after detection of failure.

NOTE: One spare DACR shall be permitted to serve as a backup for up to five DACRs in use.

[From NFPA 71, 5-3.1.1 modified, and NFPA 72, 8-7.3.1.1 modified]

4-2.3.2.2.1.2 The number of incoming telephone lines to a DACR shall be limited to eight lines.

Exception: Where the signal receiving, processing, display, and recording equipment at the supervising or subsidiary station is duplicated and a switchover can be accomplished in less than 30

seconds with no loss of signal during this period, the number of incoming lines to the unit is unlimited.

[From NFPA 71, 5-3.1.2, and NFPA 72, 8-7.3.1.2]

4-2.3.2.2.2 Transmission Channel.

[From NFPA 71, 5-3.3 modified, and NFPA 72, 8-7.3.3 modified]

4-2.3.2.2.2.1* The DACR equipment at the supervising or subsidiary station shall be connected to a minimum of two separate incoming telephone lines (numbers). If the lines (numbers) are in a single hunt group, they shall be individually accessible; otherwise, separate hunt groups are required. These lines (numbers) are to be used for no other purpose than receiving signals from DACTs. These lines (numbers) shall be unlisted.

[From NFPA 71, 5-3.3.1 modified, and NFPA 72, 8-7.3.3.1 modified]

4-2.3.2.2.2.2 Failure of any telephone line (number) connected to a DACR due to loss of line voltage shall be annunciated visually and audibly in the supervising station.

[From NFPA 71, 5-3.3.2 modified, and NFPA 72, 8-7.3.3.2 modified]

4-2.3.2.2.2.3* The loading capacity for a hunt group shall be in accordance with Table 4-2.3.2.2.2.3 or be capable of demonstrating a 90 percent probability of immediately answering the incoming call.

[From NFPA 71, 5-3.3.3 modified, and NFPA 72, 8-7.3.3.3 modified]

(a) Each supervised burglar alarm (open/close) or each suppressed guard tour transmitter shall reduce the allowable DACTs as follows:

1. up to a 4-line hunt group, by 10
2. up to a 5-line hunt group, by 7
3. up to a 6-line hunt group, by 6
4. up to a 7-line hunt group, by 5
5. up to an 8-line hunt group, by 4.

(b) Each guard tour transmitter shall reduce the allowable DACTs as follows:

1. up to a 4-line hunt group, by 30
2. up to a 5-line hunt group, by 21
3. up to a 6-line hunt group, by 18
4. up to a 7-line hunt group, by 15
5. up to an 8-line hunt group, by 12.

[From NFPA 71, Table 5-3.3.3 modified]

4-2.3.2.2.2.4* A signal shall be received on each individual incoming DACR line at least once every 24 hours.

[From NFPA 71, 5-3.3.4, and NFPA 72, 8-7.3.3.4]

4-2.3.2.2.2.5 The failure to receive a test signal from the protected premises shall be treated as a trouble signal. (See 4-3.6.1.4.)

[From NFPA 71, 5-3.3.5 modified, and NFPA 72, 8-7.3.3.5 modified]

Table 4-2.3.2.2.2.3

	Number of Lines in Hunt Group				
	1	2	3	4	5 to 8
System Loading at the Supervising Station					
With DACR lines processed in parallel					
Number of initiating circuits	N/A	5000	10,000	20,000	20,000
Number of DACTs*	N/A	500	1500	3000	3000
With DACR lines processed serially (put on hold, then answered one at a time)					
Number of initiating circuits	N/A	3000	5000	6000	6000
Number of DACTs*	N/A	300	800	1000	1000

*Table 4-2.3.2.2.2.3 is based on an average distribution of calls and an average connected time of 30 seconds for a message. The loading figures in the table presume that the lines are in a hunting group (i.e., DACT can access any available line). Note that a single-line DACR is NOT ACCEPTABLE (N/A) for any of the listed configurations.

4-2.3.2.3 Digital Alarm Radio System (DARS).

[From NFPA 71, 5-5]

4-2.3.2.3.1 In the event that any DACT signal transmission is unsuccessful, the information shall be transmitted by means of the digital alarm radio transmitter (DART). The DACT shall continue its normal transmission sequence as required by 4-2.3.2.1.5.

Exception: Simultaneous status change reporting by both the DACT and DART shall be permitted.

[From NFPA 71, 5-5.1 modified]

4-2.3.2.3.2 Failure of the telephone line at the protected premises shall result in a trouble signal being transmitted to the supervising station by means of the DART within 4 minutes of detection of the fault.

[From NFPA 71, 5-5.2 modified]

4-2.3.2.3.3 The DARS shall be capable of demonstrating a minimum of 90 percent probability of successfully completing each transmission sequence.

[From NFPA 71, 5-5.3]

4-2.3.2.3.4 Transmission sequences shall be repeated a minimum of five times. The DART transmission shall be permitted to be terminated in less than five sequences if the DACT successfully communicates to the DACR.

[From NFPA 71, 5-5.4 modified]

4-2.3.2.3.5 Each DART shall automatically initiate and complete a test signal transmission sequence to its associated digital alarm radio receiver (DARR) at least once every 24 hours. A successful DART signal transmission sequence of any other type within the same 24-hour period shall be considered sufficient to fulfill the requirement to test the integrity of the reporting system, if signal processing is automated so that 24-hour delinquencies must be individually acknowledged by supervising station personnel.

[From NFPA 71, 5-5.5]

4-2.3.2.4 Digital Alarm Radio Transmitter (DART). A DART shall transmit a digital code or equivalent by use of radio transmission to its associated digital alarm radio receiver (DARR). Signal repetition, digital parity check, or

some equivalent means of signal verification shall be used. The DART shall comply with applicable FCC rules consistent with its operating frequency.

[From NFPA 71, 5-6 modified]

4-2.3.2.5 Digital Alarm Radio Receiver (DARR).

[From NFPA 71, 5-7]

4-2.3.2.5.1 Equipment.

[From NFPA 71, 5-7.1]

4-2.3.2.5.1.1 A spare DARR shall be provided in the supervising station and shall be able to be switched in place of a failed unit within 30 seconds after detection of failure.

[From NFPA 71, 5-7.1.1]

4-2.3.2.5.1.2 Facilities shall be provided at the supervising station for the following supervisory and control functions of subsidiary and repeater station radio receiving equipment. This shall be accomplished via a supervised circuit where the radio equipment is remotely located from the supervising or subsidiary station. The following conditions shall be supervised at the supervising station:

- (a) Failure of ac power supplying the radio equipment
- (b) Receiver malfunction
- (c) Antenna and interconnecting cable malfunction
- (d) Indication of automatic switchover of the DARR
- (e) Data transmission line between the DARR and the supervising or subsidiary station.

[From NFPA 71, 5-7.1.2 modified]

4-2.3.2.6 Derived Local Channel.

4-2.3.2.6.1 When a DACT is connected to a telephone line (number) that is also supervised for adverse conditions by derived local channel, a second telephone line (number) shall not be required.

4-2.3.2.6.2 Failure of the telephone line (number) at the protected premises shall be automatically indicated and recorded at the supervising station in accordance with 4-2.2.3.

[New paragraphs and title]

4-2.3.3 McCulloh Systems.

[From NFPA 71, Chap. 6]

4-2.3.3.1 Transmitters.

[From NFPA 71, 6-2.1]

4-2.3.3.1.1 A coded alarm signal from a transmitter shall consist of not less than three complete rounds of the number or code transmitted.

[From NFPA 71, 6-2.1.1]

4-2.3.3.1.2* A coded fire alarm box shall produce not less than three signal impulses for each revolution of the coded signal wheel or equivalent device.

[From NFPA 71, 6-2.1.2 modified]

4-2.3.3.1.3 Circuit-adjusting means for emergency operating shall be permitted to either be automatic or be provided through manual operation upon receipt of a trouble signal.

[From NFPA 71, 6-2.2 modified]

4-2.3.3.1.4 Equipment shall be provided at the supervising or subsidiary station on all circuits extending from the supervising or subsidiary station utilized for McCulloh systems for making the following tests:

- (a) Current on each circuit under normal conditions
- (b) Current on each side of the circuit with the receiving equipment conditioned for an open circuit.

NOTE: The current readings in test (a) above should be compared with the normal readings to determine if a change in the circuit condition has occurred. A zero current reading in test (b) above indicates that the circuit is clear of a foreign ground.

[From NFPA 71, 6-2.3 modified]

4-2.3.3.2 Transmission Channels.

[From NFPA 71, 6-3 modified]

4-2.3.3.2.1 Circuits between the protected premises and the supervising or subsidiary station that are essential to the actuation or operation of devices initiating a signal indicative of fire shall be so arranged that the occurrence of a single break or single ground fault will not prevent transmission of an alarm.

Exception No. 1: Circuits wholly within the supervising or subsidiary station.

Exception No. 2: Carrier system portion of circuits.

[From NFPA 71, 6-3.1 modified]

4-2.3.3.2.2 The occurrence of a single break or a single ground fault on any circuit shall not of itself cause a false signal that may be interpreted as an alarm of fire. Where such single fault prevents the normal functioning of any circuit, its occurrence shall be indicated automatically at the supervising station by a trouble signal compelling attention and readily distinguishable from signals other than those indicative of an abnormal condition of supervised parts of a fire suppression system.

[From NFPA 71, 6-3.2 modified]

4-2.3.3.2.3 The circuits and devices shall be arranged to receive and record a signal readily identifiable as to location of origin, and provisions shall be made for equally identifiable transmission to the public fire service communication center.

[From NFPA 71, 6-3.3]

4-2.3.3.2.4 Multipoint transmission channels between the protected premises and the supervising or subsidiary station and within the protected premises, consisting of one or more coded transmitters and associated system unit(s), shall meet the requirements of either 4-2.3.3.2.5 or 4-2.3.3.2.6.

[From NFPA 71, 6-3.4 modified]

4-2.3.3.2.5 When end-to-end metallic continuity is present, proper signals shall be received from other points under any one of the following transmission channel fault conditions at one point on the line:

- (a) Open
- (b) Ground
- (c)* Wire-to-wire short
- (d) Open and ground.

[From NFPA 71, 6-3.4.1 modified]

4-2.3.3.2.6 When end-to-end metallic continuity is not present, the nonmetallic portion of transmission channels shall meet all of the following requirements:

(a) Two nonmetallic channels or one channel plus a means for immediate transfer to a standby channel shall be provided for each transmission channel, a maximum of eight transmission channels being associated with each standby channel, or over one channel, provided service is limited to one plant.

(b) The two nonmetallic channels (or one channel with standby arrangement) for each transmission channel shall be provided in one of the following ways, in descending order of preference:

- 1. Over separate facilities and separate routes
- 2. Over separate facilities in the same route
- 3. Over the same facilities in the same route.

(c) Failure of a nonmetallic channel or any portion thereof shall be indicated immediately and automatically in the supervising station.

(d) Proper signals shall be received from other points under any one of the following fault conditions at one point on the metallic portion of the transmission channel:

- 1. Open
- 2. Ground
- 3.* Wire-to-wire short.

[From NFPA 71, 6-3.4.2 modified]

4-2.3.3.3 Loading Capacity of McCulloh Circuits.

[From NFPA 71, 6-4 modified]

4-2.3.3.3.1 The number of transmitters connected to any transmission channel shall be limited to avoid interference.

The total number of code wheels or equivalent connected to a single transmission channel shall not exceed 250. Alarm signal transmission channels shall be reserved exclusively for fire alarm signal transmitting service, except as provided in 4-2.3.3.3.4.

[From NFPA 71, 6-4.1.1 modified]

4-2.3.3.3.2 The number of waterflow switches permitted to be connected to actuate a single transmitter shall not exceed five switches.

[From NFPA 71, 6-4.1.2]

4-2.3.3.3.3 The number of supervisory switches permitted to be connected to actuate a single transmitter shall not exceed 20.

[From NFPA 71, 6-4.1.3]

4-2.3.3.3.4 Combined alarm and supervisory transmission channels shall comply with the following:

(a) Where both sprinkler supervisory signals and fire or waterflow alarm signals are transmitted over the same transmission channel, provision shall be made to obtain either alarm signal precedence or sufficient repetition of the alarm signal to prevent the loss of any alarm signal.

(b) Other signal transmitters (burglar, industrial processes, etc.) on an alarm transmission channel shall not exceed five.

[From NFPA 71, 6-4.2 modified]

4-2.3.3.3.5* Where signals from manual fire alarm boxes and waterflow alarm transmitters within a building are transmitted over the same transmission channel and are operating at the same time, there shall be no interference with the fire box signals. Provision of the shunt noninterfering method of operation is acceptable for this performance.

[From NFPA 71, 6-4.3 modified]

4-2.3.3.3.6 One alarm transmission channel shall serve not more than 25 plants. A plant may consist of one or more buildings under the same ownership, and the circuit arrangement shall be such that an alarm signal will not be received from more than one transmitter within a plant at a time. If such noninterfering is not provided, each building shall be considered a plant.

[From NFPA 71, 6-4.4 modified]

4-2.3.3.3.7 One sprinkler supervisory transmission channel circuit shall serve not more than 25 plants. A plant may consist of one or more buildings under the same ownership.

[From NFPA 71, 6-4.5 modified]

4-2.3.3.3.8 Connections to a guard supervisory transmission channel or to a combination manual fire alarm and guard transmission channel shall be limited so that not more than 60 scheduled guard report signals will be transmitted in any 1-hour period. Patrol scheduling shall be such as to avoid interference between guard report signals.

[From NFPA 71, 6-4.6 modified]

4-2.3.4 Two-Way RF Multiplex Systems.

[From NFPA 71, Chap. 7]

4-2.3.4.1 The maximum end-to-end operating time parameters allowed for a two-way RF multiplex system are as follows:

(a) The maximum allowable time lapse from the initiation of a single fire alarm signal until it is recorded at the supervising station shall not exceed 90 seconds. When any number of subsequent fire alarm signals occur at any rate, they shall be recorded at a rate no slower than one every additional 10 seconds.

(b) The maximum allowable time lapse from the occurrence of an adverse condition in any transmission channel until recording of the adverse condition is started shall not exceed 90 seconds for Type 4 and Type 5 systems. (See 4-2.3.4.4.)

(c) In addition to the maximum operating time allowed for fire alarm signals, the requirements of one of the following paragraphs shall be met:

1. System units having more than 500 initiating device circuits shall be able to record not less than 50 simultaneous status changes in 90 seconds.

2. System units having fewer than 500 initiating device circuits shall be able to record not less than 10 percent of that total number of simultaneous status changes within 90 seconds.

[From NFPA 71, 7-2.1.3 modified]

4-2.3.4.2 Facilities shall be provided at the supervising station for the following supervisory and control functions of the supervising or subsidiary station, and repeater station radio transmitting and receiving equipment. This shall be accomplished via a supervised circuit where the radio equipment is remotely located from the system unit.

(a) The following conditions shall be supervised at the supervising station:

1. RF transmitter in use (radiating)
2. Failure of ac power supplying the radio equipment
3. RF receiver malfunction
4. Indication of automatic switchover.

(b) Independent deactivation of either RF transmitter shall be controlled from the supervising station.

[From NFPA 71, 7-2.1.4 modified]

4-2.3.4.3 Transmission Channel.

[From NFPA 71, 7-3 modified]

4-2.3.4.3.1 The RF multiplex transmission channel shall terminate in a RF transmitter/receiver at the protected premises and in a system unit at the supervising or subsidiary station.

[From NFPA 71, 7-3.1 modified]

4-2.3.4.3.2 Operation of the transmission channel shall conform to the requirements of this code whether channels are private facilities, such as microwave, or leased facilities furnished by a communication utility company. When private signal transmission facilities are utilized, the equipment necessary to transmit signals shall also comply with requirements for duplicate equipment or replacement of critical components, as described in 4-3.4.5.

[From NFPA 71, 7-3.1.1 modified]

4-2.3.4.4* Two-way RF multiplex systems are divided into two categories based upon their ability to perform under adverse conditions. System classifications are of two types.

(a) A Type 4 system shall have two or more control sites configured as follows:

1. Each site shall have a RF receiver interconnected to the supervising or subsidiary station by a separate channel.

2. The RF transmitter/receiver located at the protected premises shall be within transmission range of at least two RF receiving sites.

3. The system shall contain two RF transmitters, either:

(i) Located at one site with the capability of interrogating all of the RF transmitters/receivers on the premises, or

(ii) Dispersed with all of the RF transmitters/receivers on the premises having the capability to be interrogated by two different RF transmitters.

4. Each RF transmitter shall maintain a status that permits immediate use at all times. Facilities shall be provided in the supervising or subsidiary station to operate any off-line RF transmitter at least once every 8 hours.

5. Any failure of one of the RF receivers shall in no way interfere with the operation of the system from the other RF receiver. Failure of any receiver shall be annunciated at the supervising station.

6. A physically separate channel is required between each RF transmitter or RF receiver site, or both, and the system unit.

(b) A Type 5 system shall have a single control site configured as follows:

1. A minimum of one RF receiving site
2. A minimum of one RF transmitting site.

NOTE: The sites above can be co-located.

[From NFPA 71, 7-3.1.4 modified]

4-2.3.4.5 Loading Capacities.

[From NFPA 71, 7-4 modified]

4-2.3.4.5.1 The loading capacities of two-way RF multiplex systems are based on the overall reliability of the signal receiving, processing, display, and recording equipment at the supervising or subsidiary station and the capability to transmit signals during adverse conditions of the transmission channels. Table 4-2.3.4.5.1 establishes the allowable loading capacities.

[From NFPA 71, 7-4.1 modified]

4-2.3.4.5.2 Exceptions to Loading Capacities Listed in Table 4-2.3.4.5.1. Where the signal receiving, processing, display, and recording equipment is duplicated at the supervising station and a switch-over can be accomplished in not more than 30 seconds with no loss of signals during this period, the capacity of a system unit shall be unlimited.

[New paragraph]

Table 4-2.3.4.5.1

	System Type	
	Type 4	Type 5
A. Trunks		
Maximum number of fire alarm service initiating device circuits per primary trunk facility	5120	1280
Maximum number of leg facilities for fire alarm service per primary trunk facility	512	128
Maximum number of leg facilities for all types of fire alarm service per secondary trunk facility*	128	128
Maximum number of all types of initiating device circuits per primary trunk facility in any combination	10,240	2560
Maximum number of leg facilities for types of fire alarm service per primary trunk facility in any combination*	1024	256
B. System Units at the Supervising Station		
Maximum number of all types of initiating device circuits per system unit*	10,240**	10,240**
Maximum number of fire protected buildings and premises per system unit	512**	512**
Maximum number of fire alarm service initiating device circuits per system	5120**	5120**
C. Systems Emitting from Subsidiary Station		
	Same as B	Same as B

*Includes every initiating device circuit, i.e., waterflow, fire alarm supervisory, guard, burglary, hold up, etc.

**Paragraph 4-2.3.4.5.2 applies.

[From NFPA 71, Table 7-4.1 modified]

4-2.3.5 One-Way Private Radio Alarm Systems.

[From NFPA 71, Chap. 8 modified]

4-2.3.5.1 The requirements of this section for a radio alarm repeater station receiver (RARSR) shall be satisfied if signals from each radio alarm transmitter (RAT) are received and supervised, in accordance with this chapter, by at least two independently powered, independently operating, and separately located RARSR.

4-2.3.5.2* The end-to-end operating time parameters allowed for a one-way radio alarm system shall be as follows:

(a) There shall be a 90 percent probability that the time between the initiation of a single fire alarm signal until it is recorded at the supervising station shall not exceed 90 seconds.

(b) There shall be a 99 percent probability that the time between the initiation of a single fire alarm signal until it is recorded at the supervising station shall not exceed 180 seconds.

(c) There shall be a 99.999 percent probability that the time between the initiation of a single fire alarm signal until it is recorded at the supervising station shall not exceed 7.5 minutes (450 seconds), at which time the RAT shall cease transmitting.

When any number of subsequent fire alarm signals occur at any rate, they shall be recorded at an average rate no slower than one every additional 10 seconds.

(d) In addition to the maximum operating time allowed for fire signals, the system shall be able to record not less than 12 simultaneous status changes within 90 seconds at the supervising station.

[From NFPA 71, 8-2.1.3 modified]

4-2.3.5.3 Supervision.

4-2.3.5.3.1 Equipment shall be provided at the supervising station for the supervisory and control functions of the supervising or subsidiary station, and repeater station radio transmitting and receiving equipment. This shall be accomplished via a supervised circuit where the radio equipment is remotely located from the system unit. The following conditions shall be supervised at the supervising station:

- (a) Failure of ac power supplying the radio equipment
- (b) RF receiver malfunction
- (c) Indication of automatic switchover (if applicable).

[From NFPA 71, 8-2.1.4 modified]

4-2.3.5.3.2 Protected Premises.

4-2.3.5.3.2.1 Interconnections between elements of transmitting equipment, including any antennas, shall be supervised to either cause an indication of failure at the protected premises or transmit a trouble signal to the supervising station.

4-2.3.5.3.2.2 Where these elements are physically separated, the wiring or cabling between them shall be protected by conduit.

[New paragraphs and title]

4-2.3.5.4 Transmission Channel.

[From NFPA 71, 8-3 modified]

4-2.3.5.4.1 The one-way RF transmission channel shall originate with a one-way RF transmitting device at the protected premises and shall terminate at the RF receiving system of a RASSR capable of receiving transmissions from such transmitting devices.

A receiving network transmission channel shall terminate at a RASSR at one end, and either with another RASSR or a radio alarm supervising station receiver (RASSR) at the other end.

[From NFPA 71, 8-3.1 modified]

4-2.3.5.4.2 Operation of receiving network transmission channels shall conform to the requirements of this code whether channels are private facilities, such as microwave, or leased facilities furnished by a communication utility company. Where private signal transmission facilities are utilized, the equipment necessary to transmit signals shall

also comply with requirements for duplicate equipment or replacement of critical components as described in 4-2.4.2.

The system shall provide information indicating the quality of the received signal for each RASSR supervising each RAT in accordance with 4-2.3.5 and shall provide information at the supervising station if such signal quality falls below the minimum signal quality levels set forth in 4-2.3.5.

Each RAT shall be installed in such a manner so as to provide a signal quality over at least two independent one-way RF transmission channels, of the minimum quality level specified that satisfies the performance requirements in 4-2.2.2 and 4-2.4

[From NFPA 71, 8-3.1.1 modified]

4-2.3.5.5 Nonpublic one-way radio alarm systems shall be divided into two categories based upon the following number of RASSRs present in the system:

(a) A Type 6 system shall have one RASSR and at least two RASSRs.

(b) A Type 7 system shall have more than one RASSR and at least two RASSRs.

In a Type 7 system, if more than one RASSR is out of service and as a result any RATs are no longer being supervised, then the affected supervising station shall be notified.

In a Type 6 system, if any RASSR is out of service, a trouble signal shall be annunciated at the supervising station.

[From NFPA 71, 8-3.1.3 modified]

4-2.3.5.6 The loading capacities of one-way radio alarm systems are based on the overall reliability of the signal receiving, processing, display, and recording equipment at the supervising or subsidiary station and the capability to transmit signals during adverse conditions of the transmission channels. Table 4-2.3.5.6 establishes the allowable loading capacities.

[From NFPA 71, 8-4.1 modified]

4-2.3.5.7 Exceptions to Loading Capacities Listed in Table 4-2.3.5.6. Where the signal receiving, processing, display, and recording equipment is duplicated at the supervising station and a switch-over can be accomplished in not more than 30 seconds with no loss of signals during this period, the capacity of a system unit is unlimited.

[From NFPA 71, 8-4.2]

4-2.3.6 Directly-Connected Noncoded Systems.

[New title]

4-2.3.6.1 Circuits for transmission of alarm signals between the fire alarm control unit or the transmitter in the protected premises and the supervising station shall be arranged so as to comply with either of the following provisions:

(a) These circuits shall be arranged so that the occurrence of a single break or single ground fault will not prevent the transmission of an alarm signal. Circuits complying with this paragraph shall be automatically self-adjusting in the event of either a single break or a single ground fault and shall be automatically self-restoring in the event that the break or fault is corrected.

Table 4-2.3.5.6

	System Type	
	Type 6	Type 7
A. Radio Alarm Repeater Station Receiver (RARSR)		
Maximum number of fire alarm service initiating device circuits per RARSR	5120	5120
Maximum number of RATs for fire	512	512
Maximum number of all types of initiating device circuits per RARSR in any combination*	10,240	10,240
Maximum number of RATs for all types of fire alarm service per RARSR in any combination*†	1024	1024
B. System Units at the Supervising Station		
Maximum number of all types of initiating device circuits per system unit*	10,240**	10,240**
Maximum number of fire protected buildings and premises per system unit	512**	512**
Maximum number of fire alarm service initiating device circuits per system unit	5120**	5120**

*Includes every initiating device circuit, i.e., waterflow, fire alarm, supervisory, guard, burglary, hold-up, etc.

**Paragraph 4-2.3.5.7 applies.

†Each supervised BA (open/close) or each suppressed guard tour transmitter shall reduce the allowable RATs by 5.

Each guard tour transmitter shall reduce the allowable RATs by 15.

Each two-way protected premises radio transmitter shall reduce the allowable RATs by 2.

[From NFPA 71, Table 8-4.1 modified]

(b) These circuits shall be arranged so as to normally be isolated from ground (except for reference ground detection) and so that a single ground fault will not prevent the transmission of an alarm signal. Circuits complying with this paragraph shall be provided with a ground reference circuit so as to detect and indicate automatically the existence of a single ground fault, unless a multiple ground-fault condition that would prevent alarm operation will be indicated by an alarm or by a trouble signal.

[From NFPA 72, 8-6.1 modified]

4-2.3.6.2 Circuits for transmission of supervisory signals shall be separate from alarm circuits. These circuits within the protected premises and between the protected premises and the supervising station shall be arranged as described in 4-2.3.6.1(a) or 4-2.3.6.1(b).

Exception: Where the reception of alarm signals and supervisory signals at the same supervising station is permitted by the authority having jurisdiction, the supervisory signals do not interfere with the alarm signals, and alarm signals have priority, the same circuit between the protected premises and the supervising station shall be permitted to be used for alarm and supervisory signals.

[From NFPA 72, 8-6.2 modified]

4-2.3.6.3 The occurrence of a single break or a single ground fault on any circuit shall not of itself cause a false signal that may be interpreted as an alarm of fire.

[From NFPA 72, 4-2.2 modified]

4-2.3.6.4 The requirements of 4-2.3.6.1 and 4-2.3.6.2 shall not apply to the following circuits:

(a) Circuits wholly within the supervising station,

(b) Circuits wholly within the protected premises extending from one or more automatic fire detectors or other noncoded initiating devices other than water flow devices to a transmitter or control unit, or

(c) Power supply leads wholly within the building or buildings protected.

[From NFPA 72, 8-6.3 modified]

4-2.3.6.5 Loading Capacity of Circuits.

[From NFPA 72, 8-5]

4-2.3.6.5.1 The number of initiating devices connected to any signaling circuit and the number of plants that shall be permitted to be served by a signal circuit shall be determined by the authority having jurisdiction and shall not exceed the limitations specified in 4-2.3.6.5.

NOTE: A plant may consist of one or more buildings under the same ownership.

[From NFPA 72, 8-5.1 modified]

4-2.3.6.5.2 A single circuit shall not serve more than one plant.

[From NFPA 72, 8-5.4 modified]

NOTE: Where a single plant involves more than one gate entrance or involves a number of buildings, separate circuits may be required so that the alarm to the supervising station will indicate the area to which the fire department should be dispatched.

[From NFPA 72, 8-5.9 modified]

4-2.3.7 Private Microwave Radio Systems.

[From NFPA 72, 9-5 modified]

4-2.3.7.1 Where a private microwave radio is used as the transmission channel, appropriate supervised transmitting and receiving equipment shall be provided at supervising, subsidiary, and repeater stations.

[From NFPA 72, 9-5.1 modified]

4-2.3.7.2 Where more than 5 protected buildings or premises or 50 initiating devices or initiating device circuits are being serviced by a private radio carrier, the supervising, subsidiary, and repeater station radio facilities shall meet all of the following:

(a) Dual supervised transmitters, arranged for automatic switching from one to the other in case of trouble, shall be installed. Where the transmitters are located where someone is always on duty, switchboard facilities shall be permitted to be manually operated if the switching can be carried out within 30 seconds. Where the transmitters are located where no one is normally on duty, the circuit extending between the supervising station and the transmitters shall be a supervised circuit.

(b)* Transmitters shall be operated on a two-to-one time ratio basis within each 24 hours.

(c) Dual receivers shall be installed with a means for selecting a usable output from one of the two receivers. The failure of one shall in no way interfere with the operation of the other. Failure of either receiver shall be annunciated.

[From NFPA 72, 9-5.2 modified]

4-2.3.7.3 Means shall be provided at the supervising station for the supervision and control of supervising, subsidiary, and repeater station radio transmitting and receiving equipment. This shall be accomplished via a supervised circuit when the radio equipment is remote from the supervising station.

(a) The following conditions shall be supervised at the supervising station:

1. Transmitter in use (radiating)
2. Failure of ac power supplying the radio equipment
3. Receiver malfunction
4. Indication of automatic switchover.

(b) It shall be possible to independently deactivate either transmitter from the supervising station.

[From NFPA 72, 9-5.3 modified]

4-2.4 Display and Recording.

[New title]

4-2.4.1* Any status changes that occur in an initiating device or in any interconnecting circuits or equipment from the location of the initiating device(s) to the supervising station shall be presented in a form to expedite prompt operator interpretation. Status change signals shall provide the following information:

(a) *Type of Signal.* Identification of the type of signal to show whether it is an alarm, supervisory, delinquency, or trouble signal.

(b) *Condition.* Identification of the signal to differentiate between an initiation of an alarm, supervisory, delinquency, or trouble signal, and a restoration to normal from one or more of these conditions.

(c) *Location.* Identification of the point of origin of each status change signal.

[From NFPA 71, 4-2.1.1 modified, 5-3.2.1 modified, 5-7.2.1 modified, 7-2.1.1 modified, 8-2.1.1 modified; and NFPA 72, 8-7.3.2.1 modified]

4-2.4.2* If duplicate equipment for signal receiving, processing, display, and recording is not provided, the installed equipment shall be so designed that any critical assembly can be replaced from on-premises spares and the system restored to service within 30 minutes. A critical assembly is one in which a malfunction will prevent the receipt and interpretation of signals by the supervising station operator.

Exception: Proprietary and remote station systems.

[From NFPA 71, 4-1.2.3 modified, 7-1.2.3 modified, and 8-1.2.3 modified]

4-2.4.3* Any method of recording and display or indication of change of status signals shall be permitted, providing all of the following conditions are met:

(a) Each change of status signal requiring action to be taken by the operator shall result in an audible signal and not less than two independent methods of identifying the type, condition, and location of the status change.

(b) Each change of status signal shall be automatically recorded. The record shall provide the type of signal, condition, and location as required by 4-2.4.1 in addition to the time and date the signal was received.

(c) Failure of an operator to acknowledge or act upon a change of status signal shall not prevent subsequent alarm signals from being received, indicated or displayed, and recorded.

(d) Change of status signals requiring action to be taken by the operator shall be displayed or indicated in a manner that clearly differentiates them from those that have been acted upon and acknowledged.

(e) Each incoming signal to a DACR or DARR shall cause an audible signal that persists until manually acknowledged.

Exception: Test signals (see 4-2.3.2.1.10) received at a DACR or DARR shall be permitted to be excepted from this requirement.

[From NFPA 71, 4-2.1.2 modified, 5-3.2.2 modified, 5-7.2.2 modified, 7-2.1.2 modified, 8-2.1.2 modified; and NFPA 72, 8-7.3.2.2 modified]

4-2.5 Testing and Maintenance. Testing and maintenance of communication methods shall be in accordance with the requirements of Chapter 7.

[New paragraph]

4-3 Fire Alarm Systems for Central Station Service.

[From NFPA 71]

NOTE: The requirement of Chapters 1, 3, 5, 6, 7, and Section 4-2 shall apply to central station fire alarm systems unless they conflict with the requirements of this section.

[From NFPA 71, 1-2.5 modified]

4-3.1 Scope. This section describes the general requirements and use of fire alarm systems to provide central station service.

[From NFPA 71, 1-1.1 modified]

4-3.2 General.

[New title]

4-3.2.1 These systems include the central station physical plant, exterior communications channels, subsidiary stations, and signaling equipment located at the protected premises.

[From NFPA 71, 1-1.2 modified]

4-3.2.2* This section applies to central station service, which consists of the following elements: installation of fire alarm transmitters; alarm, guard, supervisory and trouble signal monitoring; retransmission; associated record keeping and reporting; testing and maintenance; and runner service. These services shall be provided under contract to a subscriber by one of the following:

(a) A listed central station that provides all of the elements of central station service with its own facilities and personnel.

(b) A listed central station that provides as a minimum the signal monitoring, retransmission, and associated record keeping and reporting with its own facilities and personnel and that may subcontract all or any part of the installation, testing and maintenance, and runner service.

(c) A listed fire alarm service — local company that provides the installation, and testing and maintenance with its own facilities and personnel and that subcontracts the monitoring, retransmission, and associated record keeping and reporting to a listed central station. The required runner service shall be provided by the listed fire alarm service — local company with its own personnel or the listed central station with its own personnel.

[From NFPA 71, 1-2.2 modified]

4-3.2.3 It shall be conspicuously indicated by the prime contractor that the fire alarm system providing service at a protected premises complies with all the requirements of this code by providing a means of third party verification, as specified in 4-3.2.3.1 or 4-3.2.3.2.

4-3.2.3.1 The installation shall be certificated.

4-3.2.3.1.1 Fire alarm systems providing service that complies with all requirements of this code shall be certified by the organization that has listed the central station, and a document attesting to this certification shall be located on or near the fire alarm system control unit or, if no control unit exists, on or near a fire alarm system component.

4-3.2.3.1.2 A central repository of issued certification documents, accessible to the authority having jurisdiction, shall be maintained by the organization that has listed the central station.

4-3.2.3.2 The installation shall be placarded.

4-3.2.3.2.1 Fire alarm systems providing service that complies with all requirements of this code shall be conspicuously marked by the central station to indicate compliance. The marking shall be by one or more securely affixed placards that meet the requirements of the organization that has listed the central station and requires the placard.

4-3.2.3.2.2 The placard(s) shall be 20 sq in. (130 cm²) or larger, shall be located on or near the fire alarm system control unit or, if no control unit exists, on or near a fire alarm system component, and shall identify the central station by name and telephone number.

[From NFPA 71, 1-2.3.2]

4-3.2.4* Fire alarm system service not complying with all requirements of Section 4-3 shall not be designated as central station service.

[From NFPA 71, 1-2.4]

4-3.2.5* For the purpose of Section 4-3, the subscriber shall notify the prime contractor in writing of the identity of the authority(ies) having jurisdiction.

[From NFPA 71, 1-4.1 modified]

4-3.3 Supervising Station Facilities.

[From NFPA 71, 1-7 modified]

4-3.3.1 The central station building or that portion of a building occupied by a central station shall conform to the construction, fire protection, restricted access, emergency lighting, and power facilities requirements of the latest edition of ANSI/UL 827, *Central Stations for Watchman, Fire Alarm and Supervisory Service*.

[From NFPA 71, 1-6.2 modified]

4-3.3.2 Subsidiary station buildings or those portions of buildings occupied by subsidiary stations shall conform to the construction, fire protection, restricted access, emergency lighting, and power facilities requirements of the latest edition of ANSI/UL 827, *Central Stations for Watchman, Fire Alarm and Supervisory Service*.

4-3.3.2.1 All intrusion, fire, power, and environmental control systems for subsidiary station buildings shall be monitored by the central station in accordance with 4-3.3.

4-3.3.2.2 The subsidiary facility shall be inspected at least monthly by central station personnel for the purpose of verifying the operation of all supervised equipment, all telephones, battery conditions, and all fluid levels of batteries and generators.

4-3.3.2.3 In the event of the failure of equipment at the subsidiary station or the communication channel to the central station, a backup shall be operational within 90 seconds. Restoration of a failed unit shall be accomplished within 5 days.

4-3.3.2.4 There shall be continuous supervision of each communication channel between the subsidiary station and the central station.

4-3.3.2.5 When the communication channel between the subsidiary station and the supervising station fails, the communication shall be switched to an alternate path. Public switched telephone network facilities shall be used only as the alternate path.

4-3.3.2.6 In the subsidiary station, there shall be either a cellular telephone or an equivalent communication path that is independent of the telephone cable between the subsidiary station and the serving wire center.

4-3.3.2.7 A plan of action to provide for restoration of services specified by this code shall exist for each subsidiary station.

4-3.3.2.7.1 This plan shall provide for restoration of services within 4 hours of any impairment causing loss of signals from the subsidiary station to the central station.

4-3.3.2.7.2 There shall be an exercise to demonstrate the adequacy of the plan at least once a year.

4-3.4 Equipment.

[New paragraphs and title]

4-3.4.1 The central station and all subsidiary stations shall be so equipped to receive and record all signals in

accordance with 4-2.4. Circuit-adjusting means for emergency operation shall be permitted to either be automatic or be provided through manual operation upon receipt of a trouble signal. Computer aided alarm and supervisory signal processing hardware and software shall be listed for the specific application.

[From NFPA 71, 1-7.1 modified]

4-3.4.2 Power supplies shall comply with the requirements of Chapter 1.

4-3.4.3 Transmission means shall comply with the requirements of Section 4-2.

[New paragraphs]

4-3.4.4* Two independent means shall be provided to retransmit a fire alarm signal to the appropriate public fire service communication center.

NOTE: The use of a universal emergency number 911 (public safety answering point) does not meet the intent of this code for the principal means of retransmission.

[From NFPA 71, 1-7.2 modified]

4-3.4.4.1 Where the principal means of retransmission is not equipped to permit the center to acknowledge receipt of each fire alarm report, both means shall be used to retransmit.

[From NFPA 71, 1-7.2.1 modified]

4-3.4.4.2* Where required by the authority having jurisdiction, one of the means shall be supervised so that interruption of retransmission circuit (channel) communication integrity will result in a trouble signal at the central station.

[From NFPA 71, 1-7.2.2 modified]

4-3.4.4.3 The retransmission means shall be tested in accordance with Chapter 7.

[From NFPA 71, 1-7.2.3 modified]

4-3.4.4.4 The retransmission signal and the time and date of retransmission shall be recorded at the central station.

[From NFPA 71, 1-7.2.4]

4-3.5 Personnel.

[New title]

4-3.5.1 The central station shall have sufficient personnel (a minimum of two persons) on duty at the central station at all times to ensure attention to signals received.

[From NFPA 71, 1-9.1 modified]

4-3.5.1.1 Operation and supervision shall be the primary functions of the operators, and no other interest or activity shall take precedence over the protective service.

[From NFPA 71, 1-9.1.2 modified]

4-3.6 Operations.

[New title]

4-3.6.1 Disposition of Signals.

[From NFPA 71, 1-10.2]

4-3.6.1.1 Alarm signals initiated by manual fire alarm boxes, automatic fire detectors, waterflow from the automatic sprinkler system, or actuation of other fire suppression systems or equipment shall be treated as fire alarms.

The central station shall:

(a)* Immediately retransmit the alarm to the public fire service communication center

(b) Dispatch a runner or technician to the protected premises to arrive within 1 hour after receipt of signal when equipment needs to be manually reset by the prime contractor

(c) Notify the subscriber by the quickest available method

(d) Provide notice to the subscriber and/or authority having jurisdiction, if required.

Exception: When the alarm signal results from a prearranged test, it is not necessary to take the actions required by (a) and (c).

[From NFPA 71, 1-10.2.1 modified]

4-3.6.1.2 Upon failure to receive a guard's regular signal within a 15-minute maximum grace period, the central station shall:

(a) Communicate without unreasonable delay with personnel at the protected premises

(b) If communications cannot be established, dispatch a runner to the protected premises to arrive within 30 minutes of the delinquency

(c) Report all delinquencies to the subscriber and/or authority having jurisdiction, if required.

[From NFPA 71, 1-10.2.2 modified]

4-3.6.1.2.1 Failure of the guard to follow a prescribed route in transmitting signals shall be handled as a delinquency.

[From NFPA 71, 1-10.2.2.1]

4-3.6.1.3* Upon receipt of a supervisory signal from a sprinkler system, other fire suppression system, or other equipment, the central station shall:

(a)* Communicate immediately with person(s) designated by the subscriber

(b) Dispatch a runner or maintenance person (arrival time not to exceed 1 hour) to investigate, unless abnormal condition is restored to normal in accordance with a scheduled procedure determined by (a) above

(c) Notify the fire department and/or law enforcement agency, if required

(d) Notify the authority having jurisdiction when sprinkler systems or other fire suppression systems or equipment have been wholly or partially out of service for 8 hours

(e) When service has been restored, provide notice, if required, to the subscriber and/or the authority having jurisdiction as to the nature of the signal, time of occurrence, and restoration of service when equipment has been out of service for 8 hours or more.

Exception: When the supervisory signal results from a prearranged test, it is not necessary to take the actions required by (a), (c), and (e).

[From NFPA 71, 1-10.2.3 modified]

4-3.6.1.4 Upon receipt of trouble signals or other signals pertaining solely to matters of equipment maintenance of the fire alarm systems, the central station shall:

(a)* Communicate immediately with persons designated by the subscriber

(b) If necessary, dispatch personnel to arrive within 4 hours to initiate maintenance

(c) Provide notice, if required, to the subscriber and/or the authority having jurisdiction as to the nature of the interruption, time of occurrence, and restoration of service, when the interruption is more than 8 hours.

[From NFPA 71, 1-10.2.4 modified]

4-3.6.1.5 All test signals received shall be recorded to indicate date, time, and type.

(a) Test signals initiated by the subscriber, including those for the benefit of an authority having jurisdiction, shall be acknowledged by central station personnel whenever the subscriber or authority inquires.

(b)* Any test signal not received by the central station shall be investigated immediately and appropriate action taken to reestablish system integrity.

(c) The central station shall dispatch personnel to arrive within 1 hour when protected premises equipment must be manually reset after testing.

[From NFPA 71, 1-10.2.5 modified]

4-3.6.2 Record Keeping and Reporting.

[New title]

4-3.6.2.1 Complete records of all signals received shall be retained for at least 1 year.

[From NFPA 71, 1-4.5 modified]

4-3.6.2.2 The central station shall make arrangements to furnish reports of signals received to the authority having jurisdiction in a form acceptable to it.

[From NFPA 71, 1-10.1 modified]

4-3.7 Testing and Maintenance. Testing and maintenance for central station service shall be performed in accordance with Chapter 7.

[New paragraph]

4-4 Proprietary Supervising Station Systems.

NOTE: The requirements of Chapters 1, 3, 5, 6, 7, and Section 4-2 shall apply to proprietary fire alarm systems, except where they conflict with the requirements of this section.

[From NFPA 72, Chap. 9 modified]

4-4.1 Scope. Section 4-4 describes the operational procedures for the supervising facilities of proprietary fire alarm systems. It provides the minimum requirements for the facilities, equipment, personnel, operation, and testing and maintenance of the proprietary supervising station.

[New paragraph]

4-4.2 General.

[From NFPA 72, 9-2]

4-4.2.1 Proprietary supervising stations shall be located at the protected property and operated by trained, competent personnel in constant attendance who are responsible to the owner of the protected property. (See 4-4.5.3.)

4-4.2.2 The protected property shall be either a single property or noncontiguous properties under one ownership.

[New paragraphs]

4-4.2.3* Section 4-4 recognizes the interconnection of other systems to make the premises safer in the event of fire or other emergencies indicative of hazards to life or property.

[From NFPA 72, 9-1 modified]

4-4.3 Supervising Station Facilities.

[New title]

4-4.3.1 The proprietary supervising station shall be located in a fire-resistive, detached building or in a suitable cut-off room and shall not be near or exposed to the hazardous parts of the premises protected.

[From NFPA 72, 9-2.1 modified]

4-4.3.2 Access to the proprietary supervising station shall be restricted to those persons directly concerned with the implementation and direction of emergency action and procedure.

[From NFPA 72, 9-2.2 modified]

4-4.3.3 The proprietary supervising station, as well as remotely located power rooms for batteries or engine-driven generators, shall be provided with portable fire extinguishers that comply with the requirements of NFPA 10, *Standard for Portable Fire Extinguishers*.

4-4.3.4 The proprietary supervising station shall be provided with an automatic emergency lighting system. The emergency source shall be independent of the primary lighting source.

[New paragraphs]

4-4.3.5 Where 25 or more protected buildings or premises are connected to a subsidiary station, both of the following shall be provided at the subsidiary station:

(a) Automatic means for receiving and recording signals under emergency-staffing conditions

(b) A telephone.

[From NFPA 72, 9-6 modified]

4-4.4 Equipment.

4-4.4.1 This section shall apply to signal-receiving equipment in a proprietary supervising station.

[From NFPA 72, 9-7.1 modified]

4-4.4.2 Provision shall be made to designate the building in which a signal originates. The floor, section, or other subdivision of the building shall be designated at the pro-

proprietary supervising station or at the building protected, except that the authority having jurisdiction shall be permitted to waive this detailed designation where the area, height, or special conditions of occupancy make it unessential. This detailed designation shall utilize indicating appliances acceptable to the authority having jurisdiction.

[From NFPA 72, 9-7.3 modified]

4-4.4.3 The proprietary supervising station shall have, in addition to a recording device, two different means for alerting the operator when each signal is received indicating a change of state of any connected initiating device circuit. One of these shall be an audible signal and shall persist until manually acknowledged. This shall include the receipt of alarm signals, supervisory signals, and trouble signals including signals indicating restoration to normal.

[From NFPA 72, 9-8.1.1 modified]

4-4.4.4 Where suitable means is provided in the proprietary supervising station to readily identify the type of signal received, a common audible indicating appliance shall be permitted to be used for alarm, supervisory, and trouble indication.

[From NFPA 72, 9-8.1.2 modified]

4-4.4.5 At a proprietary supervising station, an audible trouble signal shall be permitted to be silenced provided the act of silencing it shall not prevent it from operating immediately upon receipt of a subsequent trouble signal.

[From NFPA 72, 9-8.1.3 modified]

4-4.4.6 All signals received by the proprietary supervising station that show a change in status shall be automatically and permanently recorded, including time and date of occurrence. This record shall be in a form that will expedite operator interpretation in accordance with any one of the following:

(a) In the event that a visual display is used that automatically provides change of status information for each individual signal, including type and location of occurrence, any form of automatic permanent visual record shall be acceptable. The recorded information shall include the content described above. The visual display shall show status information content at all times and shall be distinctly different after the operator has manually acknowledged each signal. Acknowledgment shall cause recorded information indicating time and date of acknowledgment.

(b) In the event that a visual display is not provided, signal content information shall be automatically recorded on duplicate permanent visual recording instruments.

One recording instrument shall be used for recording all incoming signals, while the other shall be used for fire, supervisory, and trouble signals only. Failure to acknowledge a signal shall not prevent subsequent signals from recording. Restoration of the signaling device to its prior or normal condition shall be recorded.

(c) In the event that a system combines the use of a sequential visual display and recorded permanent visual presentation, the signal content information shall be displayed and recorded. The visual information component shall be either retained on the display until manual

acknowledgment or periodically repeated at intervals not greater than 5 seconds, for durations of 2 seconds each, until manually acknowledged. Each new displayed status change shall be accompanied by an audible indication that shall persist until manual acknowledgment of the signal is performed.

There shall be a means provided for the operator to redisplay status of initiating device circuits that have been acknowledged but not yet restored to a normal condition. If the system retains the signal on the visual display until manually acknowledged, subsequent recorded presentations shall not be inhibited upon failure to acknowledge. Fire alarm signals shall be segregated on a separate visual display in this configuration unless given priority status on the common visual display.

[From NFPA 72, 9-8.2 modified]

4-4.4.7 The maximum elapsed time from sensing a fire alarm at an initiating device or initiating device circuit until it is recorded or displayed at the proprietary supervising station shall not exceed 90 seconds.

[From NFPA 72, 9-8.3.1 modified]

4-4.4.8 To facilitate the prompt receipt of fire alarm signals from systems handling other types of signals that may produce multiple simultaneous status changes, the requirements of either of the following shall be met:

(a) In addition to the maximum processing time for a single alarm, the system shall record simultaneous status changes at a rate not slower than either a quantity of 50, or 10 percent of the total number of initiating device circuits connected, within 90 seconds, whichever number is smaller, without loss of any signal.

(b) In addition to the maximum processing time, the system shall display or record fire alarm signals at a rate not slower than one every 10 seconds, regardless of the rate or number of status changes occurring, without loss of any signals.

Exception: Where fire alarm, waterflow alarm, sprinkler supervisory signals, and their associated trouble signals are the only signals processed by the system, the rate of recording shall not be slower than one round of code every 30 seconds.

[From NFPA 72, 9-8.3.2]

4-4.4.9 Trouble signals required in 1-5.8 and their restoration to normal shall be automatically indicated and recorded at the proprietary supervising station within 200 seconds.

[From NFPA 72, 9-8.3.3 modified]

4-4.4.10 The recorded information for the occurrence of any trouble condition of signaling line circuit, leg facility, or trunk facility that prevents receipt of alarm signals at the proprietary supervising station shall be such that the operator is able to determine the presence of the trouble condition. Trouble conditions in a leg facility shall not affect or delay receipt of signals at the proprietary supervising station from other leg facilities on the same trunk facility.

[From NFPA 72, 9-9 modified]

4-4.5 Personnel.

[New title]

4-4.5.1 At least two operators, one of whom shall be permitted to be a runner, shall be on duty at all times.

Exception: Where the means for transmitting alarms to the fire department is automatic, at least one operator shall be on duty at all times.

4-4.5.2 When the runner is not in attendance at the proprietary supervising station, the runner shall establish two-way communications with the station at intervals not exceeding 15 minutes.

[From NFPA 72, 9-2.3 modified]

4-4.5.3 The primary duties of the operator(s) shall be to monitor signals, operate the system, and take such action as shall be required by the authority having jurisdiction. The operator(s) shall not be assigned any additional duties that would take precedence over the primary duties.

[From NFPA 72, 9-2.4]

4-4.6 Operations.

4-4.6.1 All communication and transmission channels between the proprietary supervising station and the protected premises master control unit (panel) shall be operated manually or automatically once every 24 hours to verify operation.

4-4.6.1.1 When a communication or transmission channel fails to operate, the operator shall immediately notify the person(s) identified by the owner or authority having jurisdiction.

[New paragraphs and title]

4-4.6.2 All operator controls at the proprietary supervising station(s) designated by the authority having jurisdiction shall be operated at each change of shift.

[From NFPA 72, 9-4 modified]

4-4.6.3 If operator controls fail, the operator shall immediately notify the person(s) identified by the owner or authority having jurisdiction.

[New paragraph]

4-4.6.4 Indication of a fire shall be promptly retransmitted to the public fire service communications center or other locations acceptable to the authority having jurisdiction, indicating the building or group of buildings from which the alarm has been received.

[From NFPA 72, 9-3.1]

4-4.6.5* The means of retransmission shall be acceptable to the authority having jurisdiction and shall be in accordance with Sections 4-3, 4-5, 4-6, or 4-7.

Exception: Secondary power supply capacity shall be as required in Chapter 1.

[From NFPA 72, 9-3.2 modified]

4-4.6.6* Retransmission by coded signals shall be confirmed by two-way voice communication indicating the nature of the alarm.

[From NFPA 72, 9-3.3 modified]

4-4.6.7 Dispositions of Signals.

[From NFPA 72, 9-10 modified]

4-4.6.7.1 Alarms. Upon receipt of a fire alarm signal, the proprietary supervising station operator shall initiate action to:

(a) Immediately notify the fire department, the plant fire brigade, and such other parties as the authority having jurisdiction may require

(b) Promptly dispatch a runner to the alarm location (Travel time shall not exceed 1 hour.)

(c) Restore the system to its normal operating condition as soon as possible after disposition of the cause of the alarm signal.

[From NFPA 72, 9-10.2 modified]

4-4.6.7.2 Guard's Tour Delinquency. If a regular signal is not received from a guard within a 15-minute maximum grace period, or if a guard fails to follow a prescribed route in transmitting the signals (if a prescribed route has been established), it shall be treated as a delinquency signal. When a guard's tour delinquency occurs, the proprietary supervising station operator shall initiate action to:

(a) Communicate at once with the protected areas or premises by telephone, radio, calling back over the system circuit, or other means acceptable to the authority having jurisdiction

(b) Dispatch a runner to investigate the delinquency, if communications with the guard cannot be promptly established. (Travel time shall not exceed one-half hour.)

[From NFPA 72, 9-10.3 modified]

4-4.6.7.3 Supervisory Signals. Upon receipt of sprinkler system and other supervisory signals, the proprietary supervising station operator shall initiate action to:

(a) Where required, communicate immediately with the designated person(s) to ascertain the reason for the signal

(b) Where required, dispatch a runner or maintenance person (travel time not to exceed 1 hour) to investigate, unless supervisory conditions are promptly restored to normal

(c) Where required, notify the fire department

(d) Where required, notify the authority having jurisdiction when sprinkler systems are wholly or partially out of service for 8 hours or more

(e) Where required, provide written notice to the authority having jurisdiction as to the nature of the signal, time of occurrence, and restoration of service, when equipment has been out of service for 8 hours or more.

[From NFPA 72, 9-10.4 modified]

4-4.6.7.4 Trouble Signals. Upon receipt of trouble signals or other signals pertaining solely to matters of equipment maintenance of the fire alarm system, the proprietary supervising station operator shall initiate action to:

(a) Where required, communicate immediately with the designated person(s) to ascertain reason for the signal

(b) Where required, dispatch a runner or maintenance person (travel time not to exceed 1 hour) to investigate

(c) Where required, notify the fire department

(d) Where required, notify the authority having jurisdiction when interruption of normal service will exist for 4 hours or more

(e) Where required, provide written notice to the authority having jurisdiction as to the nature of the signal, time of occurrence, and restoration of service, when equipment has been out of service for 8 hours or more.

[From NFPA 72, 9-3.4 modified and 9-10.5 modified]

4-4.6.8 Record Keeping and Reporting.

[New title]

4-4.6.8.1 Complete records of all signals received shall be retained for at least 1 year.

4-4.6.8.2 The proprietary supervising station shall make arrangements to furnish reports of signals received to the authority having jurisdiction, in a form acceptable to it.

[From NFPA 72, 9-10.1 modified]

4-4.7 Testing and Maintenance. Testing and maintenance of proprietary fire alarm systems shall be performed in accordance with Chapter 7.

[New paragraph]

4-5 Remote Supervising Station Fire Alarm Systems.

NOTE: The requirements of Chapters 1, 3, 5, 6, 7, and Section 4-2 shall apply to remote supervising station fire alarm systems, except where they conflict with the requirements of this section.

[From NFPA 72, Chap. 8 modified]

4-5.1 Scope. This section describes the installation, maintenance, testing, and use of a remote supervising station fire alarm system that serves properties under various ownership from a remote supervising station where trained competent personnel are in constant attendance. It covers the minimum requirements for the remote supervising station physical facilities, equipment, operating personnel, response, retransmission, signals, reports, and testing.

[From NFPA 72, 8-1.1 modified]

4-5.2 General.

[From NFPA 72, 8-2 modified]

4-5.2.1 Remote supervising station fire alarm systems provide an automatic audible and visible indication of alarm and, when required, of supervisory and trouble conditions at a location remote from the protected premises and a manual or automatic permanent record of these conditions.

[From NFPA 72, 8-2.1 modified]

4-5.2.2 This section does not require the use of audible signal notification appliances other than those required at the remote supervising station. If it is desired to provide fire alarm evacuation signals in the protected premises, the alarm signals, circuits, and controls shall comply with the provisions of Chapter 3 and Chapter 6 in addition to the provisions of this section.

[From NFPA 72, 8-2.6 modified]

4-5.2.3 The loading capacities of the remote supervising station equipment for any approved method of transmission shall be as designated in Section 4-2.

4-5.3* Supervising Station Facilities.

[New paragraph and title]

4-5.3.1 Where a remote supervising station connection is used to transmit an alarm signal, the signal shall be received at the public fire service communications center, at a fire station, or at the similar governmental agency that has a public responsibility for taking prescribed action to ensure response upon receipt of a fire alarm signal.

Exception: Where such an agency is unwilling to receive alarm signals or will permit the acceptance of another location by the authority having jurisdiction, such alternate location shall have personnel on duty at all times trained to receive the alarm signal and immediately retransmit it to the fire department.

[From NFPA 72, 8-2.2 modified]

4-5.3.2 Supervisory and trouble signals shall be handled at a constantly attended location having personnel on duty trained to recognize the type of signal received and to take prescribed action. This shall be permitted to be a location different from that at which alarm signals are received.

[From NFPA 72, 8-2.3 modified]

4-5.3.3 Where locations other than the public fire service communication center are used for the receipt of signals, access to receiving equipment shall be restricted in accordance with requirements of the authority having jurisdiction.

[From NFPA 72, 8-2.4 modified]

4-5.4 Equipment.

4-5.4.1 Signal-receiving equipment shall indicate receipt of each signal both audibly and visibly.

4-5.4.1.1 Audible signals shall meet the requirements of Chapter 6 for the private operating mode.

[New paragraphs and title]

4-5.4.1.2 Means for silencing alarm, supervisory, and trouble signals shall be provided and shall be so arranged that subsequent signals shall re-sound.

[From NFPA 72, 8-3.4 modified and 8-3.5 modified]

4-5.4.1.3 A trouble signal shall be received when the system or any portion of the system at the protected premises is placed in a bypass or test mode.

4-5.4.1.4 An audible and visible indication shall be provided upon restoration from any off-normal condition.

[New paragraphs]

4-5.4.1.5 Where suitable visible means are provided in the remote supervising station to readily identify the type of signal received, a common audible notification appliance shall be permitted to be used.

[From NFPA 72, 8-3.4 modified and 8-3.6 modified]

4-5.4.2 Power supplies shall comply with the requirements of Chapter 1.

Exception: In a remote supervising station fire alarm system where the alarm and supervisory signals are transmitted over a listed supervised one-way radio system, 24 hours of secondary (standby) power shall be permitted in lieu of 60 hours, as required in 1-5.2.5, at the radio alarm repeater station receivers (RARSR), provided that personnel are dispatched to arrive within 4 hours after detection of failure to initiate maintenance.

4-5.4.3 Transmission means shall comply with the requirements of Section 4-2.

[New paragraphs]

4-5.4.4 Retransmission of an alarm signal, where required, shall be by one of the following methods, listed in descending order of preference:

(a) A dedicated circuit that is independent of any switched telephone network. This circuit shall be permitted to be used for voice or data communication.

(b) A one-way (outgoing only) telephone at the remote supervising station that utilizes the public switched telephone network. This telephone shall be used primarily for voice transmission of alarms to a telephone at the public fire service communications center, which cannot be used for outgoing calls.

(c) A private radio system using the fire department frequency where permitted by the fire department.

(d) Other methods acceptable to the authority having jurisdiction.

[From NFPA 72, 8-3.2 modified]

4-5.5 Personnel. Sufficient personnel shall be available at all times to receive alarm signals at the remote supervising station and to take immediate appropriate action. Duties pertaining to other than operation of the remote supervising station receiving and retransmitting equipment shall be permitted subject to the approval of the authority having jurisdiction.

[From NFPA 72, 8-2.5 modified]

4-5.6 Operations.

[New title]

4-5.6.1 Where the remote supervising station is at a location other than the public fire service communication center, alarm signals shall be immediately retransmitted to the public fire service communications center.

[From NFPA 72, 8-3.1 modified]

4-5.6.2 Upon receipt of an alarm, supervisory, or trouble signal by the remote supervising station other than the public fire service communications center, it shall be the responsibility of the operator on duty to immediately notify the owner or the owner's designated representative.

[From NFPA 72, 8-3.3 modified]

4-5.6.3 A permanent record of the time, date, and location of all signals and restorations received; the action taken thereon; and the results of all tests shall be maintained for at least 1 year and made available to the author-

ity having jurisdiction. These records shall be permitted to be made by manual means.

[New paragraph]

4-5.6.4 All operator controls at the remote supervising station shall be operated at the beginning of each shift or change in personnel, and the status of all off-normal conditions noted and recorded.

[From NFPA 72, 8-4 modified]

4-5.7 Testing and Maintenance. Testing and maintenance for remote supervising stations shall be performed in accordance with Chapter 7.

[New paragraph]

4-6 Public Fire Alarm Reporting Systems.

[From NFPA 1221, Chap. 4 modified]

4-6.1 Scope. This section covers the general requirements and use of public fire alarm reporting systems. These systems include the equipment necessary to effect the transmission and reception of fire alarms or other emergency calls from the public.

[New paragraph]

4-6.2 General Fundamentals.

[From NFPA 1221, 4-1.1 modified]

4-6.2.1 Where implemented at the option of the authority having jurisdiction, a public fire alarm reporting system shall be designed, installed, operated, and maintained to provide the maximum practicable reliability for transmission and receipt of fire alarms.

[From NFPA 1221, 4-1.1.1 modified]

4-6.2.2 It shall be permissible for a public fire alarm reporting system, as described herein, to be used for the transmission of other signals or calls of a public emergency nature, provided such transmission does not interfere with the transmission and receipt of fire alarms.

[From NFPA 1221, 4-1.1.3 modified]

4-6.2.3 Alarm systems shall be Type A or Type B. A Type A system shall be provided when the number of all alarms required to be transmitted over the dispatch circuits exceeds 2500 per year.

NOTE: Where a Type A system is required, automatic transmission of alarms from boxes by use of electronic equipment is permissible, only if the following requirements are satisfied:

(a) Reliable facilities are provided for the automatic receipt, storage, retrieval, and transmission of alarms in the order received; and

(b) Override capability is provided to the operator(s) so that manual transmission and dispatch facilities are instantly available.

[From NFPA 1221, 4-1.1.4 modified]

4-6.2.4 Any portion(s) of a public fire alarm reporting system used to effect the auxiliated protection of a structure or multiple of structures shall be listed as compliant with Chapter 3 and Section 4-7.

[From NFPA 1221, 4-1.1.5 modified]

4-5.4.2 Power supplies shall comply with the requirements of Chapter 1.

Exception: In a remote supervising station fire alarm system where the alarm and supervisory signals are transmitted over a listed supervised one-way radio system, 24 hours of secondary (standby) power shall be permitted in lieu of 60 hours, as required in 1-5.2.5, at the radio alarm repeater station receivers (RARSR), provided that personnel are dispatched to arrive within 4 hours after detection of failure to initiate maintenance.

4-5.4.3 Transmission means shall comply with the requirements of Section 4-2.

[New paragraphs]

4-5.4.4 Retransmission of an alarm signal, where required, shall be by one of the following methods, listed in descending order of preference:

(a) A dedicated circuit that is independent of any switched telephone network. This circuit shall be permitted to be used for voice or data communication.

(b) A one-way (outgoing only) telephone at the remote supervising station that utilizes the public switched telephone network. This telephone shall be used primarily for voice transmission of alarms to a telephone at the public fire service communications center, which cannot be used for outgoing calls.

(c) A private radio system using the fire department frequency where permitted by the fire department.

(d) Other methods acceptable to the authority having jurisdiction.

[From NFPA 72, 8-3.2 modified]

4-5.5 Personnel. Sufficient personnel shall be available at all times to receive alarm signals at the remote supervising station and to take immediate appropriate action. Duties pertaining to other than operation of the remote supervising station receiving and retransmitting equipment shall be permitted subject to the approval of the authority having jurisdiction.

[From NFPA 72, 8-2.5 modified]

4-5.6 Operations.

[New title]

4-5.6.1 Where the remote supervising station is at a location other than the public fire service communication center, alarm signals shall be immediately retransmitted to the public fire service communications center.

[From NFPA 72, 8-3.1 modified]

4-5.6.2 Upon receipt of an alarm, supervisory, or trouble signal by the remote supervising station other than the public fire service communications center, it shall be the responsibility of the operator on duty to immediately notify the owner or the owner's designated representative.

[From NFPA 72, 8-3.3 modified]

4-5.6.3 A permanent record of the time, date, and location of all signals and restorations received; the action taken thereon; and the results of all tests shall be maintained for at least 1 year and made available to the author-

ity having jurisdiction. These records shall be permitted to be made by manual means.

[New paragraph]

4-5.6.4 All operator controls at the remote supervising station shall be operated at the beginning of each shift or change in personnel, and the status of all off-normal conditions noted and recorded.

[From NFPA 72, 8-4 modified]

4-5.7 Testing and Maintenance. Testing and maintenance for remote supervising stations shall be performed in accordance with Chapter 7.

[New paragraph]

4-6 Public Fire Alarm Reporting Systems.

[From NFPA 1221, Chap. 4 modified]

4-6.1 Scope. This section covers the general requirements and use of public fire alarm reporting systems. These systems include the equipment necessary to effect the transmission and reception of fire alarms or other emergency calls from the public.

[New paragraph]

4-6.2 General Fundamentals.

[From NFPA 1221, 4-1.1 modified]

4-6.2.1 Where implemented at the option of the authority having jurisdiction, a public fire alarm reporting system shall be designed, installed, operated, and maintained to provide the maximum practicable reliability for transmission and receipt of fire alarms.

[From NFPA 1221, 4-1.1.1 modified]

4-6.2.2 It shall be permissible for a public fire alarm reporting system, as described herein, to be used for the transmission of other signals or calls of a public emergency nature, provided such transmission does not interfere with the transmission and receipt of fire alarms.

[From NFPA 1221, 4-1.1.3 modified]

4-6.2.3 Alarm systems shall be Type A or Type B. A Type A system shall be provided when the number of all alarms required to be transmitted over the dispatch circuits exceeds 2500 per year.

NOTE: Where a Type A system is required, automatic transmission of alarms from boxes by use of electronic equipment is permissible, only if the following requirements are satisfied:

(a) Reliable facilities are provided for the automatic receipt, storage, retrieval, and transmission of alarms in the order received; and

(b) Override capability is provided to the operator(s) so that manual transmission and dispatch facilities are instantly available.

[From NFPA 1221, 4-1.1.4 modified]

4-6.2.4 Any portion(s) of a public fire alarm reporting system used to effect the auxilialized protection of a structure or multiple of structures shall be listed as compliant with Chapter 3 and Section 4-7.

[From NFPA 1221, 4-1.1.5 modified]

4-6.3 Management and Maintenance. (See Chapter 7.)

[From NFPA 1221, 4-1.2 modified]

4-6.4 Equipment and Installation.

[From NFPA 1221, 4-1.3]

4-6.4.1 Means for actuation of alarms by the public shall be conspicuous and readily accessible for easy operation.

[From NFPA 1221, 4-1.3.4 modified]

4-6.4.2 Public fire alarm reporting systems as defined in this chapter, shall, in their entirety, be subject to a complete operational acceptance test upon completion of system installation. Said test(s) shall be made in accordance with the requirements of the authority having jurisdiction. However, in no case shall the operational functions tested be less than those stipulated in Chapter 7. Like tests shall be performed on any alarm reporting devices as identified in this chapter that are added subsequent to the installation of the initial system.

4-6.4.3 Publicly accessible boxes shall be recognizable as such. Boxes shall have operating instructions plainly marked on the exterior surface.

[From NFPA 1221, 4-1.4.1.1 modified]

4-6.4.4 The actuating device shall be readily available and of such design and so located as to make the method of its use apparent.

[From NFPA 1221, 4-1.4.1.2 modified]

4-6.4.5 Publicly accessible boxes shall be as conspicuous as possible. Their color shall be distinctive.

[From NFPA 1221, 4-1.4.1.3]

4-6.4.6 All publicly accessible boxes mounted on support poles shall be identified by a wide band of distinctive colors or adequate signs placed 8 ft (2.44 m) above the ground and visible from all directions whenever possible.

[From NFPA 1221, 4-1.4.1.4 modified]

4-6.4.7* Indicating lights of a distinctive color, visible for at least 1500 ft (460 m), shall be installed over publicly accessible boxes in mercantile and manufacturing areas. Equipping the street light nearest the box with a distinctively colored light shall be acceptable.

[From NFPA 1221, 4-1.4.1.5 modified]

4-6.4.8 Boxes shall be securely mounted on poles, pedestals, or structural surfaces as directed by the authority having jurisdiction.

[From NFPA 1221, 4-1.4.1.8]

4-6.4.9 Concurrent operation of at least four boxes shall not result in the loss of an alarm.

[From NFPA 1221, 4-1.4.2.4]

4-6.5 Design of Boxes. (See Chapter 5.)

[From NFPA 1221, 4-1.4.2 modified]

4-6.6* Location of Boxes. Location of publicly accessible boxes shall be designated by the authority having jurisdiction.

Schools, hospitals, nursing homes, and places of public assembly shall have a box located at or near the main entrance, as directed by the authority having jurisdiction.

[From NFPA 1221, 4-1.4.3 modified, 4-1.4.3.1 modified, 4-1.4.3.2 modified, and 4-1.4.3.3 modified]

4-6.7 Power Supply.

[From NFPA 1221, 4-1.5.3]

4-6.7.1 General.

[New title]

4-6.7.1.1 Batteries, motor-generators, or rectifiers shall be sufficient to supply all connected circuits without exceeding the capacity of any battery or overloading any generator or rectifier, so that circuits developing grounds or crosses with other circuits each may be supplied by an independent source to the extent required by 4-6.7.1.8(b).

[From NFPA 1221, 4-1.5.3.1.1.1 modified]

4-6.7.1.2 Provision shall be made in the operating room for supplying any circuit from any battery, generator, or rectifier. Enclosed fuses shall be provided at points where supplies for individual circuits are taken from common leads. Necessary switches, testing, and signal transmitting and receiving devices shall be provided to permit the isolation, control, and test of each circuit, to at least 10 percent of the total number of box and dispatch circuits, but never less than 2 circuits.

[From NFPA 1221, 4-1.5.3.1.1.2]

4-6.7.1.3 If common-current source systems are grounded, the ground shall not exceed 10 percent of resistance of any connected circuit and be located at one side of the battery. Visual and audible indicating devices shall be provided for each box and dispatch circuit to give immediate warning of ground leakage endangering operability.

[From NFPA 1221, 4-1.5.3.1.1.3]

4-6.7.1.4 Local circuits at communication centers shall be supplied either in common with box circuits or coded radio-receiving system circuits or by a separate power source. The source of power for local circuits required to operate the essential features of the system shall be supervised.

[From NFPA 1221, 4-1.5.3.2]

4-6.7.1.5 Visual and audible means to indicate a 15 percent or greater reduction of normal power supply (rated voltage) shall be provided.

[From NFPA 1221, 4-1.5.3.3]

4-6.7.1.6 The forms and arrangements of power supply shall be classified as described in the paragraphs below.

NOTE: If the electrical service/capacity of the equipment required under NFPA 1221, *Standard for the Installation, Maintenance, and Use of Public Fire Service Communication Systems*, 2-1.6, is adequate to satisfy the needs of equipment in Section 4.6, said equipment need not be duplicated.

[From NFPA 1221, 4-1.5.3.1 modified]

4-6.7.1.7 Form 2. These forms shall be permissible for Type A systems only. Box circuits shall be served in multiple by:

(a)* *Form 2A.* A rectifier or motor-generator powered from a single source of alternating current, with a floating storage battery having a 24-hour standby capacity.

(b)* *Form 2B.* A rectifier or motor-generator powered from two sources of alternating current, with a floating storage battery having a 4-hour standby capacity.

(c)* *Form 2C.* A duplicate rectifier or motor-generator powered from two sources of alternating current with transfer facilities to apply power from the secondary source to the system within 30 seconds (*see NFPA 1221, Standard for the Installation, Maintenance, and Use of Public Fire Service Communication Systems*). Each rectifier or motor-generator shall be capable of powering the entire system.

NOTE: For Forms 2A, 2B, and 2C, these arrangements are permissible but are not recommended where circuits are wholly or partly open-wire because of the possibility of trouble from multiple grounds.

[From NFPA 1221, 4-1.5.3.1.1 modified]

4-6.7.1.8 Form 3. Each box circuit or coded radio receiving system shall be served by:

(a)* *Form 3A.* A rectifier or motor-generator powered from a single source of alternating current with a floating storage battery having a 60-hour standby capacity.

(b)* *Form 3B.* A rectifier or motor-generator powered from two sources of alternating current with a floating storage battery having a 24-hour standby capacity.

[From NFPA 1221, 4-1.5.3.1.2 modified]

4-6.7.1.9 Form 4. Each box circuit or coded radio receiving system shall be served by:

(a)* *Form 4A.* An inverter powered from a common rectifier receiving power by a single source of alternating current with a floating storage battery having a 24-hour standby capacity.

(b)* *Form 4B.* An inverter powered from a common rectifier receiving power from two sources of alternating current with a floating storage battery having a 4-hour standby capacity.

NOTE: For Form 4A and Form 4B, it is permissible to distribute the system load between two or more common rectifiers and batteries.

(c)* *Form 4C.* A rectifier, converter, or motor-generator receiving power from two sources of alternating current with transfer facilities to apply power from the secondary source to the system within 30 seconds (*see NFPA 1221, Standard for the Installation, Maintenance, and Use of Public Fire Service Communication Systems*).

[From NFPA 1221, 4-1.5.3.1.3 modified]

4-6.7.2 Rectifiers, Converters, Inverters, and Motor-Generators.

[From NFPA 1221, 4-1.5.4]

4-6.7.2.1 Rectifiers shall be supplied through an isolating transformer taking energy from a circuit not to exceed 250 volts.

[From NFPA 1221, 4-1.5.4.1]

4-6.7.2.2 Complete, ready-to-use spare units or spare parts shall be available in reserve.

[From NFPA 1221, 4-1.5.4.2]

4-6.7.2.3 One spare rectifier shall be provided for each ten required for operation, but in no case less than one.

[From NFPA 1221, 4-1.5.4.3]

4-6.7.2.4 Leads from rectifiers or motor-generators, with storage battery floating, shall have fuses rated at not less than 1 amp and not more than 200 percent of maximum connected load. Where not provided with battery floating, the fuse shall be not less than 3 amps.

[From NFPA 1221, 4-1.5.4.4]

4-6.7.3 Engine-Driven Generator Sets.

[From NFPA 1221, 4-1.5.5]

4-6.7.3.1 The provisions of 4-6.7.3 shall apply to generators driven by internal combustion engines.

[From NFPA 1221, 4-1.5.5.1]

4-6.7.3.2 The installation of such units shall conform to the provisions of NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, and NFPA 110, *Standard for Emergency and Standby Power Systems*, except as restricted by the provisions of 4-6.7.3.

[From NFPA 1221, 4-1.5.5.2]

4-6.7.3.3 The engine-driven generator shall be located in an adequately ventilated cutoff area of the building housing the communication center equipment. The area housing the unit shall be used for no other purpose except storage of spare parts or equipment. Exhaust fumes shall be discharged directly outside the building.

[From NFPA 1221, 4-1.5.5.3]

4-6.7.3.4 Liquid fuel shall be stored in outside underground tanks and gravity feed shall not be used. Sufficient fuel shall be available for 24 hours of operation at full load if a reliable source of fuel supply is available, at any time, on 2 hours notice. If a source of supply is not reliable or readily available, or if special arrangements must be made for refueling as necessary, a supply sufficient for 48 hours of operation at full load shall be maintained.

[From NFPA 1221, 4-1.5.5.4 modified]

4-6.7.3.5 Liquefied petroleum gas and natural gas installations shall meet the requirements of NFPA 54, *National Fuel Gas Code*, and NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*.

[From NFPA 1221, 4-1.5.5.5]

4-6.7.3.6 The unit, as a minimum, shall be of sufficient capacity to supply power to operate all fire alarm facilities and emergency lighting of the operating rooms or communication building.

[From NFPA 1221, 4-1.5.5.6]

4-6.7.3.7 A separate storage battery on automatic float charger shall be provided for starting the engine-driven generator.

[From NFPA 1221, 4-1.5.5.7]

4-6.7.3.8 Where more than one engine-driven generator is provided, each shall be provided with a separate fuel line and transfer pump.

[From NFPA 1221, 4-1.5.5.8]

4-6.7.4 Float-Charged Batteries.

[From NFPA 1221, 4-1.5.6 modified]

4-6.7.4.1 Batteries shall be of the storage type; primary batteries (dry cells) shall not be used. All cells shall be of the sealed type. Lead-acid batteries shall be in jars of glass or other suitable transparent materials; other types of batteries shall be in containers suitable for the purpose.

[From NFPA 1221, 4-1.5.6.1]

4-6.7.4.2 Batteries shall be located in the same building as the operating equipment, preferably on the same floor, readily accessible for maintenance and inspection. The battery room shall be aboveground, except as permitted by NFPA 1221, *Standard for the Installation, Maintenance, and Use of Public Fire Service Communication Systems*, 2-1.1.2, and shall be ventilated to prevent accumulation of explosive gas mixtures; special ventilation is required only for unsealed cells.

[From NFPA 1221, 4-1.5.6.2 modified]

4-6.7.4.3 Batteries shall be mounted to provide effective insulation from the ground and from other batteries. The mounting shall be suitably protected against deterioration, and consideration shall be given to stability, especially in geographic areas subject to seismic disturbance.

[From NFPA 1221, 4-1.5.6.3]

4-6.8 Requirements for Metallic Systems and Metallic Interconnections.

[From NFPA 1221, 4-1.8]

4-6.8.1 Circuit Conductors.

[From NFPA 1221, 4-1.8.1 modified]

4-6.8.1.1 Wires shall be terminated so as to provide good electrical conductivity and to prevent breaking from vibration or stress.

[From NFPA 1221, 4-1.8.1.1]

4-6.8.1.2 Circuit conductors on terminal racks shall be identified and isolated from conductors of other systems whenever possible and shall be suitably protected from mechanical injury.

[From NFPA 1221, 4-1.8.1.2 modified]

4-6.8.1.3 Except as otherwise provided herein, exterior cable and wire shall conform to International Municipal Signal Association specifications or their equivalent.

[From NFPA 1221, 4-1.8.1.3]

4-6.8.1.4 If a municipal box is installed inside a building, it shall be placed as close as practical to the point of entrance of the circuit, and the exterior wire shall be installed in conduit or electrical metallic tubing, in accordance with Chapter 3 of NFPA 70, *National Electrical Code*.

Exception: This requirement shall not apply to coded radio box systems.

[From NFPA 1221, 4-1.8.1.4]

4-6.8.2 Cables.

[From NFPA 1221, 4-1.8.2]

4-6.8.2.1 General.

[From NFPA 1221, 4-1.8.2.1]

4-6.8.2.1.1 Cables that meet the requirements of NFPA 70, *National Electrical Code*, Article 310, for installation in wet locations shall be satisfactory for overhead or underground installation, except that direct-burial cable shall be specifically approved for the purpose.

[From NFPA 1221, 4-1.8.2.1(a)]

4-6.8.2.1.2 Paper or pressed pulp insulation shall not be considered satisfactory for an emergency service such as a fire alarm system, except that cables containing conductors with such insulation shall be acceptable if pressurized with dry air or nitrogen. Loss of pressure in cables shall be indicated by a visual or audible warning system located where someone who can interpret the pressure readings and who has authority to have the indicated abnormal condition corrected is in constant attendance.

[From NFPA 1221, 4-1.8.2.1(b) modified]

4-6.8.2.1.3 Natural rubber-sheathed cable shall not be used where it may be exposed to oil, grease, or other substances or conditions that may tend to deteriorate the cable sheath. Braided-sheathed cable shall be used only inside of buildings where run in conduit or metal raceways.

[From NFPA 1221, 4-1.8.2.1(c)]

4-6.8.2.1.4 Other municipally controlled signal wires shall be permitted to be installed in the same cable with fire alarm wires. Cables controlled by or containing wires of private signaling organizations shall be permitted to be used for fire alarm purposes only by permission of the authority having jurisdiction.

[From NFPA 1221, 4-1.8.2.1(d) modified]

4-6.8.2.1.5 Signaling wires that, because of the source of current supply, might introduce a hazard shall be protected and supplied as required for lighting circuits.

[From NFPA 1221, 4-1.8.2.1(e) modified]

4-6.8.2.1.6 All cables with all taps and splices made shall be tested for insulation resistance when installed, but before connection to terminals. Such tests shall indicate an insulation resistance of at least 200 megohms per mile between any one conductor and all others, the sheath, and ground.

[From NFPA 1221, 4-1.8.2.1(f)]

4-6.8.2.2 Underground Cables.

[From NFPA 1221, 4-1.8.2.2]

4-6.8.2.2.1 Underground cables in duct or direct burial shall be brought aboveground only at points where liability of mechanical injury or of disablement from heat incident to fires in adjacent buildings is minimized.

[From NFPA 1221, 4-1.8.2.2(a) modified]

4-6.8.2.2.2 Cables shall be in duct systems and manholes containing low-tension fire alarm system conductors only, except low-tension secondary power cables shall be permitted. If in duct systems or manholes containing power

circuit conductors in excess of 250 volts to ground, fire alarm cables shall be located as far as possible from such power cables and shall be separated from them by a non-combustible barrier or by such other means as may be practicable to protect the fire alarm cables from injury.

[From NFPA 1221, 4-1.8.2.2(b) modified]

4-6.8.2.2.3 All cables installed in manholes shall be properly racked and marked for identification.

[From NFPA 1221, 4-1.8.2.2(c)]

4-6.8.2.2.4 All conduits or ducts entering buildings from underground duct systems shall be effectively sealed against moisture or gases entering the building.

[From NFPA 1221, 4-1.8.2.2(d)]

4-6.8.2.2.5 Cable joints shall be located only in manholes, fire stations, and other locations where proper accessibility is provided and where there is little liability of injury to the cable due to either falling walls or operations in the buildings. Cable joints shall be made to provide and maintain conductivity, insulation, and protection at least equal to that afforded by the cables that are joined. Cable ends shall be sealed against moisture.

[From NFPA 1221, 4-1.8.2.2(e)]

4-6.8.2.2.6 Direct-burial cable, without enclosure in ducts, shall be laid in grass plots, under sidewalks, or in other places where the ground is not apt to be opened for other underground construction. If splices are made, such splices shall, where practicable, be accessible for inspection and tests. Such cables shall be buried at least 18 in. (0.5 m) deep and, where crossing streets or other areas likely to be opened for other underground construction, shall be in duct or conduit or be covered by creosoted planking of at least 2 in. by 4 in. (50 mm by 100 mm) with half-round grooves, spiked or banded together after the cable is installed.

[From NFPA 1221, 4-1.8.2.2(f)]

4-6.8.2.3 Aerial Construction.

[From NFPA 1221, 4-1.8.3]

4-6.8.2.3.1 Fire alarm wires shall be run under all other wires except communication wires. Suitable precautions shall be provided where passing through trees, under bridges, over railroads, and at other places where injury or deterioration is possible. Wires and cables shall not be attached to a crossarm carrying electric light and power wires, except circuits carrying up to 220 volts for municipal communication use. Such 220-volt circuits shall be tagged or otherwise identified.

[From NFPA 1221, 4-1.8.3.1 modified]

4-6.8.2.3.2 Aerial cable shall be supported by messenger wire of adequate tensile strength, except as permitted in 4-6.8.2.3.3.

[From NFPA 1221, 4-1.8.3.2 modified]

4-6.8.2.3.3 Two-conductor cable shall be messenger-supported unless it has conductors of No. 20 AWG or larger size and has mechanical strength equivalent to No. 10 AWG hard-drawn copper.

[From NFPA 1221, 4-1.8.3.3]

4-6.8.2.3.4 Single wire shall meet International Municipal Signal Association specifications and shall not be smaller than No. 10 Roebing gauge if of galvanized iron or steel, No. 10 AWG if of hard-drawn copper, No. 12 AWG if of approved copper-covered steel, or No. 6 AWG if of aluminum. Span lengths shall not exceed manufacturers' recommendations.

[From NFPA 1221, 4-1.8.3.4 modified]

4-6.8.2.3.5 Wires to buildings shall contact only intended supports and shall enter through an approved weather-head or suitable sleeves slanting upward and inward. Drip loops shall be formed on wires outside of buildings.

[From NFPA 1221, 4-1.8.3.5]

4-6.8.2.4 Leads Down Poles.

[From NFPA 1221, 4-1.8.4]

4-6.8.2.4.1 Leads down poles shall be protected against mechanical injury. Any metallic covering shall form a continuous conducting path to ground. Installation, in all cases, shall prevent water from entering the conduit or box.

[From NFPA 1221, 4-1.8.4.1 modified]

4-6.8.2.4.2 Leads to boxes shall have 600-volt insulation approved for wet locations, as defined in NFPA 70, *National Electrical Code*.

[From NFPA 1221, 4-1.8.4.2]

4-6.8.2.5 Wiring Inside Buildings.

[From NFPA 1221, 4-1.8.5]

4-6.8.2.5.1 At the communication center, conductors shall extend as directly as possible to the operating room in conduits, ducts, shafts, raceways, or overhead racks and troughs of a type of construction affording protection against fire and mechanical injury.

[From NFPA 1221, 4-1.8.5.1 modified]

4-6.8.2.5.2 All conductors inside buildings shall be in conduit, electrical tubing, metal molding, or raceways. Installation shall be in accordance with NFPA 70, *National Electrical Code*.

[From NFPA 1221, 4-1.8.5.2 modified]

4-6.8.2.5.3 Conductors shall have an approved insulation; the insulation or other outer covering shall be flame-retardant and moisture-resistant.

[From NFPA 1221, 4-1.8.5.3]

4-6.8.2.5.4 Conductors shall be installed as far as possible without joints. Splices shall be permitted only in junction or terminal boxes. Wire terminals, splices, and joints shall conform to NFPA 70, *National Electrical Code*.

[From NFPA 1221, 4-1.8.5.4 modified]

4-6.8.2.5.5 Conductors bunched together in a vertical run connecting two or more floors shall have a flame-retardant covering sufficient to prevent the carrying of fire from floor to floor. This requirement shall not apply if the conductors are encased in a metallic conduit or located in a fire-resistive shaft having fire stops at each floor.

[From NFPA 1221, 4-1.8.5.5]

4-6.8.2.5.6 Where cables or wiring are exposed to unusual fire hazards, they shall be properly protected.

[From NFPA 1221, 4-1.8.5.6]

4-6.8.2.5.7 Cable terminals and cross-connecting facilities shall be located in or adjacent to the operations room.

[From NFPA 1221, 4-1.8.5.7]

4-6.8.2.5.8 Where signal conductors and electric light and power wires are run in the same shaft, they shall be separated by at least 20 in. (50 mm), or either system shall be encased in a noncombustible enclosure.

[From NFPA 1221, 4-1.8.5.8]

4-6.9 Facilities for Signal Transmission.

[New title]

4-6.9.1 Circuits.

[From NFPA 1221, 4-2.1]

4-6.9.1.1 General.

[From NFPA 1221, 4-2.1.1]

4-6.9.1.1.1 ANSI/IEEE C2, *The National Electrical Safety Code*, shall be used as a guide for the installation of outdoor circuitry.

[From NFPA 1221, 4-2.1.1.1 modified, 4-3.2.1 modified, 4-4.1.1.1 modified, and 4-5.1.1.1 modified]

4-6.9.1.1.2 In all installations, first consideration shall be given to continuity of service. Particular attention shall be given to liability of mechanical injury; disablement from heat incident to a fire; injury by falling walls; and damage by floods, corrosive vapors, or other causes.

[From NFPA 1221, 4-2.1.1.2 modified, 4-3.2.1 modified, 4-4.1.1.2 modified, and 4-5.1.1.2 modified]

4-6.9.1.1.3 Open local circuits within single buildings are permitted in accordance with Chapter 3.

[From NFPA 1221, 4-2.1.1.3 modified, 4-4.1.1.3 modified, and 4-5.1.1.3 modified]

4-6.9.1.1.4 All circuits shall be so routed as to permit ready tracing of circuits for trouble.

[From NFPA 1221, 4-2.1.1.4, 4-4.1.1.4, and 4-5.1.1.4]

4-6.9.1.1.5 Circuits shall not pass over, under, through, or be attached to buildings or property not owned by or under the control of the authority having jurisdiction or the agency responsible for maintaining the system, except where the circuit is terminated in a box on the premises.

[From NFPA 1221, 4-2.1.1.5 modified, 4-4.1.1.5 modified, and 4-5.1.1.5 modified]

4-6.9.1.2 Box Circuits.

[From NFPA 1221, 4-2.1.2]

4-6.9.1.2.1 If a box is installed inside a building, it shall be placed as close as is practical to the point of entrance of the circuit, and the exterior wire shall be installed in con-

duit or electrical metallic tubing in accordance with Chapter 3 of NFPA 70, *National Electrical Code*.

[From NFPA 1221, 4-2.1.2.1 modified]

4-6.9.1.2.2 Accessible and reliable means, available only to the authority having jurisdiction or the agency responsible for maintaining the public fire alarm reporting system, shall be provided for disconnecting the auxiliary loop to the box inside the building, and definite notification shall be given to occupants of the building when the interior box is not in service.

[From NFPA 1221, 4-2.1.2.2 modified]

4-6.9.1.3 Tie Circuits.

[From NFPA 1221, 4-2.1.3 and 4-4.1.3]

4-6.9.1.3.1 A separate tie circuit shall be provided from the communication center to each subsidiary communication center.

[From NFPA 1221, 4-2.1.3.1 modified and 4-4.1.3.1 modified]

4-6.9.1.3.2 The tie circuit between the communication center and the subsidiary communication center shall not be used for any other purpose.

[From NFPA 1221, 4-4.1.3.2 modified]

4-6.9.1.3.3 In a Type B wire system, where all boxes in the system are of succession type, it shall be permissible to use the tie circuit as a dispatch circuit, to the extent permitted by NFPA 1221, *Standard for the Installation, Maintenance, and Use of Public Fire Service Communication Systems*.

[From NFPA 1221, 4-2.1.3.2 modified]

4-6.9.1.4* Circuit Protection.

[From NFPA 1221, 4-2.2, 4-4.2, and 4-5.2]

4-6.9.1.4.1 General.

[From NFPA 1221, 4-2.2.1, 4-4.2.1, and 4-5.2.1]

4-6.9.1.4.1.1 The protective devices shall be located close to or be combined with the cable terminals.

[From NFPA 1221, 4-2.2.1.1, 4-4.2.1.1, and 4-5.2.1.1]

4-6.9.1.4.1.2 Lightning arresters suitable for the purpose shall be provided. Lightning arresters shall be marked with the name of the manufacturer and model designation.

[From NFPA 1221, 4-2.2.1.2, 4-4.2.1.2, and 4-5.2.1.2]

4-6.9.1.4.1.3 All lightning arresters shall be connected to a suitable ground in accordance with NFPA 70, *National Electrical Code*.

[From NFPA 1221, 4-2.2.1.3, 4-4.2.1.3, and 4-5.2.1.3]

4-6.9.1.4.1.4 All fuses shall be plainly marked with their rated ampere capacity. All fuses rated over 2 amps shall be of the enclosed type.

[From NFPA 1221, 4-2.2.1.4, 4-4.2.1.4, and 4-5.2.1.4]

4-6.9.1.4.1.5 Circuit protection required at the communication center shall be provided in every building housing communication center equipment.

[From NFPA 1221, 4-2.2.1.5, 4-4.2.1.5, and 4-5.2.1.5]

4-6.9.1.4.1.6 Each conductor entering a fire station from partially or entirely aerial lines shall be protected by a lightning arrester.

[From NFPA 1221, 4-2.2.1.6, 4-4.2.1.6, and 4-5.2.1.6]

4-6.9.1.4.2 Communication Center.

[From NFPA 1221, 4-2.2.2 and 4-4.2.2]

4-6.9.1.4.2.1 All conductors entering the communication center shall be protected by the following devices, in the order named, starting from the exterior circuit:

(a) A fuse rated at 3 amps minimum to 7 amps maximum, and not less than 2000 volts

(b) A lightning arrester

(c) A fuse or circuit breaker, rated at $\frac{1}{2}$ amp.

[From NFPA 1221, 4-2.2.2.1, 4-4.2.2.1, and 4-5.2.2 modified]

4-6.9.1.4.2.2 The $\frac{1}{2}$ -amp protection on the tie circuits shall be omitted at subsidiary communication centers.

[From NFPA 1221, 4-2.2.2.2 modified and 4-4.2.2.2 modified]

4-6.9.1.4.3 Protection on Aerial Construction.

[From NFPA 1221, 4-2.2.2.3, 4-4.2.2.3, and 4-5.2.2.3]

4-6.9.1.4.3.1 At junction points of open aerial conductors and cable, each conductor shall be protected by a lightning arrester of weatherproof type. There shall also be a connection between the lightning arrester ground, any metallic sheath, and messenger wire.

[From NFPA 1221, 4-2.2.3.1 modified, 4-4.2.3.1 modified, and 4-5.2.3.1 modified]

4-6.9.1.4.3.2 Aerial open-wire and non-messenger-supported 2-conductor cable circuits shall be protected by a lightning arrester at intervals of approximately 2000 ft (610 m).

[From NFPA 1221, 4-2.2.3.2, 4-4.2.3.2, and 4-5.2.3.2]

4-6.9.1.4.3.3 Lightning arresters, other than air-gap or self-restoring type, shall not be installed in fire alarm circuits.

[From NFPA 1221, 4-2.2.3.3 modified, 4-4.2.3.3 modified, and 4-5.2.3.3 modified]

4-6.9.1.4.3.4 All protective devices shall be accessible for maintenance and inspection.

[From NFPA 1221, 4-2.2.3.4, 4-4.2.3.4, and 4-5.2.3.4 modified]

4-6.10 Power.

[From NFPA 1221, 4-2.3 and 4-4.3]

4-6.10.1 Requirements for Constant-Current Systems.

[From NFPA 1221, 4-2.3.1 and 4-4.3.1]

4-6.10.1.1 Means shall be provided for manually regulating current in box circuits so that operating current is maintained within 10 percent of normal throughout changes in external circuit resistance from 20 percent above to 50 percent below normal.

[From NFPA 1221, 4-2.3.1.1 and 4-4.3.1.1]

4-6.10.1.2 The voltage supplied to maintain normal line current on box circuits shall not exceed 150 volts, measured under no-load conditions, and shall be such that the line current will not be reduced below safe operating value by the simultaneous operation of four boxes.

[From NFPA 1221, 4-2.3.1.2 and 4-4.3.1.2 modified]

4-6.10.1.3 Visual and audible means to indicate a 20 percent or greater reduction in the normal current in any alarm circuit shall be provided. All devices connected in series with any alarm circuit shall function properly when the alarm circuit current is reduced to 70 percent of normal.

[From NFPA 1221, 4-2.3.1.3 modified and 4-4.3.1.3 modified]

4-6.10.1.4 Sufficient meters shall be provided to indicate the current in any box circuit and the voltage of any power source. Meters used in common for several circuits shall be provided with cut-in devices designed to reduce the probability of cross-connecting circuits.

[From NFPA 1221, 4-2.3.1.4 and 4-4.3.1.4]

4-6.11 Receiving Equipment — Facilities for Receipt of Box Alarms.

[From NFPA 1221, 4-2.4]

4-6.11.1 General.

[From NFPA 1221, 4-2.4.3]

4-6.11.1.1 Alarms from boxes shall be automatically received and recorded at the communication center.

[From NFPA 1221, 4-2.4.3.1 and 4-4.5.4]

4-6.11.1.2 A permanent visual record and an audible signal shall be required to indicate the receipt of an alarm. The permanent record shall indicate the exact location from which the alarm is being transmitted.

NOTE: The audible signal device may be common to several box circuits and arranged so that the fire alarm operator can manually silence the signal temporarily by a self-restoring switch.

[From NFPA 1221, 4-2.4.3.2 modified and 4-4.5.5 modified]

4-6.11.1.3 Facilities shall be provided that will automatically record the date and time of receipt of each alarm, except that only the time need be automatically recorded in voice recordings.

[From NFPA 1221, 4-2.4.3.3 modified, 4-4.5.8 modified, and 4-5.5.8 modified]

4-6.11.2 Visual Recording Devices.

[From NFPA 1221, 4-2.4.1]

4-6.11.2.1 A device for producing a permanent graphic recording of all alarm, supervisory, trouble, and test signals received and/or retransmitted shall be provided at each communication center for each alarm circuit and tie circuit. If each circuit is served by a dedicated recording device, then the number of reserve recording devices required on site shall be equal to at least 5 percent of the circuits in service and in no case less than 1 percent. If two or more circuits are served by a common recording device, then a reserve recording device shall be available on site for each circuit connected to a common recorder.

[From NFPA 1221, 4-2.4.1.1 modified]

4-6.11.2.2 In a Type B wire system, one such device shall be installed in each fire station and at least one in the communication center.

[From NFPA 1221, 4-2.4.1.2 modified]

4-6.12 Supervision.

[From NFPA 1221, 4-2.5, 4-3.7, 4-4.7, and 4-5.7]

4-6.12.1 To ensure reliability, wired circuits upon which transmission and receipt of alarms depend shall be under constant electrical supervision to give prompt warning of conditions adversely affecting reliability.

[From NFPA 1221, 4-2.5.1 and 4-4.7.1]

4-6.12.2 The power supplied to all required circuits and devices of the system shall be supervised.

[From NFPA 1221, 4-2.5.2, 4-3.7.2, 4-4.7.2, and 4-5.7.1]

4-6.12.3 Trouble signals shall actuate a sounding device located where there is always a responsible person on duty.

[From NFPA 1221, 4-2.5.3, 4-3.7.3, 4-4.7.3, and 4-5.7.2]

4-6.12.4 Trouble signals shall be distinct from alarm signals and shall be indicated by both a visual light and an audible signal.

NOTE 1: The audible signal may be common to several supervised circuits.

NOTE 2: A switch for silencing the audible trouble signal is permitted if the visual signal remains operated until the silencing switch is restored to its normal position.

[From NFPA 1221, 4-2.5.4, 4-3.7.4, 4-4.7.4, and 4-5.7.3]

4-6.12.5 The audible signal shall be responsive to faults on any other circuits that may occur prior to restoration of the silencing switch to normal.

[From NFPA 1221, 4-2.5.5, 4-3.7.5, 4-4.7.5, and 4-5.7.4]

4-6.13 Coded Wired Reporting Systems.

4-6.13.1 For a Type B system, the effectiveness of noninterference and succession functions between box circuits shall be no less than between boxes in any one circuit. The

disablement of any metallic box circuit shall cause a warning signal in all other circuits, and, thereafter, the circuit or circuits not otherwise broken shall be automatically restored to operative condition.

[From NFPA 1221, 4-2.1.2.3]

4-6.13.2 Box circuits shall be sufficient in number and so laid out that the areas that would be left without box protection in case of disruption of a circuit would not exceed that covered by 20 properly spaced boxes where all or any part of the circuit is of aerial open-wire, or 30 properly spaced boxes where the circuit is entirely in underground or messenger-supported cable.

[From NFPA 1221, 4-2.1.2.4]

4-6.13.3 Where all boxes on any individual circuit and associated equipment are designed and installed to provide for receipt of alarms through the ground in event of a break in the circuit, it is permissible for the circuit to serve twice the above figures for aerial open-wire and cable circuits, respectively.

[From NFPA 1221, 4-2.1.2.5 modified]

4-6.13.4 The installation of additional boxes in an area served by the number of properly spaced boxes indicated above shall not constitute geographical overloading of a circuit.

[From NFPA 1221, 4-2.1.2.6]

4-6.13.5 Sounding devices for signals shall be provided for box circuits.

NOTE 1: In a Type A system, it is satisfactory to use a common sounding device for more than one circuit, and it should be installed at the communication center.

NOTE 2: In a Type B system, a sounding device is to be installed in each fire station at the same location as the recording device for that circuit, except that at the communication center, a common sounding device is permitted.

[From NFPA 1221, 4-2.4.2.1]

4-6.14 Coded Radio Reporting Systems.

[From NFPA 1221, 4-3]

4-6.14.1 Radio Box Channel (Frequency).

[From NFPA 1221, 4-3.1]

4-6.14.1.1 The number of boxes permitted on a single frequency shall be governed by the following:

(a) For systems utilizing one-way transmission in which the individual box automatically initiates the required message (*see 4-6.14.1.4*) using circuitry integral to the boxes, not more than 500 boxes shall be permitted on a single frequency.

(b) For systems utilizing a two-way concept in which interrogation signals (*see 4-6.14.1.4*) are transmitted to the individual boxes from the communication center on the same frequency used for receipt of alarms, not more than 250 boxes shall be permitted on a single frequency. If interrogation signals are transmitted on a frequency different from that used for receipt of alarms, not more than 500 boxes shall be permitted on a single frequency.

(c) A specific frequency shall be designated for both fire and other fire-related or public safety alarm signals, and supervisory signals (test and tamper). All acknowledgment and other signals shall utilize a separate frequency.

[From NFPA 1221, 4-3.1.1 modified]

4-6.14.1.2 Where box message signals to the communication center or acknowledgment of message receipt signals from the communication center to the box are repeated, associated repeating facilities shall conform to the requirements indicated in NFPA 1221, *Standard for the Installation, Maintenance, and Use of Public Fire Service Communication Systems*, 3-4.1.2.

[From NFPA 1221, 4-3.1.2 modified]

4-6.14.1.3 All coded radio box systems shall provide constant monitoring of the frequency in use. Both an audible and visual indication of any sustained carrier signal (when in excess of 15 seconds' duration) shall be provided for each receiving system at the communication center.

[From NFPA 1221, 4-3.1.3 modified]

4-6.14.1.4 Each coded radio box shall automatically transmit a message at least once during each 24-hour period.

[From NFPA 1221, 4-3.6.1 modified]

4-6.14.2 Metallic Interconnections. Accessible and reliable means, available only to the agency responsible for maintaining the public fire alarm reporting system, shall be provided for disconnecting the auxiliary loop to the box inside the building, and definite notification shall be given to occupants of the building when the interior box is not in service.

[From NFPA 1221, 4-3.2.2 modified]

4-6.14.3 Receiving Equipment — Facilities for Receipt of Box Alarms.

[From NFPA 1221, 4-3.4]

4-6.14.3.1 Type A System.

[From NFPA 1221, 4-3.4.2]

4-6.14.3.1.1* For each frequency used, two separate receiving networks, each including an antenna, audible alerting device, receiver, power supply, signal processing equipment, a means of providing a permanent graphic recording of the incoming message that is both timed and dated, and other associated equipment shall be provided and shall be installed at the communication center. Facilities shall be so arranged that a failure of either receiving network will not affect the receipt of messages from boxes.

[From NFPA 1221, 4-3.4.2.1 modified]

4-6.14.3.1.2 Where the system configuration is such that a polling device is incorporated into the receiving network to allow remote/selective initiation of box tests (see Chapter 7), a separate such device shall be included in each of the two required receiving networks. Further, the polling devices shall be configured for automatic cycle initiation in their primary operating mode, capable of continuous self-monitoring, and integrated into the network(s) to provide

automatic switchover and operational continuity in the event of failure of either device.

[From NFPA 1221, 4-3.4.2.2 modified]

4-6.14.3.1.3 Test signals from boxes shall not be required to include the date as part of their permanent recording, providing that the date is automatically printed on the recording tape at the beginning of each calendar day.

[From NFPA 1221, 4-3.4.2.3]

4-6.14.3.2 Type B System.

[From NFPA 1221, 4-3.4.3]

4-6.14.3.2.1 For each frequency used, a single complete receiving network shall be permitted in each fire station, providing the communication center conforms to 4-6.14.3.1.1. If the jurisdiction maintains in operation two or more alarm reception points, one receiving network shall be permitted to be at each alarm reception point.

[From NFPA 1221, 4-3.4.3.1 modified]

4-6.14.3.2.2 If alarm signals are transmitted to a fire station from the communication center using the coded radio-type receiving equipment in the fire station to receive and record the alarm message, a second receiving network conforming to 4-6.14.3.2.1 shall be provided at each fire station, and that receiving network shall employ a frequency other than that used for the receipt of box messages.

[From NFPA 1221, 4-3.4.3.2 modified]

4-6.14.4 Power. Power shall be provided in accordance with 4-6.7.

[From NFPA 1221, 4-3.5 modified]

4-6.14.5 Testing. (See Chapter 7.)

[New title]

4-6.14.6 Supervision. Radio repeaters upon which receipt of alarms depend shall be provided with dual receivers and transmitters. Failure of the primary transmitter or receiver shall cause an automatic switchover to the secondary receiver and transmitter.

Exception: If the repeater controls are located where someone is always on duty, manual switchover shall be permitted if it can be completed within 30 seconds.

[From NFPA 1221, 4-3.7.1 modified]

4-6.15 Telephone (Series) Reporting Systems.

[From NFPA 1221, 4-4]

4-6.15.1 A permanent visual recording device installed in the communication center shall be provided to record all incoming box signals. A spare recording device shall be provided for five or more box circuits.

[From NFPA 1221, 4-4.5.1]

4-6.15.2 A second visual means of identifying the calling box shall be provided.

[From NFPA 1221, 4-4.5.2]

4-6.15.3 Audible signals shall indicate all incoming calls from box circuits.

[From NFPA 1221, 4-4.5.3]

4-6.15.4 All voice transmissions from boxes for emergencies shall be recorded with the capability of instant playback.

[From NFPA 1221, 4-4.5.6]

4-6.15.5 A voice recording facility shall be provided for each operator handling incoming alarms to eliminate the possibility of interference.

[From NFPA 1221, 4-4.5.7]

4-6.15.6 Box circuits shall be sufficient in number and so laid out that the areas that would be left without box protection in case of disruption of a circuit would not exceed that covered by 20 properly spaced boxes where all or any part of the circuit is of aerial open-wire, or 30 properly spaced boxes where the circuit is entirely in underground or messenger-supported cable.

[From NFPA 1221, 4-4.1.2.1 modified]

4-6.15.7 Where all boxes on any individual circuit and associated equipment are designed and installed to provide for receipt of alarms through the ground in event of a break in the circuit, it shall be permissible for the circuit to serve twice the above figures for aerial open-wire and cable circuits, respectively.

[From NFPA 1221, 4-4.1.2.2]

4-6.15.8 The installation of additional boxes in an area served by the number of properly spaced boxes indicated above shall not constitute geographical overloading of a circuit.

[From NFPA 1221, 4-4.1.2.3]

4-6.16 Telephone (Parallel) Reporting Systems.

[From NFPA 1221, 4-5]

4-6.16.1 Box Circuits.

[From NFPA 1221, 4-5.1.2]

4-6.16.1.1 If a municipal box is installed inside a building, it shall be placed as close as practical to the point of entrance of the circuit, and the exterior wire shall be installed in conduit or electrical metallic tubing, in accordance with Chapter 3 of NFPA 70, *National Electrical Code*.

[From NFPA 1221, 4-5.1.2.1]

4-6.16.1.2 Accessible and reliable means, available only to the authority having jurisdiction or the agency responsible for maintaining the public fire alarm reporting system, shall be provided for disconnecting the box inside the building, and definite notification shall be given to occupants of the building when the interior box is not in service.

[From NFPA 1221, 4-5.1.2.2 modified]

4-6.16.1.3 A separate circuit shall be provided for each box.

[From NFPA 1221, 4-5.1.2.3]

4-6.16.1.4 Where a concentrator-identifier or similar device is employed, at least two tie circuits for the first 40 boxes connected shall be provided to the communication center. A tie circuit shall be provided for each 40 additional boxes, or fraction thereof, connected to the concentrator-identifier.

NOTE: These tie circuits are not to be used for any other purpose or function.

[From NFPA 1221, 4-5.1.3 modified]

4-6.16.1.5 Power shall be provided in accordance with Section 4-6.7

[From NFPA 1221, 4-5.3 modified]

4-6.16.2 Receiving Equipment — Facilities for Receipt of Box Alarms.

[From NFPA 1221, 4-5.5]

4-6.16.2.1 The box circuits shall be terminated:

(a) Directly on a console or switchboard located in the communication center, or

(b) In concentrator-identifier equipment located in a subsidiary communication center.

NOTE: The audible signal device may be common to several box circuits and arranged so that the operator can manually silence the signal temporarily with a self-restoring switch.

[From NFPA 1221, 4-5.5.1 modified]

4-6.16.2.2 All voice transmissions from boxes for emergencies shall be recorded with the capability of instant playback.

[From NFPA 1221, 4-5.5.6]

4-6.16.2.3 A means of voice recording shall be provided for each operator handling incoming alarms to eliminate the possibility of interference.

[From NFPA 1221, 4-5.5.7 modified]

4-6.16.2.4 Either a continuous line test or periodic (up to 6 minutes) automatic line tests shall detect an open, short, ground, or leakage condition. If one of these conditions occurs, a visual and audible trouble signal shall be actuated where there is an operator on duty.

[From NFPA 1221, 4-5.7.5]

4-7 Auxiliary Fire Alarm Systems.

NOTE: The requirements of Chapters 1, 3, 5, 6, 7, and Section 4-2 shall apply to auxiliary fire alarm systems, except where they conflict with the requirements of this section.

[From NFPA 72, Chap. 7 modified]

4-7.1 Scope. This section describes the equipment and circuits necessary to connect a protected premises (*see Chapter 3*) to a public fire alarm reporting system (*see Section 4-6*).

[From NFPA 72, 7-1 modified]

4-7.2 General.

[From NFPA 72, 7-2]

4-7.2.1 An auxiliary fire alarm system shall be used only in connection with a public fire alarm reporting system that is suitable for the service. A system satisfactory to the authority having jurisdiction shall be considered as meeting this requirement.

[From NFPA 72, 7-2.3]

4-7.2.2 Permission for the connection of an auxiliary fire alarm system to a public fire alarm reporting system and acceptance of the type of auxiliary transmitter, its actuating mechanism, circuits, and components connected thereto, shall be obtained from the authority having jurisdiction.

[From NFPA 72, 7-2.4 modified]

4-7.2.3 An auxiliary fire alarm system shall be maintained and supervised by a responsible person or corporation.

[From NFPA 72, 7-2.5 modified]

4-7.2.4 Section 4-7 does not require the use of audible alarm signals other than those necessary to operate the auxiliary fire alarm system. If it is desired to provide fire alarm evacuation signals in the protected property, the alarms, circuits, and controls shall comply with the provisions of Chapter 3, in addition to the provisions of Section 4-7.

[From NFPA 72, 7-2.6 modified]

4-7.3 Communication Center Facilities. The communication center facilities shall be in accordance with the requirements of Section 4-6.

4-7.4 Equipment.

[New paragraph and title]

4-7.4.1 Types of Systems. There are three types of auxiliary fire alarm systems in use, and these are described in (a), (b), and (c) below.

[From NFPA 72, 7-3]

(a)* The local energy type [Figure A-4-7.4.1(a)(1)] is electrically isolated from the public fire alarm reporting system and has its own power supply. The tripping of the transmitting device does not depend on the current in the system. In a wired circuit, whether or not the alarm will be received by the communication center if the circuit is accidentally opened depends on the design of the transmitting device and the associated communication center equipment, i.e., whether or not the system is designed to receive alarms through manual or automatic ground operational facilities. In a radio box type system, whether or not the alarm will be received by the communication center depends on the proper operation of the radio transmitting and receiving equipment.

[From NFPA 72, 7-3(a) modified]

1. Local energy systems shall be permitted to be of coded or noncoded type.

[From NFPA 72, 7-6.2.1 modified]

2. Power supply sources for local energy systems shall conform to Chapter 1.

[From NFPA 72, 7-6.2.2 modified]

(b)* The shunt type [Figure A-4-7.4.1(b)(1)] is electrically connected to and is an integral part of the public fire alarm reporting system. A ground fault on the auxiliary circuit is a fault on the public fire alarm reporting system circuit, and an accidental opening of the auxiliary circuit will send a needless (or false) alarm to the communication center. An open circuit in the transmitting device trip coil will not be indicated either at the protected property or at the communication center; also, if an initiating device is operated, an alarm will not be transmitted but an open cir-

cuit indication will be given at the communications center. If a public fire alarm reporting system circuit is open when a connected shunt type system is operated, the transmitting device will not trip until the public fire alarm reporting system circuit returns to normal, at which time the alarm will be transmitted unless the auxiliary circuit is first returned to a normal condition.

A local system made into an auxiliary system by the addition of a relay whose coil is energized by a local power supply and whose normally closed contacts trip a shunt type master box shall not be permitted [Figure A-4-7.4.1(b)(2)].

[From NFPA 72, 7-3(b) modified]

1. Shunt systems shall be noncoded with respect to any remote electrical tripping or actuating devices.

[From NFPA 72, 7-6.1.1 modified]

2. All conductors of the shunt circuit shall be installed in accordance with Article 346, for rigid conduit, or Article 348, for electrical metallic tubing, of NFPA 70, *National Electrical Code*.

[From NFPA 72, 7-6.1.2]

3. Both sides of the shunt circuit shall be in the same conduit.

[From NFPA 72, 7-6.1.3]

4. Where an auxiliary transmitter is located within a private premise, it shall be installed in accordance with 4-6.9.1.

[From NFPA 72, 7-6.1.4 modified]

5. Where a shunt loop is used, it shall not exceed a length of 750 ft (230 m) and shall be in conduit.

[From NFPA 72, 7-6.1.5]

6. Conductors of the shunt circuits shall not be smaller than No. 14 AWG and shall be insulated as prescribed in NFPA 70, *National Electrical Code*, Article 310.

[From NFPA 72, 7-6.1.6]

7. The power for shunt-type systems shall be provided by the public fire alarm reporting system.

[From NFPA 72, 7-6.1.7 modified]

8. Additional design restrictions for shunt systems shall be found in laws or ordinances.

[From NFPA 72, 7-6.1.8 modified]

(c)* A parallel telephone type system [Figure A-4-7.4.1(c)] is a system in which alarms are transmitted over a circuit directly connected to the annunciating switchboard at the public fire service communication center and terminated at the protected property by an end-of-line device.

Such auxiliary systems are for connection to public fire alarm reporting systems of the type in which each alarm box annunciates at the communication center by individual circuit.

NOTE: The essential difference between the local energy or parallel telephone types and the shunt-type system is that accidental opening of the alarm initiating circuits will cause an alarm on the shunt type system only.

[From NFPA 72, 7-3(c) modified]

1. Parallel telephone systems shall be noncoded with respect to any remote electrical tripping or actuating devices.

[From NFPA 72, 7-6.3.1 modified]

2. Two methods of parallel telephone systems shall be permitted to be used:

(i) The circuits are extended beyond the entrance termination point to actuating devices with the supervisory device beyond the last actuating device in the circuit; or

(ii) The supervisory device for the circuit is located at the entrance termination point. The tripping relay shall be located immediately adjacent to the supervisory device and shall be connected thereto with conductors not smaller than No. 14 AWG in conduit.

[From NFPA 72, 7-6.3.2]

3. Nonvoice circuits connected to a parallel telephone system shall be indicated with distinctive and different color from voice circuits and shall be grouped in a reserved separate section of the receiving equipment with adequate written warning that no voice is to be expected on these alarms and that the fire department must be dispatched on alarm light indications.

[From NFPA 72, 7-6.3.3 modified]

4-7.4.2 The interface of the three types of auxiliary fire alarm systems with the four types of public fire alarm reporting systems shall be in accordance with Table 4-7.4.2.

Table 4-7.4.2

	Local Energy-Type	Shunt-Type	Parallel-Type
Coded Wired	Yes	Yes	No
Coded Radio	Yes	No	No
Telephone Series	Yes	No	No
Telephone Parallel	No	No	Yes

4-7.4.3 The application of the three types of auxiliary fire alarm systems shall be limited to the initiating devices specified in Table 4-7.4.3.

Table 4-7.4.3

	Local Energy-Type	Shunt-Type	Parallel-Type
Manual Fire Alarm	Yes	Yes	Yes
Waterflow or Actuation of Extinguishing System	Yes	Yes	Yes
Automatic Detection Devices	Yes	No	Yes

[New paragraphs and tables]

4-7.4.4 Location of Transmitting Devices.

[From NFPA 72, 7-4.2]

4-7.4.4.1 Auxiliary systems shall be arranged so that one auxiliary transmitter does not serve more than 100,000 sq ft (9290 m²) total area, unless otherwise permitted by the authority having jurisdiction.

[From NFPA 72, 7-4.2.1 modified]

4-7.4.4.2 A separate auxiliary transmitter shall be provided for each building or where permitted by the authority having jurisdiction for each group of buildings of single ownership or occupancy.

[From NFPA 72, 7-4.2.2 modified]

4-7.4.4.3 The same box shall be permitted to be used as a public fire alarm reporting system box and as a transmitting device for an auxiliary system where permitted by the authority having jurisdiction, provided that the box is located at the outside of the entrance to the protected property.

NOTE: The fire department may require the box to be equipped with a signal light to differentiate between automatic and manual operation, unless local outside alarms at the protected property would serve the same purpose.

[From NFPA 72, 7-4.2.3 modified]

4-7.4.4.4 The transmitting device shall be located as required by the authority having jurisdiction.

[From NFPA 72, 7-4.2.4 modified]

4-7.4.4.5 The system shall be so designed and arranged that a single fault on the auxiliary system shall not jeopardize operation of the public fire alarm reporting system and shall not, in case of a single fault on either the auxiliary or public fire alarm reporting system, transmit a false alarm on either system.

Exception: Shunt systems. [See 4-7.4.1(b).]

[From NFPA 72, 7-4.7 modified]

4-7.5 Personnel. Personnel necessary to receive and act on signals from auxiliary fire alarm systems shall be in accordance with the requirements of Section 4-6 and NFPA 1221, *Standard for the Installation, Maintenance, and Use of Public Fire Service Communication Systems*.

4-7.6 Operations. Operations for auxiliary fire alarm systems shall be in accordance with the requirements of Section 4-6 and NFPA 1221, *Standard for the Installation, Maintenance, and Use of Public Fire Service Communication Systems*.

4-7.7 Testing and Maintenance. Testing and maintenance of auxiliary fire alarm systems shall be in accordance with the requirements of Chapter 7.

[New paragraphs]

Chapter 5 Initiating Devices

5-1 General.

5-1.1 Scope. This chapter covers minimum requirements for performance, selection, use, and location of automatic fire detection devices, sprinkler waterflow detectors, manually activated fire alarm stations, and supervisory signal initiating devices, including guard tour reporting used to ensure timely warning for the purposes of life safety and the protection of a building, space, structure, area, or object.

NOTE: For detector requirements in a household system, refer to Chapter 2.

[From NFPA 72E - 1990, 1-1 and 1-2.1 modified]

5-1.2 Application.

5-1.2.1 The material in this chapter is intended for use by persons knowledgeable in the application of fire detection and fire alarm systems/services.

[From NFPA 72E - 1990, 1-1.2 modified]

5-1.2.2 Automatic and manual initiating devices contribute to life safety, fire protection, and property conservation only when used in conjunction with other equipment. The interconnection of these devices with control equipment configurations, and power supplies or with output systems responding to external actuation is detailed elsewhere in this code and others.

[From NFPA 72E - 1990, 1-2.2 and 1-2.3 modified]

5-1.3 Installation and Required Location of Detection Devices.

[From NFPA 72E - 1990, 2-7 modified]

5-1.3.1 Where subject to mechanical damage, detectors shall be protected.

[From NFPA 72E - 1990, 2-7.1]

5-1.3.2 In all cases, detectors shall be supported independently of their attachment to the circuit conductors.

[From NFPA 72E - 1990, 2-7.2]

5-1.3.3 Detectors shall not be recessed in any way into the mounting surface, unless they have been tested and listed for such recessed mounting.

[From NFPA 72E - 1990, 2-7.3]

5-1.3.4 Detectors shall be installed in all areas where required by the appropriate NFPA standard or the authority having jurisdiction. Each installed detector shall be accessible for periodic maintenance and testing. Where total coverage is required, this shall include all rooms, halls, storage areas, basements, attics, lofts, spaces above suspended ceilings, and other subdivisions and accessible spaces, and inside all closets, elevator shafts, enclosed stairways, dumbwaiter shafts, and chutes. Inaccessible areas shall not be required to be protected by detectors unless they contain combustible material, in which case they shall be made accessible and be protected by detector(s).

Exception No. 1: Detectors may be omitted from combustible blind spaces where any of the following conditions prevail:

(a) *Where the ceiling is attached directly to the underside of the supporting beams of a combustible roof or floor deck.*

(b) *Where the concealed space is entirely filled with a noncombustible insulation. In solid joist construction, the insulation need fill only the space from the ceiling to the bottom edge of the joist of the roof or floor deck.*

(c) *Where there are small concealed spaces over rooms, provided any space in question does not exceed 50 sq ft (4.6 m²) in area.*

(d) *In spaces formed by sets of facing studs or solid joists in walls, floors, or ceilings where the distance between the facing studs or solid joists is less than 6 in. (150 mm).*

Exception No. 2: Detectors may be omitted from below open grid ceilings where all of the following conditions prevail:

(a) *The openings of the grid are 1/4 in. (6.4 mm) or larger in the least dimension.*

(b) *The thickness of the material does not exceed the least dimension.*

(c) *The openings constitute at least 70 percent of the area of the ceiling material.*

Exception No. 3: Concealed, accessible spaces above suspended ceilings, used as a return air plenum meeting the requirements of NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems, where equipped with smoke detection at each connection from the plenum to the central air handling system.

[From NFPA 72E - 1990, 2-7.4 modified]

5-1.3.5* Detectors shall be required underneath open loading docks or platforms and their covers, and for accessible underfloor spaces of buildings without basements.

Exception: By permission of the authority having jurisdiction, detectors may be omitted when all of the following conditions prevail:

(a) *The space is not accessible for storage purposes or entrance of unauthorized persons and is protected against accumulation of windborne debris.*

(b) *The space contains no equipment such as steam pipes, electric wiring, shafting, or conveyors.*

(c) *The floor over the space is tight.*

(d) *No flammable liquids are processed, handled, or stored on the floor above.*

[NFPA 72E - 1990, 2-7.5]

5-1.3.6 Where codes, standards, laws, or authorities having jurisdiction require the protection of selected areas only, the specified areas shall be protected in accordance with this code.

[From 72E, 2-7.6]

5-1.4* Connection to the Fire Alarm System.

[New title]

5-1.4.1 Duplicate terminals or leads, or equivalent, shall be provided on each initiating device for the express purpose of connecting into the fire alarm system to provide supervision of the connections. Such terminals or leads are necessary to ensure that the wire run is broken and that the individual connections are made to the incoming and outgoing leads or other terminals for signaling and power.

Exception: Initiating devices that provide equivalent supervision.

[From NFPA 72E - 1990, 2-7.7]

5-2 Heat-Sensing Fire Detectors.

[From NFPA 72E - 1990, Chap. 3]

5-2.1 Fire detectors that sense heat produced by burning substances are usually referred to as heat detectors. Heat is both the added energy that causes substances to rise in temperature as well as the energy produced by a burning substance.

[From NFPA 72E - 1990, 3-1, 3-1.1.1 modified]

5-2.2 Heat detectors shall be installed in all areas where required either by the appropriate NFPA standard or the authority having jurisdiction.

[From NFPA 72E, 3-1.1.2]

5-2.3 Operating Principles.

[From NFPA 72E - 1990, 3-2]

5-2.3.1 Fixed Temperature Detector.

[From NFPA 72E - 1990, 3-2.1]

5-2.3.1.1 A fixed temperature detector is a device that will respond when its operating element becomes heated to a predetermined level.

[From NFPA 72E - 1990, 2-2.1.1]

5-2.3.1.2 Thermal Lag. Where a fixed temperature device operates, the temperature of the surrounding air will always be higher than the operating temperature of the device itself. This difference between the operating temperature of the device and the actual air temperature is commonly referred to as thermal lag and is proportional to the rate at which the temperature is rising.

[From NFPA 72E - 1990, 3-2.1.2]

5-2.3.1.3 Typical examples of fixed temperature-sensing elements are:

(a) *Bimetallic.* A sensing element comprised of two metals having different coefficients of thermal expansion arranged so that the effect will be deflection in one direction when heated and in the opposite direction when cooled.

(b) *Electrical Conductivity.* A line-type or spot-type sensing element whose resistance varies as a function of temperature.

(c) *Fusible Alloy.* A sensing element of a special composition (eutectic) metal, which melts rapidly at the rated temperature.

(d) *Heat-Sensitive Cable.* A line-type device whose sensing element comprises, in one type, two current-carrying wires separated by heat-sensitive insulation that softens at the rated temperature, thus allowing the wires to make electrical contact. In another type, a single wire is centered in a metallic tube, and the intervening space filled with a substance that, at a critical temperature, becomes conductive, thus establishing electrical contact between the tube and the wire.

(e) *Liquid Expansion.* A sensing element comprising a liquid capable of marked expansion in volume in response to temperature increase.

[From NFPA 72E - 1990, 3-2.1.3]

5-2.3.2 Rate Compensation Detector.

[From NFPA 72E - 1990, 3-2.2]

5-2.3.2.1 A rate compensation detector is a device that will respond when the temperature of the air surrounding the device reaches a predetermined level, regardless of the rate of temperature rise.

[From NFPA 72E - 1990, 3-2.2.1]

5-2.3.2.2 A typical example is a spot-type detector with a tubular casing of a metal that tends to expand lengthwise as it is heated and an associated contact mechanism that will close at a certain point in the elongation. A second metallic element inside the tube exerts an opposing force on the contacts, tending to hold them open. The forces are

balanced in such a way that on a slow rate of temperature rise, there is more time for heat to penetrate to the inner element, which inhibits contact closure until the total device has been heated to its rated temperature level. However, on a fast rate of temperature rise, there is not as much time for heat to penetrate to the inner element, which exerts less of an inhibiting effect so that contact closure is obtained when the total device has been heated to a lower level. This, in effect, compensates for thermal lag.

[From NFPA 72E - 1990, 3-2.2.2]

5-2.3.3 Rate-of-Rise Detector.

[From NFPA 72E - 1990, 3-2.3]

5-2.3.3.1 A rate-of-rise detector is a device that will respond when the temperature rises at a rate exceeding a predetermined amount.

[From NFPA 72E - 1990, 3-2.3.1]

5-2.3.3.2 Typical examples are:

(a) *Pneumatic Rate-of-Rise Tubing.* A line-type detector comprising small diameter tubing, usually copper, that is installed on the ceiling or high on the walls throughout the protected area. The tubing is terminated in a detector unit containing diaphragms and associated contacts set to actuate at a predetermined pressure. The system is sealed except for calibrated vents that compensate for normal changes in temperature.

(b) *Spot-Type Pneumatic Rate-of-Rise Detector.* A device consisting of an air chamber, diaphragm, contacts, and compensating vent in a single enclosure. The principle of operation is the same as that described in 5-2.3.3.2(a).

(c) *Thermoelectric Effect Detector.* A device whose sensing element comprises a thermocouple or thermopile unit that produces an increase in electric potential in response to an increase in temperature. This potential is monitored by associated control equipment, and an alarm is initiated when the potential increases at an abnormal rate.

(d) *Electrical Conductivity Rate-of-Change Detector.* A line-type or spot-type sensing element whose resistance changes due to a change in temperature. The rate of change of resistance is monitored by associated control equipment, and an alarm is initiated when the rate of temperature increase exceeds a preset value.

[From NFPA 72E - 1990, 3-2.3.2 modified]

5-2.4 Classification and Sensitivity.

[From NFPA 72E - 1990, 3-3 modified]

5-2.4.1 Heat detectors of the fixed-temperature or rate-compensated spot-pattern type shall be classified as to the temperature of operation and marked with the appropriate color code. (See Table 5-2.4.1.)

[From NFPA 72E - 1990, 3-3.1]

5-2.4.1.1 Where the overall color of a detector is the same as the color code marking required for that detector, either one of the following arrangements, applied in a contrasting color and visible after installation, shall be employed:

(a) A ring on the surface of the detector

(b) The temperature rating in numerals at least $\frac{3}{8}$ in. (9.5 mm) high.

[From NFPA 72E - 1990, 3-3.1.1]

Table 5-2.4.1

Temperature Classification	Temp. Rating Range °F	Temp. Rating Range °C	Max. Ceiling Temp. °F	Max. Ceiling Temp. °C	Color Code
Low*	100 to 134	39 to 57	20 below**	11	Uncolored
Ordinary	135 to 174	58 to 79	100	38	Uncolored
Intermediate	175 to 249	80 to 121	150	66	White
High	250 to 324	122 to 162	225	107	Blue
Extra High	325 to 399	163 to 204	300	149	Red
Very Extra High	400 to 499	205 to 259	375	191	Green
Ultra High	500 to 575	260 to 302	475	246	Orange

For SI Units: C = $\frac{5}{9}$ (F - 32).

*Intended only for installation in controlled ambient areas. Units shall be marked to indicate maximum ambient installation temperature.

**Maximum ceiling temperature has to be 20°F (11°C) or more below detector rated temperature.

NOTE: The difference between the rated temperature and the maximum ambient should be as small as possible to minimize the response time.

[From NFPA 72E - 1990, 3-3.1 modified]

5-2.4.2* A heat detector integrally mounted on a smoke detector shall be listed or approved for not less than 50-ft (15-m) spacing.

[From NFPA 74 - 1990, 4-3 modified]

5-2.5 Location.

[From NFPA 72E - 1990, 3-4]

5-2.5.1* Spot-type heat detectors shall be located on the ceiling not less than 4 in. (100 mm) from the side wall or on the side walls between 4 in. (100 mm) and 12 in. (300 mm) from the ceiling. (See Figure A-5-2.5.1.)

Exception No. 1: In the case of solid open joist construction, detectors shall be mounted at the bottom of the joists.

Exception No. 2: In the case of beam construction where beams are less than 12 in. (300 mm) in depth and less than 8 ft (2.4 m) on center, detectors may be installed on the bottom of beams.

[From NFPA 72E - 1990, 3-4.1]

5-2.5.2 Line-type heat detectors shall be located on the ceiling or on the side walls not more than 20 in. (500 mm) from the ceiling.

Exception No. 1: In the case of solid open joist construction, detectors shall be mounted at the bottom of the joists.

Exception No. 2: In the case of beam construction where beams are less than 12 in. (300 mm) in depth and less than 8 ft (2.4 m) on center, detectors may be installed on the bottom of beams.

[From NFPA 72E - 1990, 3-4.2 modified]

5-2.6* Temperature. Detectors having fixed-temperature or rate-compensated elements shall be selected in accordance with Table 5-2.4.1 for the maximum ceiling temperature that can be expected.

[From NFPA 72E - 1990, 3-4.3]

5-2.7* Spacing.

[From NFPA 72E - 1990, 3-5]

5-2.7.1* Smooth Ceiling Spacing. One of the following rules shall apply:

(a) The distance between detectors shall not exceed their listed spacing, and there shall be detectors within a distance of one-half the listed spacing, measured at a right angle, from all walls or partitions extending to within 18 in. (460 mm) of the ceiling; or

(b) All points on the ceiling shall have a detector within a distance equal to 0.7 times the listed spacing (0.7S). This will be useful in calculating locations in corridors or irregular areas.

[From NFPA 72E - 1990, 3-5.1]

5-2.7.1.1* Irregular Areas. For irregularly shaped areas, the spacing between detectors may be greater than the listed spacing, provided the maximum spacing from a detector to the furthest point of a side wall or corner within its zone of protection is not greater than 0.7 times the listed spacing. (See Figure A-5-2.7.1.1.)

[From NFPA 72E - 1990, 3-5.1.1]

5-2.7.1.2* High Ceilings. On ceilings 10 ft (3 m) to 30 ft (9.1 m) high, heat detector linear spacing shall be reduced in accordance with Table 5-2.7.1.2.

[From NFPA 72E - 1990, 3-5.1.2]

Table 5-2.7.1.2

Ceiling Height Above (ft)	Up to	Percent of Listed Spacing
0	10	100
10	12	91
12	14	84
14	16	77
16	18	71
18	20	64
20	22	58
22	24	52
24	26	46
26	28	40
28	30	34

For SI Units: 1 ft = 0.305 m.

Exception: Table 5-2.7.1.2 does not apply to the following detectors, which rely on the integration effect:

(a) *Line-type electrical conductivity detectors. [See 5-2.3.1.3(b).]*

(b) *Pneumatic rate-of-rise tubing. [See 5-2.3.3.2(a).]*

(c) *Series connected thermoelectric effect detectors. [See 5-2.3.3.3(c).]*

In these cases, the manufacturer's recommendations shall be followed for appropriate alarm point and spacing.

NOTE: Table 5-2.7.1.2 provides for spacing modifications to take into account different ceiling heights for generalized fire conditions. An alternative design method that allows a designer to take into account ceiling height, fire size, and ambient temperature is provided in Appendix B.

[From NFPA 72E, Table 3-5.1.2]

5-2.7.2* Solid Joist Construction. The spacing of heat detectors, where measured at right angles to the solid joists, shall not exceed 50 percent of the smooth ceiling spacing allowable under 5-2.7.1 and 5-2.7.1.1. (See Figure A-5-2.7.2.)

[From NFPA 72E - 1990, 3-5.2]

5-2.7.3* Beam Construction. A ceiling shall be treated as a smooth ceiling if the beams project no more than 4 in. (100 mm) below the ceiling. If the beams project more than 4 in. (100 mm) below the ceiling, the spacing of spot-type heat detectors at right angles to the direction of beam travel shall be not more than two-thirds the smooth ceiling spacing allowable under 5-2.7.1 and 5-2.7.1.1. If the beams project more than 18 in. (460 mm) below the ceiling and are more than 8 ft (2.4 m) on center, each bay formed by the beams shall be treated as a separate area.

[From NFPA 72E - 1990, 3-5.3]

5-2.7.4 Sloped Ceilings.

[From NFPA 72E - 1990, 3-5.4]

5-2.7.4.1* Peaked. A row of detectors shall first be spaced and located at or within 3 ft (0.9 m) of the peak of the ceiling, measured horizontally. The number and spacing of additional detectors, if any, shall be based on the horizontal projection of the ceiling in accordance with the type of ceiling construction. (See Figure A-5-2.7.4.1.)

[From NFPA 72E - 1990, 3-5.4.1]

5-2.7.4.2* Shed. Sloped ceilings having a rise greater than 1 ft in 8 ft (1 m in 8 m) horizontally shall have a row of detectors located on the ceiling within 3 ft (0.9 m) of the high side of the ceiling measured horizontally, spaced in accordance with the type of construction. Remaining detectors, if any, shall then be located in the remaining area on the basis of the horizontal projection of the ceiling. (See Figure A-5-2.7.4.2.)

[From NFPA 72E - 1990, 3-5.4.2]

5-2.7.4.3 For a roof slope of less than 30 degrees, all detectors shall be spaced utilizing the height at the peak. For a roof slope of greater than 30 degrees, the average slope height shall be used for all detectors other than those located in the peak.

[From NFPA 72E, 3-5.4.3]

5-3 Smoke-Sensing Fire Detectors.

[From NFPA 72E - 1990, Chap. 4]

5-3.1 General.

[From NFPA 72E - 1990, 4-1]

5-3.1.1* The purpose of Section 5-3 is to provide information to assist in design and installation of reliable early warning smoke detection systems for protection of life and property.

[From NFPA 72E - 1990, 4-1.1]

5-3.1.2 Section 5-3 covers general area application of smoke detectors in ordinary indoor locations.

[From NFPA 72E - 1990, 4-1.2]

5-3.1.3 For information on use of smoke detectors for control of smoke spread, refer to Section 5-11.

[From NFPA 72E - 1990, 4-1.2.1 modified]

5-3.1.4 For additional guidance in the application of smoke detectors for flaming fires of various sizes and growth rates in areas of various ceiling heights, refer to Appendix B.

[From NFPA 72E - 1990, 4-1.2.2]

5-3.2* Smoke detectors shall be installed in all areas where required either by the appropriate NFPA standard or by the authority having jurisdiction.

[From NFPA 72E - 1990, 4-1.3]

5-3.3 Principles of Detection.

[From NFPA 72E - 1990, 4-2]

5-3.3.1 Ionization Smoke Detection. Ionization smoke detection is based on the principle of using a small amount of radioactive material to ionize the air between two differentially charged electrodes. This gives the sensing chamber an effective measurable electrical conductance. Where smoke particles enter the ionization volume, they decrease the conductance of the air by reducing ion mobility. The conductance signal is processed and used to convey an alarm condition where the signal meets preset criteria.

[From NFPA 72E - 1990, 4-2.1 modified]

5-3.3.1.1 Ionization detection is more responsive to invisible (less than one micron in size) particles produced by most flaming fires. It is somewhat less responsive to the larger particles typical of most smoldering fires.

[From NFPA 72E - 1990, 4-2.1.1]

5-3.3.1.2 Smoke detectors utilizing the ionization principle are usually of the spot type.

[From NFPA 72E - 1990, 4-2.1.2]

5-3.3.2* Photoelectric Light-Scattering Smoke Detection. Photoelectric light-scattering smoke detection is based on the principle of a light source and a photosensitive sensor arranged so that the principal portion of rays from the light source do not normally fall on the photosensitive sensor. Where smoke particles enter the light path, some of the light is scattered by reflection and refraction onto the sensor. The scattered light signal is processed and used to convey an alarm condition where the signal meets preset criteria.

[From NFPA 72E - 1990, 4-2.2 modified]

5-3.3.2.1 Photoelectric light-scattering detection is more responsive to visible (more than one micron in size) particles produced by most smoldering fires. It is somewhat less responsive to the smaller particles typical of most flaming fires. It is also less responsive to black smoke than to lighter colored smoke.

[From NFPA 72E - 1990, 4-2.2.1 modified]

5-3.3.2.2 Smoke detectors utilizing the light-scattering principle are usually of the spot type.

[From NFPA 72E - 1990, 4-2.2.2]

5-3.3.3* Photoelectric Light Obscuration Smoke Detection. Photoelectric light obscuration smoke detection is based on the principle of reduction of light transmission between a light source and a photosensitive sensor onto which the principal portion of the source emissions are focused. Where smoke particles enter the light path, some of the light is scattered and some absorbed, thereby reducing the light reaching the receiving sensor. The receiving sensor signal is processed and used to convey an alarm condition where the signal meets preset criteria.

[From NFPA 72E - 1990, 4-2.3 modified]

5-3.3.3.1 The response of photoelectric light obscuration smoke detectors is usually not affected by the color of smoke.

[From NFPA 72E - 1990, 4-2.3.1]

5-3.3.3.2 Smoke detectors utilizing the light obscuration principle are usually of the line type. These detectors are commonly called projected beam smoke detectors.

[From NFPA 72E - 1990, 4-2.3.2]

5-3.3.4 Cloud Chamber Smoke Detection. Cloud chamber smoke detection is usually of the sampling type. An air sample is drawn from the protected areas into a high humidity chamber within the detector. After the humidity of the sample has been raised, the pressure is lowered slightly. If smoke particles are present, the moisture in the air condenses on them, forming a cloud in the chamber. The density of this cloud is then measured by a photoelectric principle. The density signal is processed and used to convey an alarm condition where the signal meets preset criteria.

[From NFPA 72E - 1990, 4-2.4 modified]

5-3.4 Sensitivity.

[From NFPA 72E - 1990, 4-2 modified]

5-3.4.1 Smoke detectors shall be marked with their normal production sensitivity (percent per foot obscuration), measured as required by the listing. The production tolerance around the normal sensitivity shall also be indicated.

[From NFPA 72E - 1990, 4-3.1 modified]

5-3.4.2 Smoke detectors that have provision for field adjustment of sensitivity shall have an adjustment range of not less than 0.6 percent per ft obscuration. If the means of adjustment is on the detector, a method shall be available to restore the detector to its factory calibration. Detectors that have provision for program controlled adjustment of sensitivity shall be permitted to only be marked with their programmable sensitivity range.

[From NFPA 72E - 1990, 4-3.1.1 modified]

5-3.5 Location and Spacing.

[From NFPA 72E - 1990, 4-4]

5-3.5.1* General. The location and spacing of smoke detectors shall result from an evaluation based on the guidelines detailed in this code and on engineering judgment. Ceiling shape and surfaces, ceiling height, configuration of contents, burning characteristics of combustible

material present, ventilation, and the ambient environment are some of the conditions that shall be considered.

[From NFPA 72E - 1990, 4-4.1 modified]

5-3.5.1.1 Where the intent is to protect against a specific hazard, the detector(s) shall be permitted to be installed closer to the hazard in a position where the detector will readily intercept the smoke.

[From NFPA 72E - 1990, 4-4.1.1]

5-3.5.1.2* Stratification. The possible effect of smoke stratification at levels below the ceiling shall be considered.

[From NFPA 72E - 1990, 4-4.1.2]

5-3.5.2* Spot-Type Smoke Detectors. Spot-type smoke detectors shall be located on the ceiling not less than 4 in. (100 mm) from a sidewall to the near edge or, if on a sidewall, between 4 in. (100 mm) and 12 in. (300 mm) down from the ceiling to the top of the detector. (See Figure A-5-2.1.)

Exception No. 1: See 5-3.5.1.2.

Exception No. 2: See 5-3.5.6.

Exception No. 3: See 5-3.5.7.

[From NFPA 72E - 1990, 4-4.2]

5-3.5.2.1* To minimize dust contamination of smoke detectors where installed under raised room floors and similar spaces, they shall only be mounted in an orientation for which they have been listed. (See Figure A-5-3.5.2.1.)

[From NFPA 72E - 1990, 4-4.2.1]

5-3.5.3 Projected Beam-Type Smoke Detectors. Projected beam-type smoke detectors (see 5-3.3.3.1) shall normally be located with their projected beams parallel to the ceiling and in accordance with the manufacturer's documented instructions.

Exception No. 1: See 5-3.5.1.2.

Exception No. 2: Beams may be installed vertically or at any angle needed to afford protection of the hazard involved. (Example: Vertical beams through the open shaft area of a stairwell where there is a clear vertical space inside the handrails.)

[From NFPA 72E - 1990, 4-4.3 modified]

5-3.5.3.1 The beam length shall not exceed the maximum permitted by the equipment listing.

[From NFPA 72E - 1990, 4-4.3.1]

5-3.5.3.1.1 Where mirrors are used with projected beams, they shall be installed in accordance with the manufacturer's documented instructions.

[From NFPA 72E - 1990, 4-4.3.1.1 modified]

5-3.5.4 Sampling-Type Smoke Detector. Each sampling port of a sampling-type smoke detector shall be treated as a spot-type detector for the purpose of location and spacing. Maximum air sample transport time from the farthest sampling point shall not exceed 120 seconds.

[From NFPA 72E - 1990, 4-4.4 modified]

5-3.5.5 Smooth Ceiling Spacing.

[From NFPA 72E - 1990, 4-4.5]

5-3.5.5.1 Spot-Type Detectors. On smooth ceilings, spacing of 30 ft (9.1 m) shall be permitted to be used as a guide. In all cases, the manufacturer's documented instructions shall be followed. Other spacing shall be permitted to be used depending on ceiling height, different conditions, or response requirements. (*See Appendix B for detection of flaming fires.*)

[From NFPA 72E - 1990, 4-4.5.1 modified]

5-3.5.5.1.1* For smooth ceilings, all points on the ceiling shall have a detector within a distance equal to 0.7 times the selected spacing.

[From NFPA 72E - 1990, 4-4.5.1.1 modified]

5-3.5.5.2* Projected Beam-Type Detectors. For location and spacing of projected beam-type detectors, the manufacturer's documented installation instructions shall be followed. (*See Figure A-5-3.5.5.2.*)

[From NFPA 72E - 1990, 4-4.5.2 modified]

5-3.5.6* Solid Joist Construction.

[From NFPA 72E - 1990, 4-4.6]

5-3.5.6.1 Ceiling construction where joists are 8 in. (200 mm) or less in depth shall be considered equivalent to a smooth ceiling. Spot-type detectors shall be mounted on the bottom of the joists. (*See also 5-3.5.1.2.*)

[From NFPA 72E - 1990, 4-4.6.1]

5-3.5.6.2 If joists exceed 8 in. (200 mm) in depth, the spacing of spot-type detectors in the direction perpendicular to the joists shall be reduced by one third. If the projected light beams of line-type detectors run perpendicular to the joists, no spacing reduction shall be necessary; however, if the projected light beams are parallel to the joists, the spacing between light beams shall be reduced. Spot-type detectors shall be mounted on the bottom of the joists. (*See also 5-3.5.1.2.*)

[From NFPA 72E - 1990, 4-4.6.2]

5-3.5.7 Beam Construction.

[From NFPA 72E - 1990, 4-4.7]

5-3.5.7.1 Ceiling construction where beams are 8 in. (200 mm) or less in depth shall be considered equivalent to a smooth ceiling. (*See also 5-3.5.1.2.*)

[From NFPA 72E - 1990, 4-4.7.1]

5-3.5.7.2 If beams are over 8 in. (200 mm) in depth, the spacing of spot-type detectors in the direction perpendicular to the beams shall be reduced. The spacing of projected light beam detectors run perpendicular to the ceiling beams need not be reduced; however, if the projected light beams are run parallel to the ceiling beams, the spacing shall be reduced. (*See also 5-3.5.1.2.*)

[From NFPA 72E - 1990, 4-4.7.2]

5-3.5.7.3 If beams are less than 12 in. (305 mm) in depth and less than 8 ft (2.4 m) on center, spot-type detectors shall be permitted to be installed on the bottom of beams.

[From NFPA 72E - 1990, 4-4.7.3]

5-3.5.7.4* If the beams exceed 18 in. (460 mm) in depth and are more than 8 ft (2.4 m) on center, each bay shall be treated as a separate area requiring at least one spot-type or projected beam-type detector.

[From NFPA 72E - 1990, 4-4.7.4]

5-3.5.8 Sloped Ceilings.

[From NFPA 72E - 1990, 4-4.8]

5-3.5.8.1 Peaked. Detectors shall first be spaced and located within 3 ft (0.9 m) of the peak, measured horizontally. The number and spacing of additional detectors, if any, shall be based on the horizontal projection of the ceiling. (*See Figure A-5-2.7.4.1.*)

[From NFPA 72E - 1990, 4-4.8.1]

5-3.5.8.2 Shed. Detectors shall first be spaced and located within 3 ft (0.9 m) of the high side of the ceiling, measured horizontally. The number and spacing of additional detectors, if any, shall be based on the horizontal projection of the ceiling. (*See Figure A-5-2.7.4.2.*)

[From NFPA 72E - 1990, 4-4.8.2]

5-3.5.9 Raised Floors and Suspended Ceilings. In under-floor spaces and above-ceiling spaces that are not HVAC plenums, detector spacing shall be in accordance with Section 5-3.5.

[From NFPA 72E - 1990, 4-4.9]

5-3.5.10 Partitions. Where partitions extend upward to within 18 in. (460 mm) of the ceiling, they will not influence the spacing. Where the partition extends to within less than 18 in. (460 mm) of the ceiling, the effect of smoke travel shall be considered in reduction of spacing.

[From NFPA 72E - 1990, 4-4.10]

5-3.6 Heating, Ventilating, and Air Conditioning (HVAC).

[From NFPA 72E - 1990, 4-5]

5-3.6.1* In spaces served by air-handling systems, detectors shall not be located where air from supply diffusers could dilute smoke before it reaches the detectors. Detectors shall be located to intercept the air flow toward the return air opening(s). This may require additional detectors, since placing detectors only near return air openings may leave the balance of the area with inadequate protection when the air-handling system is shut down.

[From NFPA 72E - 1990, 4-5.1 modified]

5-3.6.2 In under-floor spaces and above-ceiling spaces that are used as HVAC plenums, detectors shall be listed for the anticipated environment. (*See 5-3.7.1.1.*) Detector spacings and locations shall be selected based upon anticipated airflow patterns and fire type.

[From NFPA 72E - 1990, 4-5.2 modified]

5-3.6.2.1 Detectors placed in environmental air ducts or plenums shall not be used as a substitute for open area detectors. (*See Section 5-11, Table A-5-3.7.1.1, A-5-11.1, and A-5-11.2.*) Where open area protection is required, 5-3.5 shall apply.

Smoke may not be drawn into the duct or plenums when the ventilating system is shut down. Further, when

the ventilating system is operating, the detector(s) may be less responsive to a fire condition in the room of fire origin due to dilution by clean air.

[From NFPA 72E - 1990, 4-5.2.1 modified]

5-3.7 Special Considerations.

[From NFPA 72E - 1990, 4-6]

5-3.7.1 The selection and placement of smoke detectors shall take into consideration both the performance characteristics of the detector and the areas into which the detectors will be installed to prevent nuisance alarm or nonoperation after installation. Some of the considerations are as follows.

[From NFPA 72E - 1990, 4-6.1 modified]

5-3.7.1.1* The installation of smoke detectors shall take into consideration the range of environmental conditions present. Smoke detectors shall be intended for installation in areas where the normal ambient conditions are not likely to exceed the following:

(a) A temperature of 100°F (38°C), or fall below 32°F (0°C); or

(b) A relative humidity of 93 percent; or

(c) An air velocity of 300 fpm (1.5 mps).

Exception: Detectors specifically designed for use in ambients exceeding the limits of (a) through (c) and listed for the temperature, humidity, and air velocity conditions expected.

[From NFPA 72E - 1990, 4-6.1.1 modified]

5-3.7.1.2* To avoid nuisance alarms, the location of smoke detectors shall take into consideration normal sources of smoke, moisture, dust or fumes, and electrical or mechanical influences.

[From NFPA 72E - 1990, 4-6.1.2 modified]

5-3.7.1.3 Detectors shall not be installed until after the construction clean-up of all trades is complete and final.

Exception: Where required by the authority having jurisdiction for protection during construction.

Detectors that have been installed prior to final clean-up by all trades shall be cleaned or replaced per Chapter 7.

[From NFPA 72E - 1990, 4-6.1.3]

5-3.7.2 Spot-Type Detectors.

5-3.7.2.1 Smoke detectors having a fixed temperature element as part of the unit shall be selected in accordance with Table 5-2.4.1 for the maximum ceiling temperature that can be expected in service.

[From NFPA 72E - 1990, 4-6.2.1]

5-3.7.2.2* Holes in the back of a detector shall be covered by a gasket, sealant, or equivalent, and the detector shall be mounted so that air flow from inside or around the housing will not prevent the entry of smoke during a fire or test condition.

[From NFPA 72E - 1990, 4-6.2.2 modified]

5-3.7.3 Projected Beam-Type Detectors.

[From NFPA 72E - 1990, 4-6.3]

5-3.7.3.1 Projected beam-type detectors and mirrors shall be firmly mounted on stable surfaces so as to prevent false or erratic operation due to movement. The beam shall be so designed that small angular movements of the light source or receiver do not prevent operation due to smoke and do not cause nuisance alarms.

[From NFPA 72E - 1990, 4-6.3.1 modified]

5-3.7.3.2 Since the projected beam-type unit will not operate for alarm [but will give a trouble signal (see A-5-3.3.3)] where the light path to the receiver is abruptly interrupted or obscured, the light path shall be kept clear of opaque obstacles at all times.

[From NFPA 72E - 1990, 4-6.3.2]

5-3.7.4 Air Sampling-Type Detectors.

5-3.7.4.1* To ensure proper performance, a sampling pipe network shall be designed to include details of the sampling network based on and supported by sound fluid dynamic principles and calculations showing flow characteristics of the pipe network and for each sampling point.

5-3.7.4.2* Air sampling detectors shall give a trouble signal where the air flow is outside the manufacturer's specified range. The sampling ports and inline filter (if used) shall be kept clear in accordance with manufacturer's documented instructions.

5-3.7.4.3 Air sampling network piping and fittings shall be airtight and permanently fixed. Sampling piping shall be conspicuously identified as "SMOKE DETECTOR SAMPLING PIPE," with a warning not to disturb or alter.

[New paragraphs and title]

5-3.7.5* High Rack Storage. [See Figures A-5-3.7.5(a) and (b).] Detection systems are often installed in addition to suppression systems. Where smoke detectors are installed for early warning in high rack storage areas, it shall be necessary to consider installing detectors at several levels in the racks to ensure quicker response to smoke. Where detectors are installed to actuate a suppression system, see NFPA 231C, *Standard for Rack Storage of Materials*.

[From NFPA 72E - 1990, 4-6.4]

5-3.7.6 High Air Movement Areas.

[From NFPA 72E - 1990, 4-6.5]

5-3.7.6.1 General. The purpose and scope of 5-3.7.6 are to provide location and spacing guidance for smoke detectors in high air movement areas for early warning of fire.

Exception: Detectors provided for the control of smoke spread are covered by the requirements of Section 5-11.

[From NFPA 72E - 1990, 4-6.5.1]

5-3.7.6.2 Location. Smoke detectors shall not be located directly in the air stream of supply registers.

[From NFPA 72E - 1990, 4-6.5.3]

5-3.7.6.3 Spacing. Smoke detector spacing depends upon the movement of air within the room (including both supplied and recirculated air), which can be designated as minutes per air change or air changes per hour. Spacing shall be in accordance with Table 5-3.7.6.3 and Figure 5-3.7.6.3.

Exception: Air sampling or projected beam smoke detectors installed in accordance with the manufacturer's documented instructions.

[From NFPA 72E - 1990, 4-6.5.4 modified]

Table 5-3.7.6.3

Minutes/Air Change	Air Changes/Hour	Sq Ft/Detector
1	60	125
2	30	250
3	20	375
4	15	500
5	12	625
6	10	750
7	8.6	875
8	7.5	900
9	6.7	900
10	6	900

For SI Units: 1 sq ft = 0.0929 m².

[From NFPA 72E - 1990, 4-6.5.4(b)]

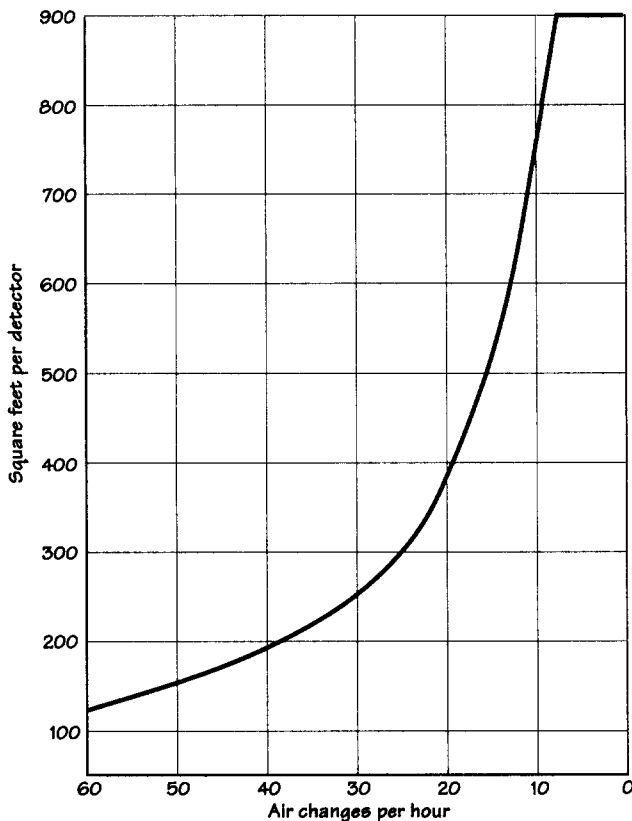


Figure 5-3.7.6.3 High air movement areas (not to be used for under-floor or above-ceiling spaces).

[From NFPA 72E - 1990, 4-6.5.4(a) modified]

5-4 Radiant Energy-Sensing Fire Detectors.

5-4.1 General.

5-4.1.1 The purpose and scope of Section 5-4 are to provide standards for the selection, location, and spacing of fire detectors that sense the radiant energy produced by burning substances. These detectors are categorized as flame detectors and spark/ember detectors.

[From NFPA 72E - 1990, 5-1.2 modified]

5-4.1.1.1 Flame Detectors. (See 5-4.2.1, definition of Flame Detectors.)

[From NFPA 72E - 1990, 2-2.1.3.1]

5-4.1.1.2 Spark/Ember Detectors. (See 5-4.2.1, definition of Spark/Ember Detectors.)

[From NFPA 72E - 1990, 2-2.1.3.2]

5-4.1.2 Radiant Energy. For the purpose of this code, radiant energy includes the electromagnetic radiation emitted as a by-product of the combustion reaction, which obeys the laws of optics. This includes radiation in the ultraviolet, visible, and infrared spectrum emitted by flames or glowing embers. These portions of the spectrum are distinguished by wavelengths as follows:

Ultraviolet	0.1 to 0.35 microns
Visible	0.36 to 0.75 microns
Infrared	0.76 to 220 microns

(1.0 micron = 1000 nanometers = 10,000 Angstroms)

[From NFPA 72E - 1990, 5-1.1 modified]

5-4.2 Definitions and Operating Principles.

[From NFPA 72E - 1990, 5-2]

5-4.2.1 Definitions.

[From NFPA 72E - 1990, 5-2.1]

Ember.* A particle of solid material that emits radiant energy due either to its temperature or the process of combustion on its surface. (See definition of Spark.)

[From NFPA 72E - 1990, 5-2.1.1 modified]

Field of View. The solid cone extending out from the detector within which the effective sensitivity of the detector is at least 50 percent of its on-axis, listed, or approved sensitivity.

[From NFPA 72E - 1990, 5-2.1.2]

Flame. A body or stream of gaseous material involved in the combustion process and emitting radiant energy at specific wavelength bands determined by the combustion chemistry of the fuel. In most cases, some portion of the emitted radiant energy is visible to the human eye.

[From NFPA 72E - 1990, 5-2.1.3]

Flame Detector Sensitivity. The distance along the optical axis of the detector at which the detector will detect a fire of specified size and fuel within a given time frame.

[From NFPA 72E - 1990, 5-2.1.5 modified]

Flame Detectors. Radiant energy fire detectors that are intended to detect flames and are designed to operate in environments where sunlight or other ambient lighting is assumed.

[From NFPA 72E - 1990, 5-2.1.4 modified]

Spark.* A moving ember.

[From NFPA 72E - 1990, 5-2.1.6]

Spark/Ember Detector Sensitivity. The number of watts (or fractions of watts) of radiant power from a point source radiator applied as a unit step signal at the wavelength of maximum detector sensitivity, necessary to produce an alarm signal from the detector within the specified response time.

[From NFPA 72E - 1990, 5-2.1.8]

Spark/Ember Detectors. Radiant energy fire detectors that are designed to detect sparks or embers, or both. These devices are normally intended to operate in dark environments and in the infrared part of the spectrum.

[From NFPA 72E - 1990, 5-2.1.7]

Wavelength.* The distance between the peaks of a sinusoidal wave. All radiant energy can be described as a wave having a wavelength. Wavelength serves as the unit of measure for distinguishing between different parts of the spectrum. Wavelengths are measured in microns (uM), nanometers (nM), or angstroms (Å).

[From NFPA 72E - 1990, 5-2.1.9 modified]

5-4.2.2 Operating Principles of Flame Detectors.

[From NFPA 72E - 1990, 5-2.2]

5-4.2.2.1 Ultraviolet flame detectors typically use a vacuum photodiode Geiger-Muller tube to detect the ultraviolet radiation that is produced by a flame. The photodiode allows a burst of current to flow for each ultraviolet photon that hits the active area of the tube. When the number of current bursts per unit time reaches a predetermined level, the detector initiates an alarm.

[From NFPA 72E - 1990, 5-2.2.1 modified]

5-4.2.2.2 A single wavelength infrared flame detector uses one of several different photocell types to detect the infrared emissions in a single wavelength band that are produced by a flame. These detectors generally include provisions to minimize alarms from commonly occurring infrared sources such as incandescent lighting or sunlight.

[From NFPA 72E - 1990, 5-2.2.2 modified]

5-4.2.2.3 An ultraviolet/infrared (UV/IR) flame detector senses ultraviolet radiation with a vacuum photodiode tube and a selected wavelength of infrared radiation with a photocell and uses the combined signal to indicate a fire. These detectors require both types of radiation to be present before an alarm signal is initiated.

[From NFPA 72E - 1990, 5-2.2.3 modified]

5-4.2.2.4 A multiple wavelength infrared (IR/IR) flame detector senses radiation at two or more narrow bands of wavelengths in the infrared spectrum. These detectors electronically compare the emissions between the band and initiate a signal where the relationship between the two bands indicates a fire.

[From NFPA 72E - 1990, 5-2.2.4 modified]

5-4.2.3 Operating Principles of Spark/Ember Detectors.

A spark/ember-sensing detector usually uses a solid state photodiode or phototransistor to sense the radiant energy emitted by embers, typically between 0.5 and 2.0 microns in normally dark environments. These detectors can be made extremely sensitive (microwatts), and their response times can be made very short (microseconds).

[From NFPA 72E - 1990, 5-2.3 and 5-2.3.1 modified]

5-4.3 Fire Characteristics and Detector Selection.

[From NFPA 72E - 1990, 5-3]

5-4.3.1* The type and quantity of radiant energy-sensing fire detectors shall be determined based upon an analysis of the hazard, including the burning characteristics of the fuel, the fire growth rate, the environment, the ambient conditions, and the capabilities of the extinguishing media and equipment.

[From NFPA 72E - 1990, 5-3.1 modified]

5-4.3.2 The selection of the radiant energy-sensing detectors shall be based upon:

(a) The matching of the spectral response of the detector to the spectral emissions of the fire or fires to be detected; and

(b) Minimizing the possibility of spurious nuisance alarms from nonfire sources inherent to the hazard area. (See A-5-4.3.1.)

[From NFPA 72E - 1990, 5-6.1 modified]

5-4.4 Spacing Considerations.

[From NFPA 72E - 1990, 5-4]

5-4.4.1 General Rules.

[From NFPA 72E - 1990, 5-4.1]

5-4.4.1.1* Radiant energy-sensing fire detectors shall be employed consistent with the listing or approval and the inverse square law, which defines the fire size vs. distance curve for the detector.

[From NFPA 72E - 1990, 5-4.1.1]

5-4.4.1.2 Detectors shall be used in sufficient quantity and positioned so that no point requiring detection in the hazard area is obstructed or outside the field of view of at least one detector.

[From NFPA 72E - 1990, 5-4.1.2]

5-4.4.2 Spacing Considerations for Flame Detectors.

[From NFPA 72E - 1990, 5-4.2]

5-4.4.2.1* The location and spacing of detectors shall be the result of an engineering evaluation, taking into consideration:

- (a) The size of the fire that is to be detected
- (b) The fuel involved
- (c) The sensitivity of the detector
- (d) The field of view of the detector
- (e) The distance between the fire and the detector
- (f) The radiant energy absorption of the atmosphere
- (g) The presence of extraneous sources of radiant emissions
- (h) The purpose of the detection system
- (i) The response time required.

[From NFPA 72E - 1990, 5-4.2.1 modified]

5-4.4.2.2 The system design shall specify the size of the flaming fire of given fuel that is to be detected.

[From NFPA 72E - 1990, 5-4.2.2 modified]

5-4.4.2.3* In applications where the fire to be detected could occur in an area not on the optical axis of the detector, the distance shall be reduced or detectors added to compensate for the angular displacement of the fire in accordance with the manufacturer's documented instructions.

[From NFPA 72E - 1990, 5-4.2.3 modified]

5-4.4.2.4* In applications in which the fire to be detected is of a fuel different than the test fuel used in the process of listing or approval, the distance between the detector and the fire shall be adjusted consistent with the fuel specificity of the detector as established by the manufacturer.

[From NFPA 72E - 1990, 5-4.2.4]

5-4.4.2.5 Since flame detectors are essentially line of sight devices, special care shall be taken to ensure that their ability to respond to the required area of fire in the zone that is to be protected will not be compromised by the presence of intervening structural members or other opaque objects or materials.

[From NFPA 72E - 1990, 5-4.2.5 and 5-5.1]

5-4.4.2.6* Provisions shall be made to sustain detector window clarity in applications where airborne particulates and aerosols coat the detector window between maintenance intervals and affect sensitivity.

[From NFPA 72E - 1990, 5-4.2.6 modified]

5-4.5 Spacing Considerations for Spark/Ember Detectors.

[From NFPA 72E - 1990, 5-4.3]

5-4.5.1* The location and spacing of detectors shall be the result of an engineering evaluation, taking into consideration:

- (a) The size of the spark or ember that is to be detected
- (b) The fuel involved
- (c) The sensitivity of the detector
- (d) The field of view of the detector
- (e) The distance between the fire and the detector
- (f) The radiant energy absorption of the atmosphere
- (g) The presence of extraneous sources of radiant emissions
- (h) The purpose of the detection systems
- (i) The response time required.

[From NFPA 72E - 1990, 5-4.3.1 modified]

5-4.5.2* The system design shall specify the size of the spark or ember of given fuel that the detection system is to detect.

[From NFPA 72E - 1990, 5-4.3.2 modified]

5-4.5.3 Spark detectors shall be positioned so that all points within the cross section of the conveyance duct, conveyor, or chute where the detectors are located are within the field of view of at least one detector as defined in 5-4.2.1.

[From NFPA 72E - 1990, 5-4.3.3]

5-4.5.4 The location and spacing of the detectors shall be adjusted using the inverse square law, modified for the

atmospheric absorption and the absorption of nonburning fuel suspended in the air in accordance with the manufacturer's documented instructions. (See A-5-4.4.1.1.)

[From NFPA 72E - 1990, 5-4.3.4 modified]

5-4.5.5* In applications where the sparks to be detected could occur in an area not on the optical axis of the detector, the distance shall be reduced or detectors added to compensate for the angular displacement of the fire in accordance with the manufacturer's documented instructions.

[From NFPA 72E - 1990, 5-4.3.5 modified]

5-4.5.6* Provisions shall be made to sustain the detector window clarity in applications where airborne particulates and aerosols coat the detector window and affect sensitivity.

[From NFPA 72E - 1990, 5-4.3.6 modified]

5-4.6 Other Considerations.

[From NFPA 72E - 1990, 5-6]

5-4.6.1 Radiant energy-sensing detectors shall be protected either by way of design or installation to ensure that optical performance is not compromised.

[From NFPA 72E - 1990, 5-6.2 modified]

5-4.6.2 Where necessary, radiant energy-sensing detectors shall be shielded or otherwise arranged to prevent action from unwanted radiant energy.

[From NFPA 72E - 1990, 5-6.3]

5-4.6.3 Where used in outdoor applications, radiant energy-sensing detectors shall be shielded or otherwise arranged in a fashion to prevent diminishing sensitivity by rain, snow, etc., and yet allow a clear field of vision of the hazard area.

[From NFPA 72E - 1990, 5-6.4 modified]

5-5 Gas-Sensing Fire Detectors.

[From NFPA 72E - 1990, Chap. 6]

5-5.1* The purpose of Section 5-5 is to provide information to assist in application and installation of fire detectors that sense gases produced by burning substances. These detectors are hereafter referred to as fire-gas detectors. This section covers general area application of fire-gas detectors in ordinary indoor locations.

[New paragraph]

5-5.2 Fire-gas detectors shall be installed in all areas where required either by the appropriate NFPA standard or by the authority having jurisdiction.

[From NFPA 72E - 1990, 6-1.1.3]

5-5.3 Fire-gas detectors shall respond to one or more of the gases produced by a fire. Gases are molecules without cohesion that are produced by a burning substance and are subject to oxidation or reduction.

[From NFPA 72E - 1990, 6-1.1.4]

5-5.4 Although some fire-gas detectors are capable of detecting combustible gases or vapors prior to ignition, such applications are not within the scope of this code.

5-5.5 Operating Principles.

[From NFPA 72E - 1990, 6-2]

5-5.5.1 Semiconductor. Fire-gas detectors of the semiconductor type respond to either oxidizing or reducing gases by creating electrical changes in the semiconductor. The subsequent conductivity change of the semiconductor causes actuation.

[From NFPA 72E - 1990, 6-2.1]

5-5.5.2 Catalytic Element. Fire-gas detectors of the catalytic element type contain a material that remains unchanged, but accelerates the oxidation of combustible gases. The resulting temperature rise of the element causes actuation.

[From NFPA 72E - 1990, 6-2.2]

5-5.6 Location and Spacing.

[From NFPA 72E - 1990, 6-3]

5-5.6.1* General. The location and spacing of fire-gas detectors shall result from an evaluation based on the guidelines detailed in this code and on engineering judgment. Ceiling shape and surfaces, ceiling height, configuration of contents, burning characteristics of combustible material present, ventilation, and the ambient environment are some of the conditions that shall be considered.

[From NFPA 72E - 1990, 6-3.1 modified]

5-5.6.1.1 Where the intent is to provide protection from a specific hazard, the detector(s) may be installed closer to the hazard in a position where the detector will readily intercept the fire gases.

[From NFPA 72E - 1990, 6-3.1.1]

5-5.6.1.2 Stratification. The possible effect of gas stratification at levels below the ceiling shall also be considered. (See A-5-3.5.1.2.)

[From NFPA 72E - 1990, 6-3.1.2]

5-5.6.2 Spot-type fire-gas detectors shall be located on the ceiling not less than 4 in. (100 mm) from a sidewall to the near edge or, if on a sidewall, between 4 in. (100 mm) and 12 in. (300 mm) down from the ceiling to the top of the detector. (See Figure A-5-2.5.1.)

Exception No. 1: See 5-5.6.1.2.

Exception No. 2: In the case of solid joist construction, detectors shall be mounted at the bottom of the joists.

Exception No. 3: In the case of beam construction where beams are less than 12 in. (300 mm) in depth and less than 8 ft (2.4 m) on center, detectors may be installed on the bottom of beams.

[From NFPA 72E - 1990, 6-3.2]

5-5.6.3* Each sampling port of a sampling-type fire-gas detector shall be treated as a spot-type detector for the purpose of location and spacing.

[From NFPA 72E - 1990, 6-3.3]

5-5.6.4 Smooth Ceiling Spacing.

[From NFPA 72E - 1990, 6-3.4]

5-5.6.4.1 Spot-Type Detectors. On smooth ceilings, spacing of 30 ft (9.1 m) shall be permitted to be used as a guide. In all cases, the manufacturer's recommendations shall be followed. Other spacing shall be permitted to be used depending on ceiling height, varying conditions, or response requirements.

[From NFPA 72E - 1990, 6-3.4.1]

5-5.6.5 Solid Joist Construction. (See A-5-3.5.6.)

[From NFPA 72E - 1990, 6-3.5]

5-5.6.5.1 Ceiling construction in which joists are 8 in. (200 mm) or less in depth shall be considered equivalent to a smooth ceiling. (See also A-5-3.5.1.2.)

[From NFPA 72E - 1990, 6-3.5.1]

5-5.6.5.2 If joists exceed 8 in. (200 mm) in depth, the spacing of spot-type detectors in the direction perpendicular to the joists shall be reduced. (See also A-5-3.5.1.2.)

[From NFPA 72E - 1990, 6-3.5.2]

5-5.6.6 Beam Construction.

[From NFPA 72E - 1990, 6-3.6]

5-5.6.6.1 Ceiling construction where beams are 8 in. (200 mm) or less in depth shall be considered equivalent to a smooth ceiling. (See also A-5-3.5.1.2.)

[From NFPA 72E - 1990, 6-3.6.1]

5-5.6.6.2 If beams are over 8 in. (200 mm) in depth, the spacing of spot-type detectors in the direction perpendicular to the beams shall be reduced. (See also A-5-3.5.1.2.)

[From NFPA 72E - 1990, 6-3.6.2]

5-5.6.6.3* If the beams exceed 18 in. (460 mm) in depth and are more than 8 ft (2.4 m) on center, each bay shall be treated as a separate area requiring at least one spot-type detector.

[From NFPA 72E - 1990, 6-3.6.3]

5-5.6.7 Sloped Ceilings.

[From NFPA 72E - 1990, 6-3.7]

5-5.6.7.1 Peaked. Detectors shall first be spaced and located within 3 ft (0.9 m) of the peak, measured horizontally. The number and spacing of additional detectors, if any, shall be based on the horizontal projection of the ceiling. (See Figure A-5-2.7.4.1.)

[From NFPA 72E - 1990, 6-3.7.1]

5-5.6.7.2 Shed. Detectors shall first be spaced and located within 3 ft (0.9 m) of the high side of the ceiling, measured horizontally. The number and spacing of additional detectors, if any, shall be based on the horizontal projection of the ceiling. (See Figure A-5-2.7.4.2.)

[From NFPA 72E - 1990, 6-3.7.2]

5-5.6.8 Suspended Ceilings. (See 5-5.6.)

[From NFPA 72E - 1990, 6-3.8]

5-5.6.9 Partitions. Where partitions extend upward to within 18 in. (460 mm) of the ceiling, they will not influence the spacing. Where the partition extends to within less than 18 in. (460 mm) of the ceiling, the effect on gas travel shall be considered in reduction of spacing.

[From NFPA 72E - 1990, 6-3.9]

5-5.7 Heating, Ventilating, and Air Conditioning (HVAC).

[From NFPA 72E - 1990, 6-4]

5-5.7.1* In spaces served by air-handling systems, detectors shall not be located where air from supply diffusers could dilute fire gases before they reach the detectors. Detectors shall be located to intercept the airflow toward the return air opening(s).

[From NFPA 72E - 1990, 6-4.1]

5-5.7.2 In under-floor spaces and above-ceiling spaces used as HVAC plenums, detectors shall be listed for the anticipated environment. (See 5-3.7.1.1.) Detector spacings and locations shall be selected based on anticipated air-flow patterns and fire types.

[From NFPA 72E - 1990, 6-4.2]

5-5.7.2.1 Detectors placed in environmental air ducts or plenums shall not be used as a substitute for open area detectors. (See Section 5-11 and associated appendix material for related information.) Where open area protection is required, 5-5.6 shall apply.

[From NFPA 72E - 1990, 6-4.2.1 modified]

5-5.8 Special Considerations.

[From NFPA 72E - 1990, 6-5]

5-5.8.1 The selection and placement of fire-gas detectors shall take into consideration both the performance characteristics of the detector and the areas into which the detectors will be installed to prevent nuisance alarm or nonoperation after installation. Some of the considerations are as follows.

[From NFPA 72E - 1990, 6-5.1]

5-5.8.1.1 Fire-gas detectors may alarm in nonfire situations due to certain human activities. The use of some aerosol sprays and hydrocarbon solvents are examples. Accordingly, considerable care shall be employed when installing fire-gas detectors. They shall not be installed where, under normal conditions, concentrations of detectable gases may be present. A garage is not a place to use fire-gas detectors for fire alarm purposes because the concentration of carbon monoxide may be high enough to trigger an alarm.

[From NFPA 72E - 1990, 6-5.1.1]

5-5.8.1.2 Fire-gas detectors having a fixed temperature element as part of the unit shall be selected in accordance with Table 5-2.4.1 for the maximum ceiling temperature that can be expected in service.

[From NFPA 72E - 1990, 6-5.1.2]

5-5.8.1.3* The installation of fire-gas detectors shall take into consideration the environmental condition of the

area(s). (See Table A-5-3.7.1.1.) Fire-gas detectors are intended for installation in areas where the normal ambient conditions are not likely to exceed the following:

(a) A temperature of 100°F (38°C), or fall below 32°F (0°C); or

(b) A relative humidity outside the range of 10 to 93 percent; or

(c) An air velocity of 300 fpm (1.5 mps).

Exception: Detectors specifically designed for use in ambients exceeding the limits of (a) through (c) and listed for the temperature, humidity, and air velocity conditions expected.

[From NFPA 72E - 1990, 6-5.1.3]

5-6 Other Fire Detectors.

[From NFPA 72E - 1990, Chap. 7]

5-6.1 Detectors in the classification of "Other Fire Detectors" are those that operate on principles different from those described in 5-2.3, 5-3.3, 5-4.3, and 5-5.5. Such detectors shall be installed in all areas where they are required either by the appropriate NFPA standard or by the authority having jurisdiction.

[From NFPA 72E - 1990, 7-1]

5-6.2 Facilities for testing or metering or instrumentation to ensure adequate initial sensitivity and adequate retention thereof, relative to the protected hazard, shall be provided. These facilities shall be employed at regular intervals.

[From NFPA 72E - 1990, 7-1.1.2]

5-6.3 These detectors shall operate where subjected to the abnormal concentration of combustion effects that occur during a fire, such as water vapor, ionized molecules, or other phenomena for which they are designed. Detection is dependent upon the size and intensity of fire to provide the necessary amount of required products and related thermal lift, circulation, or diffusion for adequate operation.

[From NFPA 72E - 1990, 7-2.1]

5-6.4 Room sizes and contours, airflow patterns, obstructions, and other characteristics of the protected hazard shall be taken into account.

[From NFPA 72E - 1990, 7-2.2]

5-6.5 Location and Spacing.

[From NFPA 72E - 1990, 7-3]

5-6.5.1 The location and spacing of detectors shall be based on the principle of operation and an engineering survey of the conditions anticipated in service. The manufacturer's technical bulletin shall be consulted for recommended detector uses and locations.

[From NFPA 72E - 1990, 7-3.1]

5-6.5.2 Detectors shall not be spaced beyond their listed or approved maximums. Closer spacing shall be utilized where the structural or other characteristics of the protected hazard warrant.

[From NFPA 72E - 1990, 7-3.2]

5-6.5.3 Consideration shall be given to all factors with bearing on the location and sensitivity of the detectors, including structural features such as sizes and shapes of rooms and bays, their occupancies and uses, ceiling heights, ceiling and other obstructions, ventilation, ambient environment, stock piles, files, and fire hazard locations.

[From NFPA 72E - 1990, 7-3.3]

5-6.5.4 The overall situation shall be reviewed frequently to ensure that changes in structural or usage conditions that could interfere with fire detection are remedied.

[From NFPA 72E - 1990, 7-3.4]

5-6.6 Special Considerations. The selection and placement of detectors shall take into consideration both the performance characteristics of the detector and the areas into which the detectors will be installed to prevent nuisance alarm or nonoperation after installation.

[New paragraph]

5-7 Sprinkler Waterflow Alarm-Initiating Devices.

5-7.1 The provisions of Section 5-7 apply to devices that initiate an alarm indicating a flow of water in a sprinkler system.

[From NFPA 72, 3-4.1.1 modified]

5-7.2* Provisions shall be made to indicate the flow of water in a sprinkler system by an alarm signal within 90 seconds after flow of water at the alarm-initiating device equal to or greater than that from a single sprinkler of the smallest orifice size installed in the system. Movement of water due to waste, surges, or variable pressure shall not be indicated.

[From NFPA 72, 3-4.1.2 modified]

5-7.3 Piping between the sprinkler system and a pressure actuated alarm-initiating device shall be galvanized or of nonferrous metal or other approved corrosion resistant material, not less than $\frac{3}{8}$ in. (9.5 mm) nominal pipe size.

[From NFPA 71, 3-4.2.1 modified]

5-8 Detection of the Operation of Other Automatic Extinguishing Systems.

[From NFPA 71, 3-4.3 modified]

5-8.1* Provision shall be made to detect the operation of an automatic extinguishing system by means appropriate to the system, such as agent flow or agent pressure, by alarm-initiating devices installed in accordance with their individual listings.

[From NFPA 71, 3-4.3.1 modified]

5-9 Manually Actuated Alarm-Initiating Devices.

5-9.1 Manual fire alarm boxes shall be used only for fire alarm-initiating purposes. However, combination manual fire alarm boxes and guard's signaling stations shall be permitted.

[From NFPA 71, 3-1.1.1, and NFPA 72, 3-2.1 modified]

5-9.1.1 Mounting. Each manual fire alarm box shall be securely mounted. The operable part of each manual fire

alarm box shall be not less than $3\frac{1}{2}$ ft (1.1 m) and not more than $4\frac{1}{2}$ ft (1.37 m) above floor level.

[From NFPA 72, 3-2.2, and NFPA 71, 3-4.1.1 modified]

5-9.1.2 Distribution. Manual fire alarm boxes shall be distributed throughout the protected area so that they are unobstructed, readily accessible, and located in the normal path of exit from the area as follows:

(a) At least one manual fire alarm box shall be provided on each floor.

(b) Additional manual fire alarm boxes shall be provided so that travel distance to the nearest fire alarm box will not be in excess of 200 ft (61 m) measured horizontally on the same floor.

(c) For systems employing automatic fire detectors or waterflow detection devices, at least one manual fire alarm box shall be provided to initiate a fire alarm signal. This manual fire alarm box shall be located where required by the authority having jurisdiction.

[From NFPA 72-1990, 3-2.3 modified and 3-2.4]

5-9.1.3* A coded manual fire alarm box shall produce at least three repetitions of the coded signal, each repetition to consist of at least three impulses.

[From NFPA 72, 2-4.3 modified]

5-9.2 Publicly Accessible Fire Service Boxes (Street Boxes).

[From NFPA 1221, 4-1.4 modified]

5-9.2.1 Street boxes, when in an abnormal condition, shall leave the circuit usable.

[From NFPA 1221, 4-1.4.2.1 modified]

5-9.2.2 Street boxes shall be designed so that recycling will not occur if a box actuating device is held in the actuating position and so that they will be ready to accept a new signal as soon as the actuating device is released.

[From NFPA 1221, 4-1.4.2.2 modified]

5-9.2.3 Street boxes, when actuated, shall give a visible or audible indication to the user that the box is operating or that the signal has been transmitted to the communication center.

NOTE: Where the operating mechanism of a box creates sufficient sound to be heard by the user, the requirements are satisfied.

[From NFPA 1221, 4-1.4.2.3 modified]

5-9.2.4 The street box housing shall protect the internal components from the weather.

[From NFPA 1221, 4-1.4.2.5 modified]

5-9.2.5 Doors on street boxes shall remain operable under adverse climatic conditions, including icing and salt spray.

[From NFPA 1221, 4-1.4.2.6 modified]

5-9.2.6 Street boxes shall be recognizable as such. Street boxes shall have instructions for use plainly marked on their exterior surfaces.

[From NFPA 1221, 4-1.4.1.1 modified]

5-9.2.7 Street boxes shall be securely mounted on poles, pedestals, or structural surfaces as directed by the authority having jurisdiction.

[From NFPA 1221, 4-1.4.1.8 modified]

5-9.2.8 Street boxes shall be as conspicuous as possible. Their color shall be distinctive, and they shall be visible from as many directions as possible. A wide band of distinctive colors visible over the tops of parked cars or adequate signs completely visible from all directions shall be applied to supporting poles.

[From NFPA 1221, 4-1.4.1.3 and 4-1.4.1.4 modified]

5-9.2.9* Location-designating lights of distinctive color, visible for at least 1500 ft (460 m) in all directions, shall be installed over street boxes. The street light nearest the street box, where equipped with a distinctively colored light, shall be acceptable.

[From NFPA 1221, 4-1.4.1.5 modified]

5-9.2.10 Street box cases and parts at any time accessible to users shall be of insulating materials or permanently and effectively grounded. All ground connections to street boxes shall comply with the requirements of NFPA 70, *National Electrical Code*, Article 250.

[From NFPA 1221, 4-1.4.1.6 and 4-1.4.1.7 modified]

5-9.2.11 If a street box is installed inside a structure, it shall be placed as close as is practical to the point of entrance of the circuit, and the exterior wire shall be installed in conduit or electrical metallic tubing in accordance with Chapter 3 of NFPA 70, *National Electrical Code*.

[From NFPA 1221, 4-2.1.2.1 modified]

5-9.2.12 Coded Radio Street Boxes.

[From NFPA 1221, 4-3.3]

5-9.2.12.1 Coded radio street boxes shall be designed and operated in compliance with all applicable rules and regulations of the FCC, as well as with the requirements established herein.

[From NFPA 1221, 4-3.3.1 modified]

5-9.2.12.2 Coded radio street boxes shall provide no less than three specific and individually identifiable functions to the communication center in addition to the street box number, and they shall be "test," "tamper," and "fire."

[From NFPA 1221, 4-3.3.2.1]

5-9.2.12.3* Coded radio street boxes shall transmit to the communication center no less than one repetition for "test," no less than one repetition for "tamper," and no less than three repetitions for "fire."

[From NFPA 1221, 4-3.3.2.2 modified]

5-9.2.12.4 Where multifunction coded radio street boxes are used to transmit to the communication center request(s) for emergency service or assistance in addition to those stipulated in 5-9.2.12.2, each such additional message function shall be individually identifiable.

[From NFPA 1221, 4-3.3.2.3]

5-9.2.12.5 Multifunction coded radio street boxes shall be so designed as to prevent the loss of supplemental or concurrently actuated messages.

[From NFPA 1221, 4-3.3.2.4 modified]

5-9.2.12.6 An actuating device held or locked in the activating position shall not prevent the activation and transmission of other messages.

[From NFPA 1221, 4-3.3.2.5 modified]

5-9.2.13 Power Source.

[From NFPA 1221, 4-3.3.3 modified]

5-9.2.13.1 Box primary power shall be permitted to be from a utility distribution system, a photovoltaic power system, user power, or be self-powered using either an integral battery or other stored energy source, as approved by the authority having jurisdiction.

[From NFPA 1221, 4-3.3.3.1]

5-9.2.13.2 Self-powered boxes shall have power for uninterrupted operation for not less than a period of 6 months. Self-powered boxes shall transmit a low power warning message to the communication center for at least 15 days prior to the time the power source will fail to operate the box. This message shall be part of all subsequent transmissions.

Use of a charger to extend the life of a self-powered box shall be permitted if the charger does not interfere with box operation. The box shall be capable of operation for not less than 6 months with the charger disconnected.

[From NFPA 1221, 4-3.3.3.2]

5-9.2.13.3 Boxes powered by a utility distribution system shall have an integral standby, sealed, rechargeable battery capable of powering box functions for at least 60 hours in the event of primary power failure. Transfer to standby battery power shall be automatic and without interruption to box operation. Where operating from primary power, the box shall be capable of operation with a dead or disconnected battery. A local trouble indication shall activate upon primary power failure. A battery charger shall be provided in compliance with 1-5.2.11.2, except as modified herein.

Where the primary power has failed, boxes shall transmit a power failure message to the communication center as part of subsequent test messages until primary power is restored. A low battery message shall be transmitted to the communication center where the remaining battery standby time is less than 54 hours.

[From NFPA 1221, 4-3.3.3.3]

5-9.2.13.4 Photovoltaic power systems shall provide box operation for not less than 6 months.

Photovoltaic power systems shall be supervised. The battery shall have power to sustain operation for a minimum period of 15 days without recharging. The box shall transmit a trouble message to the communication center when the charger has failed for more than 24 hours. This message shall be part of all subsequent transmissions. Where the remaining battery standby duration is less than 10 days, a low battery message shall be transmitted to the communication center.

[From NFPA 1221, 4-3.3.3.4]

5-9.2.13.5 User-powered boxes shall have an automatic self-test feature.

[From NFPA 1221, 4-3.3.3.5]

5-9.2.14 Design of Telephone Street Boxes (Series or Parallel).

[From NFPA 1221, 4-4.4 and 4-5.4 modified]

5-9.2.14.1 If a handset is used, the caps on the transmitter and receiver shall be secured to reduce the probability of the telephone street box being disabled due to vandalism.

[From NFPA 1221, 4-4.4.1 and 4-5.4.2 modified]

5-9.2.14.2 Telephone street boxes shall be designed to permit the communication center operator to determine whether or not the telephone street box has been restored to normal condition after use.

[From NFPA 1221, 4-4.4.2 and 4-5.4.1 modified]

5-10 Supervisory Signal-Initiating Devices.

[From NFPA 71, 3-4.4, and NFPA 72, 3-4]

5-10.1 Control Valve Supervisory Signal-Initiating Device. Two separate and distinct signals shall be initiated: one indicating movement of the valve from its normal position, and the other indicating restoration of the valve to its normal position. The off-normal signal shall be initiated during the first two revolutions of the hand wheel or during one-fifth of the travel distance of the valve control apparatus from its normal position. The off-normal signal shall not be restored at any valve position except normal.

[From NFPA 71, 3-4.4.2, and NFPA 72, 3-4.2.5 modified]

5-10.2 Pressure Supervisory Signal-Initiating Device. Two separate and distinct signals shall be initiated: one indicating that the required pressure has increased or decreased, and the other indicating restoration of the pressure to its normal value.

(a) A pressure tank supervisory signal-initiating device for a pressurized limited water supply, such as a pressure tank, shall indicate both high and low pressure conditions. A signal shall be initiated where the required pressure is increased or decreased 10 psi (70 kPa) from the normal pressure.

(b) A pressure supervisory signal-initiating device for a dry-pipe sprinkler system shall indicate both high and low pressure conditions. A signal shall be initiated where the pressure is increased or decreased 10 psi (70 kPa) from the normal pressure.

(c) A steam pressure supervisory signal-initiating device shall indicate a low pressure condition. A signal shall be initiated where the pressure reaches or exceeds 110 percent of the minimum operating pressure of the steam-operated equipment supplied.

(d) An initiating device for supervising the pressure of sources other than those specified in (a) through (c) shall be provided as required by the authority having jurisdiction.

[From NFPA 71, 3-4.4.3, and NFPA 72, 3-4.2.6 modified]

5-10.3 Water Level Supervisory Signal-Initiating Device

Two separate and distinct signals shall be initiated: one indicating that the required water level has been lowered or raised, and the other indicating restoration to the normal level.

(a) A pressure tank signal-initiating device shall indicate both high and low level conditions. A signal shall be obtained where the water level is lowered or raised 3 in (76 mm) from the normal level.

(b) A supervisory signal-initiating device for other than pressure tanks shall initiate a low level signal where the water level is lowered 12 in. (300 mm) below the normal level.

[From NFPA 71, 3-4.4.4, and NFPA 72, 3-4.2.1 modified]

5-10.4 Water Temperature Supervisory Signal-Initiating Device.

A temperature supervisory device for a water storage container exposed to freezing conditions shall initiate two separate and distinctive signals. One signal shall indicate that the temperature of the water has dropped to 40°F (4.4°C), and the other indicating restoration to proper temperature.

[From NFPA 71, 3-4.4.5, and NFPA 72, 3-4.2.1 modified]

5-10.5 Room Temperature Supervisory Signal-Initiating Device.

A room temperature supervisory device shall indicate the decrease in room temperature to 40°F (4.4°C) and its restoration to above 40°F (4.4°C).

[From NFPA 71, 3-4.4.7 modified]

5-11 Smoke Detectors for Control of Smoke Spread.

[From NFPA 72E - 1990, Chap. 9]

NOTE: See NFPA 101®, *Life Safety Code*®, for definition of smoke compartment; NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, for definition of duct systems; and NFPA 92A, *Recommended Practice for Smoke-Control Systems*, for definition of smoke zone.

[From NFPA 72E - 1990, 9-1 modified]

5-11.1* Section 5-11 covers installation and use of all types of smoke detectors to prevent smoke spread by initiating control of fans, dampers, doors, and other equipment. Detectors for this use shall be classified as:

(a) Area detectors that are installed in the related smoke compartments

(b) Detectors that are installed in the air duct systems.

[From NFPA 72E - 1990, 9-1.1]

5-11.2* Detectors that are installed in the air duct system per 5-11.1(b) shall not be used as a substitute for open area protection. Where open area protection is required, 5-3.1 shall apply.

[From NFPA 72E - 1990, 9-1.2 modified]

5-11.3 Smoke detectors in the related smoke compartment for open area protection are the preferred means to initiate control of smoke spread.

[From NFPA 72E - 1990, 9-1.3]

5-11.4 Purposes.

[From NFPA 72E - 1990, 9-2]

5-11.4.1 The purposes to which smoke detectors may be applied in order to initiate control of smoke spread are:

(a) Prevention of the recirculation of dangerous quantities of smoke within a building

(b) Selective operation of equipment to exhaust smoke from a building

(c) Selective operation of equipment to pressurize smoke compartments

(d) Operation of doors and dampers to close the openings in smoke compartments.

[From NFPA 72E - 1990, 9-2.1 modified]

5-11.4.2 To prevent the recirculation of dangerous quantities of smoke, a detector approved for air duct use shall be installed on the supply side of air handling systems in accordance with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, and 5-11.5.2.1.

[From NFPA 72E - 1990, 9-2.2]

5-11.4.3 To selectively initiate the operation of equipment to control smoke spread, the requirements of 5-11.5.2.2 shall apply.

[From NFPA 72E - 1990, 9-2.3]

5-11.4.4 Where detectors are used to initiate the operation of smoke doors, the requirements of 5-11.7 shall apply.

[From NFPA 72E - 1990, 9-2.4 modified]

5-11.4.5 Where duct detectors are used to initiate the operation of smoke dampers within ducts, the requirements of 5-11.6 shall apply.

[New paragraph]

5-11.5 Application.

[From NFPA 72E - 1990, 9-3]

5-11.5.1 Area Detectors Within Smoke Compartments. Area smoke detectors located within a smoke compartment for complete area coverage shall be permitted to be used to initiate control of smoke spread by operating doors, dampers, and other equipment where appropriate in the overall fire safety plan.

[From NFPA 72E - 1990, 9-3.1]

5-11.5.2 Smoke Detection for the Air Duct System.

[From NFPA 72E - 1990, 9-3.2]

5-11.5.2.1 Supply Air System. Where the detection of smoke in the supply air system is required by other NFPA standards, detector(s) listed for the air velocity present and located in the supply air duct downstream of both the fan and the filters shall be installed.

Exception No. 1: Where complete smoke detection is installed in the smoke compartment, installation of air duct detectors in the supply air system is not necessary if their function can be accomplished by the design of the area detection system.

Exception No. 2: Additional smoke detectors are not required to be installed in ducts where the air duct system passes through other smoke compartments not served by the duct.

[From NFPA 72E - 1990, 9-3.2.1 modified]

5-11.5.2.2* Return Air System. Where the detection of smoke in the return air system is required by other NFPA standards, detector(s) listed for the air velocity present shall be located at every return air opening within the smoke compartment, where the air leaves each smoke compartment, or in the duct system before the air enters the return air system common to more than one smoke compartment. [See Figures A-5-11.5.2.2(a), (b), and (c).]

Exception No. 1: Where complete smoke detection is installed in the smoke compartment, installation of air duct detectors in the return air system is not necessary if their function can be accomplished by the design of the area detection system.

Exception No. 2: Additional smoke detectors are not required to be installed in ducts where the air duct system passes through other smoke compartments not served by the duct.

[From NFPA 72E - 1990, 9-3.2.2]

5-11.6 Location and Installation of Detectors in Air Duct Systems.

[From NFPA 72E - 1990, 9-4]

5-11.6.1 Detectors shall be listed for the purpose.

[From NFPA 72E - 1990, 9-4.1]

5-11.6.2* Air duct detectors shall be securely installed in such a way as to obtain a representative sample of the air stream. This shall be permitted to be achieved by any of the following methods:

(a) Rigidly mounted within the duct

(b) Rigidly mounted to the wall of the duct with the sensing element protruding into the duct

(c) Outside the duct with rigidly mounted sampling tubes protruding into the duct

(d) Through the duct with projected light beam.

[From NFPA 72E - 1990, 9-4.2 modified]

5-11.6.3 Detectors shall be readily accessible for cleaning and shall be mounted in accordance with the manufacturer's recommendations. If necessary, access doors or panels shall be provided.

[From NFPA 72E - 1990, 9-4.3]

5-11.6.4 The location of all detectors in air duct systems shall be permanently and clearly identified and recorded.

[From NFPA 72E - 1990, 9-4.4]

5-11.6.5 Detectors mounted outside of a duct employing sampling tubes for transporting smoke from inside the duct to the detector shall be designed and installed to permit verification of airflow from the duct to the detector.

[From NFPA 72E - 1990, 9-4.5 modified]

5-11.6.6 Detectors shall be listed for proper operation over the complete range of air velocities, temperature, and humidity expected at the detector when the air handling system is operating.

[From NFPA 72E - 1990, 9-4.6 modified]

5-11.6.7 All penetrations of a return air duct in the vicinity of detectors installed on or in an air duct shall be sealed to prevent entrance of outside air and possible dilution or redirection of smoke within the duct.

[From NFPA 72E - 1990, 9-4.7]

5-11.7 Smoke Detectors for Door Release Service.

[From NFPA 72E - 1990, 9-5]

5-11.7.1 Smoke door release not initiated by a fire alarm system that includes smoke detectors protecting the areas on both sides of the door affected shall be accomplished by smoke detectors applied as specified in 5-11.7.

[From NFPA 72E - 1990, 9-5.1]

5-11.7.2 Smoke detectors listed or approved exclusively for door release service shall not be used for open area protection.

A smoke detector used concurrently for door release service and open area protection shall be acceptable if listed or approved for open area protection and installed in accordance with 5-3.5.

[From NFPA 72E - 1990, 9-5.2]

5-11.7.3 Smoke detectors shall be of the photoelectric, ionization, or other approved type.

[From NFPA 72E - 1990, 9-5.3]

5-11.7.4 Number of Detectors Required.

[From NFPA 72E - 1990, 9-5.4]

5-11.7.4.1 Where doors are to be closed in response to smoke flowing in either direction, the following rules shall apply.

[From NFPA 72E - 1990, 9-5.4.1]

5-11.7.4.1.1 Where the depth of wall section above the door is 24 in. (610 mm) or less, one ceiling-mounted detector shall be required on one side of the doorway only. (See Figure 5-11.7.4.1.1, parts B and C.)

[From NFPA 72E - 1990, 9-5.4.1.1]

5-11.7.4.1.2 Where the depth of wall section above the door is greater than 24 in. (610 mm), two ceiling-mounted detectors shall be required, one on each side of the doorway. (See Figure 5-11.7.4.1.1, part F.)

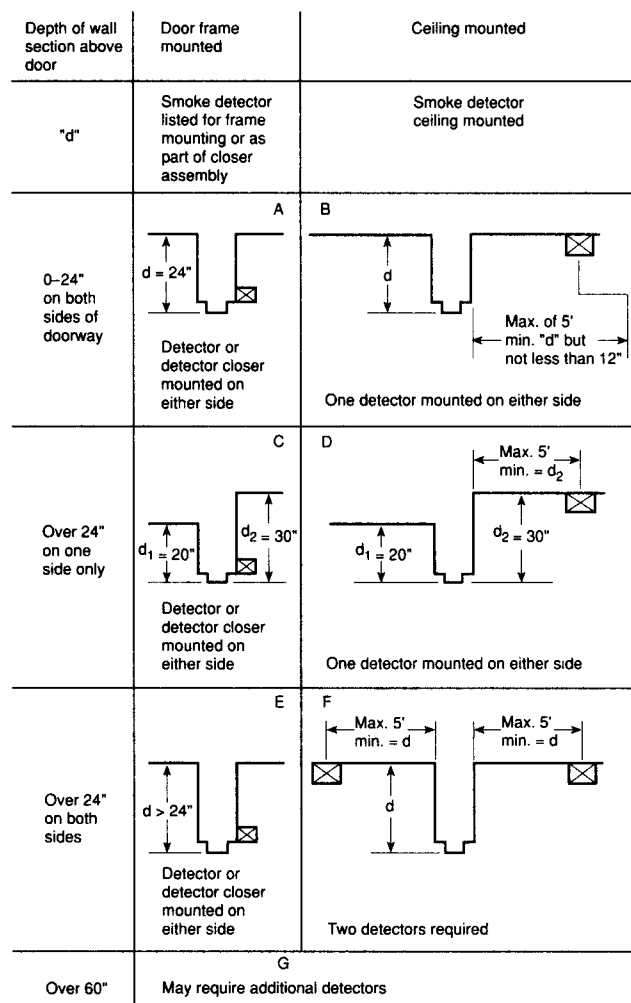
[From NFPA 72E - 1990, 9-5.4.1.2]

5-11.7.4.1.3 Where the depth of wall section above the door is 60 in. (1520 mm) or greater, additional detectors may be required as indicated by an engineering evaluation.

[From NFPA 72E - 1990, 9-5.4.1.3]

5-11.7.4.1.4 Where a detector is specifically listed for door frame mounting or where a listed combination or integral detector-door closer assembly is used, only one detector shall be required where installed in the manner recommended by the manufacturer.

[From NFPA 72E - 1990, 9-5.4.1.4]



For SI Units: 1 in. = 25.4 mm; 1 ft = 0.305 m.

Figure 5-11.7.4.1.1

[From NFPA 72E - 1990, 9-5.4.1.1]

5-11.7.4.2 Where door release is intended to prevent smoke transmission from one space to another in one direction only, one detector located in the space to which smoke is to be confined shall suffice regardless of the depth of wall section above the door. Alternatively, a smoke detector conforming with 5-11.7.4.1.4 shall be used.

[From NFPA 72E - 1990, 9-5.4.2]

5-11.7.4.3 Where there are multiple doorways, additional ceiling-mounted detectors shall be required as follows.

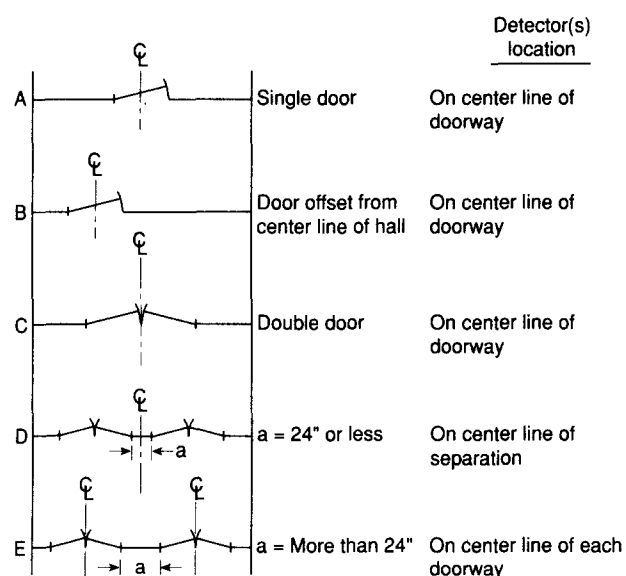
[From NFPA 72E - 1990, 9-5.4.3]

5-11.7.4.3.1 Where the separation between doorways exceeds 24 in. (610 mm), each doorway shall be treated separately. (See Figure 5-11.7.4.3.1.)

[From NFPA 72E - 1990, 9-5.4.3.1]

5-11.7.4.3.2* Each group of three doorway openings shall be treated separately.

[From NFPA 72E - 1990, 9-5.4.3.2]



For SI Units: 1 in. = 25.4 mm.

Figure 5-11.7.4.3.1

[From NFPA 72E - 1990, 9-5.4.3.1]

5-11.7.4.3.3* Each group of doorway openings that exceeds 20 ft (6 m) in width measured at its overall extremes shall be treated separately.

[From NFPA 72E - 1990, 9-5.4.3.3]

5-11.7.4.4 Where there are multiple doorways and listed door frame-mounted detectors or where listed combination or integral detector-door closer assemblies are used, there shall be one detector for each single or double doorway.

[From NFPA 72E - 1990, 9-5.4.4]

5-11.7.4.4.1 A double doorway is a single opening that has no intervening wall space or door trim separating the two doors. (See Figure 5-11.7.4.3.1.)

[From NFPA 72E - 1990, 9-5.4.4.1]

5-11.7.5 Location.

[From NFPA 72E - 1990, 9-5.5]

5-11.7.5.1 Where ceiling-mounted smoke detectors are to be installed on a smooth ceiling for a single or double doorway, they shall be located as follows. (See Figure 5-11.7.4.3.1.)

- (a) On the centerline of the doorway, and
- (b) No more than 5 ft (1.5 m) measured along the ceiling and perpendicular to the doorway (see Figure 5-11.7.4.1.1), and
- (c) No closer than shown in Figure 5-11.7.4.1.1, parts B, D, and F.

[From NFPA 72E - 1990, 9-5.5.1 modified]

5-11.7.5.2 Where ceiling-mounted detectors are to be installed in conditions other than those outlined in 5-11.7.5.1, engineering judgment is required.

[From NFPA 72E - 1990, 9-5.5.1]

Chapter 6 Notification Appliances for Fire Alarm Systems

6-1 Scope.

6-1.1 Minimum Requirements. This chapter covers minimum requirements for the performance, location, and mounting required for notification appliances for fire alarm systems for the purpose of evacuation or relocation of the occupants.

[From NFPA 72G, 1-2.1 modified]

6-1.2 Intended Use. These requirements are intended to be used with other NFPA standards that deal specifically with fire alarm, extinguishment, or control systems. Notification appliances for fire alarm systems add to fire protection by providing stimuli for initiating emergency action.

[From NFPA 72G, 1-2.2 modified]

6-1.3 All notification appliances or combinations thereof installed in conformity with this chapter shall be listed for the purpose for which they are used.

[From NFPA 72G, 3-4.2 modified]

6-1.4 These requirements are intended to address the reception of a notification signal and not its information content.

[From NFPA 72G, Chap. 2 modified]

6-1.5 Interconnection of Appliances. The interconnection of appliances, the control configurations, the power supply, and the use of the information provided by notification appliances for fire alarm systems are described in Chapter 1 and Chapter 3.

[From NFPA 72G, 1-2.3 modified]

6-2 General.

6-2.1 Definitions.

[New title]

Classification of Notification Signals. For the purpose of this chapter, notification signals for fire alarm systems are classified as listed below:

[From NFPA 72G, 2-1.1]

Coded. An audible or visible signal conveying several discrete bits or units of information. Notification signal examples are numbered strokes of an impact-type appliance and numbered flashes of a visible appliance.

[From NFPA 72G, 2-1.1.2]

Noncoded. An audible or visible signal conveying one discrete bit of information.

[From NFPA 72G, 2-1.1.1]

Noncoded Perceptually Constant. The continuous operation of a notification appliance (for example, a bell, horn, siren, or light) that is energized continuously.

[From NFPA 72G, 2-1.1.1.2]

Noncoded Perceptually Repetitious. The interrupted operation of a notification appliance (for example, a bell, horn, siren, or light) that is energized at a continuous uniform rate.

[From NFPA 72G, 2-1.1.1.3]

Noncoded Single Event. One stroke of an impact-type appliance or one flash of a strobe flash appliance. This should not be used for fire alarm purposes.

[From NFPA 72G, 2-1.1.1.1]

Textual. An audible or visible signal conveying a stream of information. An example of an audible textual signal is a voice message.

[From NFPA 72G, 2-1.1.3]

General Audible. Labeled ratings are in accordance with ANSI S12.31, *Precision Methods for the Determination of Sound Power Levels of Broad Band Noise Sources in Reverberation Rooms*, and ANSI S12.32, *Precision Methods for the Determination of Sound Power Levels of Discrete Frequency and Narrow Band Noise Sources in Reverberation Rooms*, unless otherwise noted.

[From NFPA 72G, 2-2.1]

General/Notification. Audible or visible signals used for alerting the general public or specific individuals responsible for implementation and direction of emergency action.

[From NFPA 72G, 2-2.3 modified]

General Visible. Definitions are in accordance with IES RP-16, *Nomenclature and Definitions for Illuminating Engineering*, unless otherwise noted.

[From NFPA 72G, 2-2.2]

Operating Mode, Private. Audible or visible signaling only to those persons directly concerned with the implementation and direction of emergency action initiation and procedure in the area protected by the fire alarm system.

[From NFPA 72G, 2-3.2]

Operating Mode, Public. Audible or visible signaling to occupants or inhabitants of the area protected by the fire alarm system.

[From NFPA 72G, 2-3.1]

6-2.2 Nameplates.

[From NFPA 72G, 2-4]

6-2.2.1 The notification appliances shall include on their nameplates reference to electrical requirements and rated audible or visible performance, or both, as defined by the listing authority.

[From NFPA 72G, 2-4.1]

6-2.2.2 The audible appliances shall include on their nameplates reference to their parameters or reference to installation documents (supplied with the appliance) that include the parameters in accordance with 6-3.1. The visible appliances shall include on their nameplates reference to their parameters or reference to installation documents

(supplied with the appliance) that include the parameters in accordance with 6-4.2.1.

6-2.3 Physical Construction. All material for audible, textual, and visible appliances shall be moisture-, fire-, and climate-resistant in accordance with the stated purpose and shall be designed and fabricated to render them damage- and tamper-resistant.

[From NFPA 72G, 4-3.1, 5-3.1, 7-3.1 modified, and NFPA 72 - 1990, 2-4.8.3 modified]

6-2.4 Where subject to obvious mechanical damage, appliances shall be suitably protected.

[From NFPA 72G, 3-5.1]

6-2.5 Appliances shall be supported, in all cases, independently of their attachments to the circuit conductors.

[From NFPA 72G, 3-5.2]

6-3 Audible Characteristics.

6-3.1* Public Mode.

6-3.1.1 Audible signals intended for operation in the public mode shall have a sound level of not less than 75 dBA at 10 ft (3 m) or more than 130 dBA at the minimum hearing distance from the audible appliance.

[From NFPA 72G, 3-1.1.1]

6-3.1.2 To ensure that audible public mode signals are clearly heard, it shall be required that their sound level be at least 15 dBA above the average ambient sound level or 5 dBA above the maximum sound level having a duration of at least 60 seconds (whichever is greater), measured 5 ft (1.5 m) above the floor in the occupiable area.

[From NFPA 72G, 4-2.1]

6-3.1.3 Temporary sound sources not normally found continuously in the occupied area need not be considered in measuring maximum sound level. The average ambient sound level is the root mean square, A-weighted sound pressure measured over a 24-hour period.

6-3.1.4 An average sound level greater than 115 dBA shall require the use of a visible signal appliance(s) in accordance with Section 6-4.

6-3.1.5 Each section of a floor divided by a required 2-hour rated fire wall shall be considered as a separate area.

[From NFPA 72 - 1990, A-10-4.6.2 modified]

NOTE: The typical average ambient sound level should be considered.

6-3.2 Private Mode. Audible signals intended for operation in the private mode shall have a sound level of not less than 45 dBA at 10 ft (3 m) or more than 130 dBA at the minimum hearing distance from the audible appliance. An average sound level greater than 115 dBA requires the use of a visible signal appliance(s) in accordance with Section 6-4.

[From NFPA 72G, 3-1.1.2]

6-3.3 Audibility. The sound level of an installed audible signal shall be adequate to perform its intended function and shall meet the requirements of the authority having jurisdiction or other applicable standards.

[From NFPA 72G, 3-1.1.3]

6-3.4 Mechanical Equipment Rooms. Where audible appliances are installed in mechanical equipment rooms, the average ambient sound level that shall be used for design guidance is at least 85 dBA for all occupancies.

[From NFPA 72G, 3-1.1.4]

6-3.5 Sleeping Areas.

6-3.5.1 Where audible appliances are installed to signal sleeping areas, the maximum of 15 dBA above the average ambient sound or a minimum of 70 dBA shall be provided.

6-3.5.2 Sound level measurements at any point within the sleeping areas shall be the maximum of 15 dbA above the average ambient sound or a minimum of 70 dbA.

6-3.6 Noncoded Audible Signal Appliances. The purpose and scope of 6-3.6 is to provide requirements for location and spacing of noncoded audible appliances.

[From NFPA 72G, 4-1.1]

6-3.7 Location of Audible Signal Appliances. Where ceiling heights permit, wall-mounted appliances shall have their tops at heights above the finished floors of not less than 90 in. (2.30 m) and below the finished ceilings of not less than 6 in. (0.15 m). This shall not preclude ceiling-mounted or recessed appliances.

[From NFPA 72G, 4-4.1]

Exception: Combination audible/visible appliances installed in sleeping areas shall comply with 6-4.4.3.

6-3.7.1 Where combination audible/visible appliances are installed, the location of the installed appliance shall be determined by the requirements of 6-4.4.

Exception: Where the combination audible/visible appliance serves as an integral part of a smoke detector, the mounting location shall be in accordance with Chapter 2.

[New paragraphs]

6-4 Visible Characteristics, Public Mode.

6-4.1 There are two methods of visible signaling. These are methods in which the message of notification of an emergency condition is conveyed by direct viewing of the illuminating appliance or by means of illumination of the surrounding area.

[From NFPA 72G, 3-2.1.1 and 3-2.1.2]

NOTE: One method of determining compliance with Section 6-4 is that the product be listed in accordance with UL 1971, *Signaling Applications for the Hearing Impaired*.

[New paragraph]

6-4.2 Light Pulse Characteristics. The flash rate shall not exceed three flashes per second nor be less than one flash every three seconds.

[From NFPA 72G, 3-2.3.1]

6-4.2.1 A maximum pulse duration shall be 0.2 sec with a maximum duty cycle of 40 percent. The pulse duration is defined as the time interval between initial and final points of 10 percent of maximum signal.

[From NFPA 72G, 3-2.3.2]

6-4.2.2 The light source color shall be clear or nominal white and shall not exceed 1000 candela (cd) (effective intensity).

[From NFPA 72G, 3-2.3.3]

6-4.3 Appliance Photometrics. Visible notification appliances used in the public mode shall be located so that the operating effect of the appliance can be seen by the intended viewers and shall be of a type, size, intensity, and number so that the viewer can discern when they have been illuminated, regardless of the viewer's orientation.

[From NFPA 72G, 3-2.4.1]

6-4.4 Appliance Location. Wall-mounted appliances shall have their bottoms at heights above the finished floor of not less than 80 in. (2-m) and no greater than 96 in. (2.4 m). Ceiling-mounted appliances shall be installed per Table 6-4.4.1(b).

[From NFPA 72G, 5-2.1.1]

Exception: Appliances installed in sleeping areas shall comply with 6-4.4.3.

[New paragraph]

6-4.4.1* Spacing Allocation for Rooms.

6-4.4.1.1 Spacing shall be in accordance with Figure 6-4.4.1 and Tables 6-4.4.1(a) and (b). A maximum separation between appliances shall not exceed 100 ft (30 m).

6-4.4.1.2 If a room configuration is not square, the square room size that will entirely encompass the room or subdivide the room into multiple squares shall be used.

6-4.4.2* Spacing Allocation for Corridors.

6-4.4.2.1 Table 6-4.4.2 applies to corridors not exceeding 20 ft (6.1 m) wide. For corridors greater than 20 ft (6.1 m) wide, refer to Figure 6-4.4.1 and Tables 6-4.4.1(a) and (b). In a corridor application, visible appliances shall be rated not less than 15 cd.

6-4.4.2.2 The visible appliances shall be located no more than 15 ft (4.57 m) from the end of the corridor with a separation no greater than 100 ft (30.4 m) between appliances. Where there is an interruption of the concentrated viewing path, such as a fire door, an elevation change, or any other obstruction, the area shall be considered as a separate corridor.

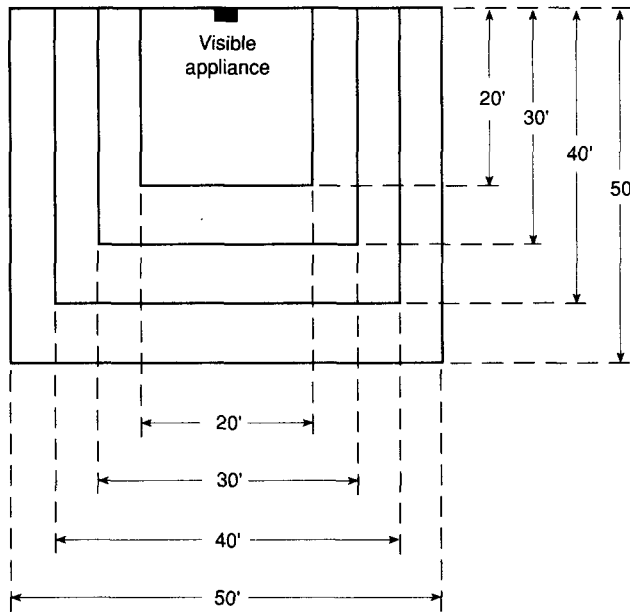


Figure 6-4.4.1 Room spacing allocation for wall-mounted visible appliances.

Note: The above is based on locating the visible signaling appliance at the halfway distance of the longest wall. In square rooms with appliances not centered or nonsquare rooms, the effective intensity (cd) from one visible signaling appliance shall be determined by maximum room size dimensions obtained either by the distance to the farthest wall or by double the distance to the farthest adjacent wall, whichever is greater, as shown in Table 6-4.4.1(a).

Table 6-4.4.1(a) Room Spacing Allocation for Wall-Mounted Visible Appliances

Maximum Room Size	Minimum Required Light Output, Candela (cd) (Effective Intensity)		
	One Light Per Room (cd)	Two Lights per Room (Located on Opposite Walls) (cd)	Four Lights per Room (One Light per Wall) (cd)
20' × 20'	15	-	-
30' × 30'	30	15	-
40' × 40'	60	30	15
50' × 50'	95	60	30
60' × 60'	135	95	30
70' × 70'	185	110	60
80' × 80'	-	140	60
90' × 90'	-	180	95
100' × 100'	-	-	95
110' × 110'	-	-	135
120' × 120'	-	-	160
130' × 130'	-	-	185

6-4.4.3* Sleeping Areas.

6-4.4.3.1 Smoke detectors shall be installed in accordance with the applicable requirements of Chapter 2 and Chapter 5.

6-4.4.3.2 Table 6-4.4.3 applies to sleeping areas having no linear dimension greater than 16 ft (4.87 m). For larger rooms, the visible notification appliance shall be located within 16 ft (4.87 m) of the pillow.

Table 6-4.4.1(b) Room Spacing Allocation for Ceiling-Mounted Visible Appliances

Maximum Room Size	Minimum Required Light Output, Candels (cd) (Effective Intensity)	
	Maximum Ceiling Height	One Light (cd)
20' × 20'	10'	15
30' × 30'	10'	30
40' × 40'	10'	60
50' × 50'	10'	95
20' × 20'	20'	30
30' × 30'	20'	45
40' × 40'	20'	80
50' × 50'	20'	115
20' × 20'	30'	55
30' × 30'	30'	75
40' × 40'	30'	115
50' × 50'	30'	150

NOTE 1: Where ceiling heights exceed 30 ft, visible signaling appliances shall be suspended at or below 30 ft or wall-mounted in accordance with Table 6-4.4.1(a).

NOTE 2: The above is based on locating the visible signaling appliance at the center of the room. Where it is not located at the center of the room, the effective intensity (cd) shall be determined by doubling the distance from the appliance to the farthest wall to obtain the maximum room size.

Table 6-4.4.2 Corridor Spacing Allocation for Wall-Mounted Visible Appliances

Corridor Length (ft)	Minimum Number of 15-cd Visible Appliances Required
0 - 30	1
31 - 130	2
131 - 230	3
231 - 330	4
331 - 430	5
431 - 530	6

Table 6-4.4.3 Effective Intensity Requirements for Sleeping Area

Visible Notification Appliance	
Distance from Ceiling to Top of Lens	Intensity
greater than or equal to 24"	110 cd
less than 24"	177 cd

6-4.4.4 Where visible appliances are required, a minimum of one appliance shall be installed in the concentrated viewing path such as might be experienced in such areas as classrooms, theater stages, etc.

[From NFPA 72G, 5-2.1.4]

6-5 Visible Characteristics, Private Mode. Visible signals used in the private mode shall be adequate for their intended purpose.

[From NFPA 72G, 3-3.1]

6-6 Supplementary Visible Signaling Method. A supplementary visible appliance is intended to augment an audible or visible signal.

[From NFPA 72G, 3-2.2.1]

6-6.1 A supplementary visible appliance shall comply with its marked rated performance.

[From NFPA 72G, 3-2.2.2]

6-6.2 Supplementary visible notification appliances shall be permitted to be located less than 80 in. (2 m) above the floor.

[From NFPA 72G, 5-2.1.5]

6-7 Coded Appliance Characteristics. All requirements for noncoded appliances shall be met. In addition, the appliances shall differentiate several bits or units of information from all other information conveyed by that appliance.

[From NFPA 72G, 6-1.1]

6-8 Textual Audible Appliances.

6-8.1 Performance. The textual appliance shall reproduce normal voice frequencies.

6-8.2 Loudspeaker Appliance. The sound level in dBA of the loudspeaker appliance evacuation tone signals of the particular mode installed shall comply with all the requirements in 6-3.1.

[From NFPA 72G, 7-2.1.1]

6-8.3 Location of Loudspeaker Appliances. Where ceiling heights permit, wall-mounted loudspeaker appliances shall have their tops at heights above the finished floors of not less than 90 in. (2.30 m) and below the finished ceilings of not less than 6 in. (0.15 m). This does not preclude ceiling-mounted or recessed appliances.

[From NFPA 72G, 7-4.1]

6-8.3.1 Where loudspeaker/visible appliances are installed, the height of the installed appliance shall comply with 6-4.4.

Exception: Combination loudspeaker/visible appliances installed in sleeping areas shall comply with 6-4.4.3.

[New paragraphs]

6-8.4 Telephone Appliance. The telephone appliance shall be in accordance with EIA Tr 41.3, *Telephones*.

6-8.5 Location of Telephone Appliances. Wall-mounted telephone appliances or related jacks shall be of convenient heights not to exceed 66 in. (1.7 m), except that where accessible to the general public, one telephone appliance per location should be no higher than 54 in. (1.37 m) with clear access to the wall at least 30 in. (0.76 m) wide.

[From NFPA 72G, 7-4.2]

6-9 Textual Visible Appliances.

[New title]

6-9.1 The temporary textual visible appliance shall be a nonstorage display that produces either visible alphanumeric subtending a character angle to the observing eye of not less than 10 minutes of arc or visible pictorial images.

[From NFPA 72G, 8-2.1]

6-9.1.1 The alphanumeric display shall have an equivalent minimum 7 by 5 matrix character definition, a minimum grey scale contrast as defined by 10 shades of grey, and a character retentivity from 1/2 minute to 5 minutes.

[From NFPA 72G, 8-2.1.1]

6-9.1.2 The pictorial display shall have a minimum of 250 line scan per frame, a minimum of 250 points per line scan, each arranged on a scale of 10 shades of grey, and shall have 30 frames per second. The display shall have an aspect ratio of 1:1.33.

[From NFPA 72G, 8-2.1.2]

6-9.1.3 The permanent textual visible appliance shall be a storage display that produces retrieved alphanumerics or retrieved pictorial images defined in accordance with 6-9.1. The retrieval time for the permanent textual visible appliance shall be not less than 1 year.

[From NFPA 72G, 8-2.2]

6-9.2 Location. All textual visible appliances in the private mode shall be located in rooms accessible only to those persons directly concerned with the implementation and direction of emergency action initiation and procedure in the areas protected by the fire alarm system.

[From NFPA 72G, 8-4.1]

Exception: In the lobby of a building where required by the authority having jurisdiction.

[From NFPA 72G, 8-4.1 Exception]

Chapter 7 Inspection, Testing, and Maintenance

7-1 General.

7-1.1 This chapter covers the requirements for the inspection, testing, and maintenance of the fire alarm systems described in Chapters 3 and 4 and for their initiation and notification components described in Chapters 5 and 6. The testing and maintenance requirements for household fire warning equipment are located in Chapter 2.

[New paragraph]

7-1.1.1 Inspection, testing, and maintenance programs shall satisfy the requirements of this code and the equipment manufacturer's instructions.

[From NFPA 72E, 8-1.2 modified]

7-1.1.2 Nothing in this chapter is intended to prevent the use of other test methods or testing devices, provided these other methods or devices are equivalent in effectiveness and safety and meet the intent of the requirements of this chapter.

[From NFPA 72, 1-3.2, and NFPA 72H, 1-1.3 modified]

7-1.2 The owner or his designated representative shall be responsible for inspection, testing, and maintenance of the system and alterations or additions to this system. Delegation of responsibility shall be in writing, with a copy of such delegation made available to the authority having jurisdiction.

[From NFPA 72E, 8-1.3, 8-1.3.1; and NFPA 72, 2-5.4 modified]

7-1.2.1 Inspection, testing, or maintenance shall be permitted to be done by a person or organization other than the owner when conducted under a written contract. Delegation of responsibility shall be in writing, with a copy of such delegation made available to the authority having jurisdiction.

[From NFPA 72, 2-5.4, and NFPA 1221, 2-1.11.2 modified]

7-1.2.2 Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include but are not limited to:

- (a) Factory trained and certified
- (b) National Institute for Certification in Engineering Technologies Fire Alarm certified
- (c) International Municipal Signaling Association Fire Alarm certified
- (d) Certified by state or local authority
- (e) Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.

[From NFPA 72, 2-5.4; NFPA 72E, 8-1.3.2 and A-8-1.3.2 modified]

7-1.3 Before proceeding with any testing, all persons and facilities who would receive an alarm, supervisory, or trouble signal, and building occupants, shall be notified to prevent unnecessary response. At the conclusion of testing, those previously notified (and others necessary) shall be further notified that testing has been concluded.

[From NFPA 71, 1-9.5(a), (h), (i); NFPA 72H, 2-2.1, 4-1; NFPA 72G, 9-1.3; and NFPA 72E, 8-1.4 modified]

7-1.3.1 The owner or his designated representative and service personnel shall coordinate system testing to prevent interruption of critical building systems or equipment.

[New paragraph]

7-1.4 Prior to system maintenance or testing, the system certificate and the information regarding the system and system alterations including specifications, wiring diagrams, and floor plans shall be made available by the owner or designated representative to the service personnel.

[From NFPA 72, 2-2.1 and 2-2.2 modified]

7-1.5 Special Hazards Systems and Equipment. Special hazards systems and equipment shall include but not be limited to preaction and deluge sprinkler systems, Halon systems, carbon dioxide systems, dry chemical systems, foam systems, and fire pump controllers.

7-1.5.1 Where a special hazards system has its own control unit that is connected to and monitored by a protected premises fire alarm system, testing shall be limited to the point of interface.

7-1.5.2 Where the special hazards system does not have its own control unit and the protected premises fire alarm system is used to provide complete control of the special

hazards equipment, testing shall include verification of the simulated release of the extinguishing agent or activation of the fire pump controls.

7-1.5.3 Only qualified service personnel familiar with the special hazards system and equipment used shall be permitted to perform the required tests.

7-1.6 System Reacceptance Testing. Reacceptance test shall be performed after system components are added or deleted; after any modification, repair, or adjustment to system hardware or wiring; or after any change to software. All components, circuits, system operations, or software functions known to be affected by the change or identified by a means that indicates the system operational changes shall be 100 percent tested. In addition, 10 percent of initiating devices that are not directly affected by the change, up to a maximum of 50 devices, shall also be tested and proper system operation verified.

7-2 Test Methods.

7-2.1* Central Stations. The installation shall be inspected at the request of the authority having jurisdiction for complete information regarding the system, including specifications, wiring diagrams, and floor plans having been submitted for approval prior to installation of equipment and wiring.

[From NFPA 71, 1-4.1(b)]

7-2.1.1 The installation shall be inspected to ensure all devices, combinations of devices, and equipment constructed and installed shall be approved for the purpose for which they are intended.

[From NFPA 71, 1-4.2]

7-2.2* Fire alarm systems and other systems and equipment that may be associated with fire alarm systems and accessory equipment shall be tested according to Table 7-2.2.

[From NFPA 72H, 4-1 modified]

7-3 Inspection and Testing Frequency.

7-3.1 Visual Inspection.

7-3.1.1 Visual inspection shall be performed in accordance with the schedules in this chapter or more frequently where required by the authority having jurisdiction. The visual inspection shall be made to ensure that there are no changes that would affect equipment performance, such as building modifications, occupancy hazards, and environmental effects.

Exception: Items in areas that are inaccessible for safety considerations due to continuous process operations, energized electrical equipment, etc., shall be inspected during each scheduled shutdown but not more than every 18 months.

7-3.1.2 Where automatic testing is performed at a frequency of not less than weekly by a remotely monitored fire alarm control unit specifically listed for this application, the visual inspection frequency shall be permitted to be extended to annually. (See Table 7-3.1.)

[From NFPA 72E, 8-3.2 modified]

Table 7-2.2 Test Methods

DEVICE	METHOD
1. Control Equipment:	
a. Functions	All functions of the system, including operation of the system in various alarm and trouble modes for which it is designed (e.g., open circuit, grounded circuits, power outage, etc.), shall be tested in accordance with the manufacturer's instructions. [From NFPA 72, 2-5.1, and NFPA 72H, 7-1.3 modified]
b. Fuses	Remove fuse and verify rating and supervision. [From NFPA 72H, 4-1]
c. Interfaced Equipment	Integrity of single or multiple circuits providing interface between two or more control panels shall be verified. Interfaced equipment connections shall be tested by operating or simulating operation of the equipment being supervised. Signals required to be transmitted shall be verified at the control panel. [New paragraphs]
d. Lamps and LEDs	Lamps and LEDs shall be illuminated.
e. Primary (Main) Power Supply	All secondary (standby) power shall be disconnected and tested under maximum load, including all alarm appliances requiring simultaneous operation. All secondary (standby) power shall be reconnected at end of test. For redundant power supplies, each shall be tested separately. [From NFPA 72H, 4-1]
2. Engine-Driven Generator	If an engine-driven generator dedicated to the fire alarm system is used as a required power source, operation of the generator shall be verified in accordance with NFPA 110, <i>Standard for Emergency and Standby Power Systems</i> , by the building owner. [From NFPA 72, 2-5.2.3 modified]
3. Secondary (Standby) Power Supply	Disconnect all primary (main) power supplies and verify that required trouble indication for loss of primary power occurs. Measure or verify system's standby and alarm current demand and, using manufacturer's data, verify whether batteries are adequate to meet standby and alarm requirements. Operate general alarm systems for a minimum of five minutes and emergency voice communication systems for a minimum of fifteen minutes. Reconnect primary (main) power supply at end of test. [From NFPA 72H, 4-1, and NFPA 72, 5-3.3]
4. Uninterrupted Power Supply (UPS)	If a UPS system dedicated to the fire alarm system is used as a required power source, verify the operation of the UPS system in accordance with NFPA 111, <i>Standard on Stored Electrical Energy Emergency and Standby Power Systems</i> , by the building owner. [From NFPA 71, 2-2.3.7 modified]
5. Batteries — General Tests:	
a. Visual Inspection	Inspect batteries for corrosion or leakage. Check and ensure tightness of connections. If necessary, clean and coat the battery terminals or connections. Visually inspect electrolyte level in lead acid batteries.
b. Battery Replacement	Batteries shall be replaced in accordance with the recommendations of the alarm equipment manufacturer, or when the recharged battery voltage or current falls below the manufacturer's recommendations.
c. Charger Test	Check operation of battery charger in accordance with charger test for the specific type of battery. [From NFPA 72H, 4-1 modified]
d. Discharge Test	With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. The voltage level shall not fall below the levels specified. [From NFPA 71, 2-2.3.7 modified] <i>Exception: An artificial load equal to the full fire alarm load connected to the battery shall be permitted to be utilized in conducting this test.</i> [New paragraph]

Table 7-2.2 Test Methods (cont.)

DEVICE	METHOD
e. Load Voltage Test	With the battery charger disconnected, measure the terminal voltage while supplying the maximum load required by its application. [From NFPA 71, 2-2.5.3, and NFPA 72H 4-1 modified] The voltage level shall not fall below the levels specified for the specific type of battery. If the voltage falls below the level specified, corrective action shall be taken and the batteries retested. [From NFPA 71, 2-2.5.3 modified] <i>Exception: An artificial load equal to the full fire alarm load connected to the battery shall be permitted to be utilized in conducting this test.</i>
f. Open Circuit Voltage	[New paragraph] With the battery charger disconnected, measure the open circuit voltage of the battery. [From NFPA 72H, 4-1 modified]
6. Battery Tests (Specific Types):	
a. Primary Batteries:	
1. Load Voltage Test*	The maximum load for a No. 6 primary battery shall not be more than 2 amperes per cell. An individual (1.5-volt) cell shall be replaced when a load of 1 ohm reduces the voltage below 1 volt. A 6-volt assembly shall be replaced where a test load of 4 ohms reduces the voltage below 4 volts. [From NFPA 71, A-2-2.5]
b. Lead-Acid Type:	
1. Charger Test	With the batteries fully charged and connected to the charger, measure the voltage across the batteries with a voltmeter. The voltage shall be 2.30 volts per cell $\pm$.02 volts (at 25°C) or as specified by the equipment manufacturer. [New paragraph]
2. Load Voltage Test*	Under load, the battery shall not fall below 2.05 volts per cell. [From NFPA 71, 2-2.3.7 modified]
3. Specific Gravity	The specific gravity of the liquid in the pilot cell or all of the cells shall be measured as required. The specific gravity shall be within the range specified by the manufacturer. Although the specified specific gravity may vary from manufacturer to manufacturer, a range of 1.205 – 1.220 is typical for regular lead acid batteries, while 1.240 – 1.260 is typical for high performance batteries. A hydrometer that only shows a pass or fail condition of the battery and does not indicate the specific gravity shall not be used since such a reading does not give a true indication of the battery condition.
c. Nickel-Cadmium Type:	
1. Charger Test	With the batteries fully charged and connected to the charger, place an amp meter in series with the battery under charge. The charging current shall be in accordance with the manufacturer's recommendations for the type of battery used. In the absence of specific information, this usually is 1/30 to 1/25 of the battery rating. (Example: 4000mAh $\times$ 1/25 = 160ma charging current at 25°C.) [New paragraphs]
2. Load Voltage Test*	Under load, the float voltage for the entire battery shall be 1.42 volts per cell nominal. If possible, cells shall be measured individually. [From NFPA 1221, 2-1.10.2.2, 3-1.5.3.2, and 4-1.6.2.3 modified]
d. Sealed Lead-Acid Type:	
1. Charger Test	With the batteries fully charged and connected to the charger, measure the voltage across the batteries with a voltmeter. The voltage should be 2.30 volts per cell $\pm$.02 volts (at 25°C) or as specified by the equipment manufacturer. [New paragraph]
2. Load Voltage Test*	Under load, the float voltage shall not fall below 2.05 volts per cell. [From NFPA 71, 2-2.3.7; NFPA 1221, 2-1.10.2.2 and 3-1.5.3.2 modified]
7. Public Reporting System Tests	In addition to the tests and inspection required above, the following requirements shall apply. Manual tests of the power supply for public reporting circuits shall be made and recorded at least once during each 24-hour period. Such tests shall include: (a) Current strength of each circuit. Changes in current of any circuit, amounting to 10 percent of normal current, shall be investigated immediately.

Table 7-2.2 Test Methods (cont.)

DEVICE	METHOD
	(b) Voltage across terminals of each circuit, inside of terminals of protective devices. Changes in voltage of any circuit, amounting to 10 percent of normal voltage, shall be investigated immediately. (c) Voltage between ground and circuits. Where this test shows a reading in excess of 50 percent of that shown in test (b) above, the trouble shall be immediately located and cleared; readings in excess of 25 percent shall be given early attention. These readings shall be taken with a voltmeter of not more than 100-ohms resistance per volt. NOTE 1: The voltmeter sensitivity has been changed from 1000 ohms per volt to 100 ohms per volt so that false ground readings (caused by induced voltages) will be minimized. NOTE 2: Systems in which each circuit is supplied by an independent current source (Forms 3 and 4) will require tests between ground and each side of each circuit. Common current source systems (Form 2) will require voltage tests between ground and each terminal of each battery and other current source. (d) A ground current reading shall be acceptable in lieu of (c) above. When this method of testing is used, all grounds showing a current reading in excess of 5 percent of the normal line current shall given immediate attention. (e) Voltage across terminals of common battery, on switchboard side of fuses. (f) Voltage between common battery terminals and ground. Abnormal ground readings shall be investigated immediately. NOTE: Tests (e) and (f) apply only to those systems using a common battery. If more than one common battery is used, each common battery is to be tested.
8. Transient Suppressors	Lightning protection equipment shall be inspected and maintained per manufacturer's specifications. Additional inspections shall be required after any lightning strikes. Equipment located in moderate to severe areas outlined in NFPA 780, <i>Lightning Protection Code</i>, Appendix I, shall be inspected semi-annually and after any lightning strikes.
9. Control Panel Trouble Signals:	
a. Audible and Visual	Verify operation of panel trouble signals and ring back feature for systems using a trouble silencing switch that requires resetting.
b. Disconnect Switches	When control unit (panel) has disconnect or isolating switches, verify that each switch performs its intended function and a trouble signal is received when a supervised function is disconnected.
c. Ground-Fault Monitoring Circuit	When system has ground detection feature, verify that a ground fault indication is given whenever any installation conductor is grounded.
d. Transmission of Signals to Off-Premises Location	Actuate an appropriate initiating device and verify that alarm signal is received at the off-premises location. Create a trouble condition and verify that a trouble signal is received at the off-premises location. [New paragraphs] Actuate a supervisory device and verify that a supervisory signal is received at the off-premises location. If transmission carrier is capable of operation under a single or multiple fault condition, activate an initiating device during such fault condition and verify that a trouble signal is received at the off-premises location in addition to the alarm signal.
10. Remote Annunciators	Verify for proper operation and confirm proper identification. Where provided, verify proper operation under a fault condition.
11. Conductors/Metallic:	
a. Stray Voltage	All installation conductors shall be tested with a volt/ohm meter to verify that there are no stray (unwanted) voltages between installation conductors or between installation conductors and ground. Unless a different threshold is specified in the system manufacturer's documentation, the maximum allowable stray voltage shall not exceed 1 volt ac/dc. [From NFPA 72H, 2-2.2]
b. Ground Faults	All installation conductors other than those intentionally and permanently grounded shall be tested for isolation from ground per the manufacturer's recommendations. [From NFPA 72H, 2-2.3]

Table 7-2.2 Test Methods (cont.)

DEVICE	METHOD
c. Short Circuit Faults	All installation conductors other than those intentionally connected together shall be tested for conductor-to-conductor isolation per the manufacturer's recommendations. These same circuits shall be tested conductor-to-ground, also. [From NFPA 72H, 2-2.4]
d. Loop Resistance	With each initiating and indicating circuit installation conductor pair short-circuited at the far end, measure and record the resistance of each circuit. Verify that the loop resistance does not exceed the manufacturer's specified limits. [From NFPA 72H, 2-2.5]
12. Conductors/Non-Metallic:	
a. Circuits' Integrity	Test each initiating device, indicating appliance, and signaling line circuit to confirm that the integrity of installation conductors are being properly supervised.
b. Fiber Optics	The fiber optic transmission line shall be tested in accordance with the manufacturer's instructions or by the use of an optical power meter, or an optical time domain reflectometer to measure the relative power lost of the line. This relative figure for each fiber optic line shall be recorded in the fire alarm control panel. If the power level drops 2 percent or more from the figure recorded during the initial acceptance test, the transmission line, section thereof, or connectors shall be repaired and/or replaced by a qualified technician to bring the line back into compliance with an accepted transmission level per manufacturer's recommendations.
c. Supervision	Introduction of a fault in any supervised circuit shall result in a suitable trouble indication at the control unit. One connection shall be opened at no less than 10 percent of the initiating device, indicating appliance, and signaling line circuits. [From NFPA 72H, 2-3.2 modified] Test each initiating device, indicating appliance, and signaling line circuit for proper alarm response. [From NFPA 72H, 2-3.2]
13. Initiating Devices:	
a. Electromechanical Releasing Device:	
1. Nonrestorable-Type Link	NOTE: See Table 3-6.1 for description of circuit performance and capacity. Remove the fusible link and operate the associated device to ensure proper operation. Lubricate any moving parts as necessary.
2. Restorable-Type Link	Remove the fusible link and operate the associated device to ensure proper operation. Lubricate any moving parts as necessary. [New paragraphs] NOTE: Fusible thermal link detectors are commonly used to close fire doors and fire dampers. They can be actuated by the presence of external heat, which causes a solder element in the link to fuse, and by an electric thermal device which, when energized, generates heat within the body of the link, causing the link to fuse and separate.
b. Extinguishing System Alarm Switch	Mechanically or electrically operate the switch and verify receipt of signal by the control panel. [From NFPA 72H, 4-1]
c. Fire-Gas and Other Detectors	Fire-gas detectors and other fire detectors shall be tested as prescribed by the manufacturer and as necessary for the application. [From NFPA 72E, 8-3.6]
d. Heat Detectors:	
1. Fixed-Temperature and/or Rate-of-Rise or Rate-of-Compensation, Restorable Line or Spot Type (Except Pneumatic Tube)	Heat test with a heat source per manufacturer's recommendations for response within 1 minute. Precaution should be taken to avoid damage to the nonrestorable fixed-temperature element of a combination rate-of-rise/fixed-temperature element.
2. Fixed-Temperature, Non-restorable Line Type	Do not heat test. Test mechanically and electrically for function. Measure and record loop resistance. Investigate changes from acceptance test.
3. Fixed-Temperature, Non-restorable Spot Type	After 15 years, replace all devices or laboratory test two detectors per 100. Replace the two detectors with new devices. If a failure occurs on any of the detectors removed, additional detectors shall be removed and tested to determine either a general problem involving faulty detectors or a localized problem involving one or two defective detectors. [From NFPA 72E, 8-3.3.1 modified]
4. Nonrestorable (General)	Do not heat test. Test mechanically and electrically for function.
5. Restorable Line Type, Pneumatic Tube Only	Heat source (where test chambers are in circuit) or pressure pump. [From NFPA 72H, 4-1, and NFPA 72E, 8-2.3]

Table 7-2.2 Test Methods (cont.)

DEVICE	METHOD
e. Fire Alarm Boxes	Operate per manufacturer's instruction. For key operated pre-signal fire alarm boxes, test both pre-signal and general alarm circuit.
f. Radiant Energy Fire Detectors	Flame detectors and spark/ember detectors shall be tested in accordance with the manufacturer's instructions to determine that each detector is operative. [From NFPA 72E, 8-3.5.1] Flame detector and spark/ember detector sensitivity shall be determined using either: (a) A calibrated test method, or (b) The manufacturer's calibrated sensitivity test instrument, or (c) Listed control panel arranged for the purpose, or (d) Other calibrated sensitivity test method acceptable to the authority having jurisdiction that is directly proportional to the input signal from a fire consistent with the detector listing or approval. Detectors found to be outside of the approved range of sensitivity shall be replaced or adjusted to bring them into the approved range if designed to be field adjustable. Flame detector and spark/ember detector sensitivity shall not be determined using a light source that administers an unmeasured quantity of radiation at an undefined distance from the detector. [From NFPA 72E, 8-3.5.2]
g. Smoke Detectors:	
1. All Types	The detectors shall be tested in place to ensure smoke entry into the sensing chamber and an alarm response. Testing with smoke or listed aerosol acceptable to the manufacturer, or other means acceptable to the detector manufacturer shall be permitted as one acceptable test method. [From NFPA 72E, 8-2.4.1.1] Ensure that each smoke detector is within its listed and marked sensitivity range by testing using either: (a) A calibrated test method, or (b) The manufacturer's calibrated sensitivity test instrument, or (c) Listed control equipment arranged for the purpose, or (d) Other calibrated sensitivity test method acceptable to the authority having jurisdiction. NOTE: The detector sensitivity cannot be tested or measured using any spray device that administers an unmeasured concentration of aerosol into the detector. [From NFPA 72E, 8-2.4.2]
2. Air Sampling:	
Wilson Cloud Chamber	Per manufacturer's recommended test methods, including verification of sampling from each method.
Photoelectric-Type	Verify detector alarm response through the end sampling port on each pipe run, as well as verifying air flow through all other ports.
3. Duct-Type	Air duct detectors shall be tested or inspected to ensure that the device will sample the air stream. The test shall be made in accordance with the manufacturer's instructions. [From NFPA 72E, 8-3.4.3 modified]
4. Projected Beam-Type	The detector shall be tested by introducing smoke, other aerosol, or an optical filter into the beam path. [From NFPA 72E, 8-2.4.1.2]
5. Smoke Detector with Built-in Thermal Element	Operate both portions of the detector independently as described for the respective devices. [New paragraph]
6. Smoke Detectors with Control Output Functions	When individual fire detectors are used to control the operation of equipment as permitted by 3-7.1, the control capability shall remain operable even if all of the initiating devices connected to the same initiating circuit are in an alarm state.
h. Initiating Devices, Supervisory:	
1. Control Valve Switch	Operate valve and verify signal receipt within the first two revolutions of the hand wheel or within one-fifth of the travel distance, or manufacturer's specifications.
2. High or Low Air Pressure Switch	Operate switch and verify that receipt of signal is obtained where the required pressure is increased or decreased 10 psi from the required pressure level. [From NFPA 71, 3-4.4.3 modified]

Table 7-2.2 Test Methods (cont.)

DEVICE	METHOD
3. Room Temperature Switch	Operate switch and verify receipt of signal to indicate the decrease in room temperature to 40°F (4.4°C) and its restoration to above 40°F (4.4°C). [From NFPA 71, 3-4.4.7 modified]
4. Water Level Switch	Operate switch and verify the receipt of signal indicating the water level raised or lowered 3 in. (76.2 mm) from the required level within a pressure tank, or 12 in. (305 mm) from the required level of a nonpressure tank, and its restoration to required level. [From NFPA 71, 3-4.4.4 modified]
5. Water Temperature Switch	Operate switch and verify receipt of signal to indicate the decrease in water temperature to 40°F (4.4°C) and its restoration to above 40°F (4.4°C). [From NFPA 71, 3-4.4.7 modified]
i. Waterflow Device:	
1. Mechanical, Electrosonic, or Pressure Type	Flow water through an inspector's test connection indicating the flow of water equal to that from a single sprinkler of the smallest orifice size installed in the system for wet-pipe systems, or an alarm test bypass connection for dry-pipe, pre-action, or deluge systems in accordance with NFPA 25, <i>Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems</i> . [From NFPA 71, 1-9.5 and 3-4.2.1; NFPA 72, 2-5.3 and 3-4.1.2 modified]
14. Alarm Notification Appliances:	
a. Audible	Measure sound pressure level with sound level meter meeting ANSI S-1.4a, <i>Sound Level Meters</i> , Type 2 requirements. Measure and record levels throughout protected area. [From NFPA 72G, 9-2.1 modified]
b. Speakers	Measure sound pressure level with sound level meter meeting ANSI S-1.4a, <i>Sound Level Meters</i> , Type 2 requirements. Measure and record levels throughout protected area. [From NFPA 72G, 9-1.2 modified] Verify voice clarity. [From NFPA 72H, 4-1]
c. Visible	Test in accordance with manufacturer's instructions. Verify device locations are per approved layout and confirm that no floor plan changes affect the approved layout. [From NFPA 72G, 9-2.2 modified]
15. Special Hazard Equipment:	
a. Abort Switch (IRI-Type)	Operate abort switch. Verify correct sequence and operation.
b. Abort Switch (Recycle-Type)	Operate abort switch. Verify correct matrix develops with each sensor operated.
c. Abort Switch (Special-Type)	Operate abort switch. Verify correct sequence and operation in accordance with authority having jurisdiction. Note sequence on as-built drawings or in owner's manual.
d. Cross Zone Detection Circuit	Operate one sensor or detector on each zone. Verify that correct sequence occurs with operation of first zone and then with operation of second zone.
e. Matrix Type Circuit	Operate all sensors in system. Verify correct matrix develops with each sensor operated.
f. Release Solenoid Circuit	Use solenoid with equal current requirements. Verify operation of solenoid.
g. Squibb Release Circuit	Use AGI flashbulb or other test light acceptable to the manufacturer. Verify operation of flashbulb or light.
h. Verified, Sequential, or Counting Zone Circuit	Operate required sensors at a minimum of four locations in circuit. Verify correct sequence with both the first and second detector in alarm.
i. All Above Devices and/or Circuits	Verify supervision of circuits by creating an open circuit. Note specific trouble indications.
16. Transmission and Receiving Equipment, Off Premises:	
a. All Equipment	Verify all system functions and features in accordance with manufacturer's instructions. Remove primary power, actuate an initiating device, and verify that the initiating device signal is received at the monitoring station. On completion of test, restore system to normal. Where test jacks are used, the first and last tests shall be made without the use of the test jack.
b. Transmitters—Digital Alarm Communicator Systems (DACS)	Verify that the failure of the primary transmission path at the protected premises shall result in a trouble signal being transmitted via the secondary path to the monitoring station within 4 minutes of the detection of the fault.

Table 7-2.2 Test Methods (cont.)

DEVICE	METHOD
1. DACT	See 7-4.4.1. Verify the DACT is connected to two separate lines (numbers) at the protected premises. In turn, disconnect each telephone line at the protected premises and verify local annunciation and that trouble signals are transmitted to the monitoring station over the other line (number). <i>Transmission shall be initiated within 4 minutes of the detection of the fault.</i>
2. DACR	Verify that the DACR equipment is connected to a minimum of two separate incoming telephone lines (numbers). Verify that if the lines (numbers) are in a single hunt group, they are individually accessible. Use 7-4.4.2(b). Use 7-4.4.2(c). Use 7-4.4.2(d).
3. DARR	Verify supervision of the following conditions at the monitoring station: (a) Failure of ac power supplying the radio equipment (b) Receiver malfunction (c) Antenna and interconnecting cable malfunction (d) Indication of automatic switchover of the DARR (e) Data transmission line between the DARR and the monitoring station.
4. McCulloh Systems	Verify that signals are received during one of the following signaling line fault conditions: (a) Open (b) Ground (c) Wire-to-wire short (d) Open and ground.
17. Emergency Communication Equipment:	
a. Amplifier/Tone Generators	Verification of proper switching and operation of backup equipment.
b. Call-in Signal Silence	Operate function and verify receipt of proper visual and audible signals at control panel.
c. Off-hook Indicator (Ring Down)	Install phone set or remove phone from hook and verify receipt of signal at control panel.
d. Phone Jacks	Visual inspection and initiate communication path through jack.
e. Phone Set	Activate each phone set and verify proper operation.
f. System Performance	Operate system with a minimum of any five handsets simultaneously. Verify acceptable voice quality and clarity. [New paragraphs]
18. Interface Equipment	Interface equipment connections shall be tested by operating or simulating the equipment being supervised. Signals required to be transmitted shall be verified at the control panel. <i>Test frequency for interface equipment shall be the same as the frequency required by the applicable NFPA standard(s) for the equipment being supervised.</i>
19. Guard's Tour Equipment	Test the device in accordance with manufacturer's specifications.
20. Special Procedures:	
a. Alarm Verification	Verify time delay and alarm response for smoke detector circuits identified as having alarm verification. [From NFPA 72H, 5-1.1 modified]
b. Multiplex Systems	Verify communication between sending and receiving units under both normal and standby power. [From NFPA 72H, 6-1.1 modified] Verify communication between sending and receiving units under open circuit and short-circuit trouble conditions. [From NFPA 72H, 6-1.2 modified] Verify communication between sending and receiving units in all directions when multiple communication pathways are provided. [From NFPA 72H, 6-1.6 modified] When redundant central control equipment is provided, verify switchover and all required functions and operations of secondary control equipment. [From NFPA 72H, 6-1.6.2 modified] Verify all system functions and features in accordance with manufacturer's instructions. [From NFPA 72H, 6-1.7 modified]

Table 7-3.1 Visual Inspection Frequencies

		Init./Reacct.	Monthly	Quarterly	Semiann.	Ann.
1.	Alarm Indicating Appliances — Supervised	X			X	
2.	Batteries					
	a. Lead-Acid	X	X			
	b. Nickel-Cadmium	X			X	
	c. Primary (Dry Cell)	X	X			
	d. Sealed Lead-Acid	X			X	
3.	Control Equipment: Fire Alarm Systems Monitored for Alarm, Supervisory, Trouble Signals					
	a. Fuses	X				X
	b. Interfaced Equipment	X				X
	c. Lamps and LEDs	X				X
	d. Primary (Main) Power Supply	X				X
4.	Control Equipment: Fire Alarm Systems Unmonitored for Alarm, Supervisory, Trouble Signals					
	a. Fuses	X				X
	b. Interfaced Equipment	X				X
	c. Lamps and LEDs	X				X
	d. Primary (Main) Power Supply	X				X
5.	Control Panel Trouble Signals	X			X	
6.	Emergency Voice/Alarm Communications Equipment	X			X	
7.	Fiber Optic Cable Connections	X				X
8.	Guard's Tour Equipment	X			X	
9.	Initiating Devices					
	a. Air Sampling	X			X	
	b. Duct Detectors	X			X	
	c. Electromechanical Releasing Device	X			X	
	d. Extinguishing System Switches	X			X	
	e. Fire Alarm Boxes	X			X	
	f. Heat Detectors	X			X	
	g. Radiant Energy Fire Detectors	X			X	
	h. Smoke Detectors	X			X	
	i. Supervisory Signal Devices	X		X		
	j. Waterflow Devices	X		X		
10.	Interface Equipment	X			X	
11.	Remote Annunciators	X			X	
12.	Special Procedures	X			X	
13.	Transient Suppressors	X			X	
14.	Transmission and Receiving Equipment — Off Premises					
	a. All Equipment	X			X	
	b. DACT — Telephone Line	X			X	
	c. DACR — Telephone Line	X	X			
	d. DACR — Signal Receipt	X (DAILY)				

7-3.2* Testing. Testing shall be performed in accordance with the schedules in this chapter or more frequently where required by the authority having jurisdiction. Where automatic testing is performed at least weekly by a remotely monitored fire alarm control unit specifically listed for the application, the manual testing frequency shall be permitted to be extended to annually. (See Table 7-3.2.)

[From NFPA 72H, 4-1 modified]

Exception: Devices in areas that are inaccessible for safety considerations, such as continuous process operations, shall be tested during scheduled shutdowns at intervals approved by the authority having jurisdiction.

[New]

7-3.2.1* Detector sensitivity shall be checked within 1 year after installation and every alternate year thereafter. After the second required calibration test, if sensitivity tests indicate that the detector has remained within its listed and marked sensitivity range, the length of time between calibration tests shall be permitted to be extended not to exceed 5 years. If the frequency is extended, records of detector-caused unwanted alarms and subsequent trends of these alarms shall be maintained. In zone or in areas where unwanted alarms show any increase over the previous year, calibration tests shall be performed.

To ensure that each smoke detector is within its listed and marked sensitivity range, it shall be tested using either:

- (a) A calibrated test method, or
- (b) The manufacturer's calibrated sensitivity test instrument, or
- (c) Listed control equipment arranged for the purpose, or
- (d) A smoke detector/control unit arrangement whereby the detector causes a signal at the control unit where its sensitivity is outside its acceptable sensitivity range, or
- (e) Other calibrated sensitivity test method acceptable to the authority having jurisdiction.

Detectors found to have a sensitivity outside the listed and marked sensitivity range shall be cleaned and recalibrated or replaced.

Exception: Detectors listed as field adjustable may be either adjusted within the listed and marked sensitivity range, cleaned, and recalibrated, or replaced.

The detector sensitivity shall not be tested or measured using any device that administers an unmeasured concentration of smoke or other aerosol into the detector.

7-3.2.2 Test frequency of interfaced equipment shall be the same as specified by the applicable NFPA standards for the equipment being supervised.

7-3.3 Single-station smoke detectors shall be inspected, tested, and maintained as specified by Chapter 2.

[New]

7-3.4 Test of all circuits extending from the central station shall be made at intervals of not more than 24 hours.

7-4 Maintenance.

[From NFPA 72H, 4-1]

7-4.1 Fire alarm system equipment shall be periodically maintained in accordance with manufacturer's instructions. The frequency of maintenance will depend on the type of equipment and the local ambient conditions.

7-4.2 Any accumulation of dust and dirt may adversely effect device and appliance performance. The frequency of cleaning will depend on the type of equipment and the local ambient conditions.

[From NFPA 72E, 8-4.1, and NFPA 72G, 9-4.1 modified]

7-4.3 All apparatus requiring rewinding or resetting to maintain normal operation shall be restored to normal as promptly as possible after each test and alarm and kept in normal condition for operation. All test signals received shall be recorded to indicate date, time, and type.

[From NFPA 71, 1-5.4]

7-4.4 The retransmission means as defined in Section 4-3 shall be tested at intervals of not more than 12 hours. The retransmission signal and the time and date of the retransmission shall be recorded in the central station.

Exception: Where the retransmission means is the public switched telephone network, it need only be tested weekly to confirm its operation to each public fire service communications center.

[From NFPA 71, 1-7.2.4]

7-4.4.1 Digital Alarm Communicator Transmitter (DACT).

[New]

(a) Verify the DACT is capable of seizing the telephone line (going off-hook) at the protected premises, disconnecting an outgoing or incoming telephone call, and preventing its use for outgoing calls until signal transmission is completed.

[From NFPA 71, 5-1]

(b) Verify the DACT has the means to satisfactorily obtain an available dial tone, dial the number(s) of the DACR, obtain verification that the DACR is ready to receive signals, transmit the signal, and receive acknowledgment that the DACR has accepted the signal. In no event shall the time from going off-hook to on-hook exceed 90 seconds per attempt.

(c) Verify the DACT has a suitable means to reset and retry if the first attempt to complete a signal transmission sequence is unsuccessful. A failure to complete connection shall not prevent subsequent attempts to transmit an alarm if such alarm is generated from any other initiating device circuit. Additional attempts shall be made until the signal transmission sequence has been completed to a minimum of five and a maximum of ten attempts.

(d) If the maximum number of attempts to complete the sequence is reached, an indication of the failure shall be made at the premises.

(e) Verify the DACT is connected to two separate lines (numbers) at the protected premise by disconnecting the primary phone line of the DACT. The DACT trouble signal shall be transmitted within the time specified in accordance with 7-4.4.1(a). Operate an initiating device to test the secondary transmission of the DACT. The DACT shall be capable of selecting the operable line (number) in the event of failure in either (line number).

(f) Failure of either of the telephone lines (numbers) at the protected premises shall be annunciated at the protected premises, and a trouble signal shall be transmitted to the central station over the other line (number). Transmission shall be initiated within 4 minutes of the detection of the fault.

[New paragraphs]

Table 7-3.2 Testing Frequencies

	Init./Reaccpt.	Monthly	Quarterly	Semiann.	Ann.	Table 7-2.2 Reference
1. Alarm Notification Appliances						14
a. Audible Devices	X				X	
b. Speakers	X				X	
c. Visible Devices	X				X	
2. Batteries — Central Station Facilities						
a. Lead-Acid Type						6b
1. Charger Test (Replace battery as needed.)	X				X	
2. Discharge Test (30 min.)	X	X				
3. Load Voltage Test	X	X				
4. Specific Gravity	X			X		
b. Nickel-Cadmium Type						6c
1. Charger Test (Replace battery as needed.)	X		X			
2. Discharge Test (30 min.)	X				X	
3. Load Voltage Test	X				X	
c. Sealed Lead-Acid Type	X	X				6d
1. Charger Test (Replace battery as needed.)	X	X	X			
2. Discharge Test (30 min.)	X	X				
3. Load Voltage Test	X	X				
3. Batteries — Fire Alarm Systems						
a. Lead-Acid Type						6b
1. Charger Test (Replace battery as needed.)	X				X	
2. Discharge Test (30 min.)	X			X		
3. Load Voltage Test	X			X		
4. Specific Gravity	X			X		
b. Nickel-Cadmium Type						6c
1. Charger Test (Replace battery as needed.)	X				X	
2. Discharge Test (30 min.)	X				X	
3. Load Voltage Test	X			X		
c. Primary Type (Dry Cell)						6a
1. Load Voltage Test	X	X				
d. Sealed Lead-Acid Type						6d
1. Charger Test (Replace battery every 4 years.)	X				X	
2. Discharge Test (30 min.)	X				X	
3. Load Voltage Test	X			X		
4. Batteries — Public Fire Alarm Reporting Systems	X (DAILY)					
Voltage tests in accordance with Table 7-2.2, Public Reporting System Tests, paragraphs (a) - (f).						
a. Lead-Acid Type						6b
1. Charger Test (Replace battery as needed.)	X				X	
2. Discharge Test (2 hours)	X		X			
3. Load Voltage Test	X		X			
4. Specific Gravity	X			X		
b. Nickel-Cadmium Type						6c
1. Charger Test (Replace battery as needed.)	X				X	
2. Discharge Test (2 hours)	X				X	
3. Load Voltage Test	X		X			
c. Sealed Lead-Acid Type						6d
1. Charger Test (Replace battery as needed.)	X				X	
2. Discharge Test (2 hours)	X				X	
3. Load Voltage Test	X		X			
5. Conductors/Metallic	X					11
6. Conductors/Nonmetallic	X					12

Table 7-3.2 Testing Frequencies (cont.)

	Init./Reacctp.	Monthly	Quarterly	Semiann.	Ann.	Table 7-2.2 Reference
7. Control Equipment: Fire Alarm Systems Monitored for Alarm, Supervisory, Trouble Signals						1, 7 and 16
a. Functions	X				X	
b. Fuses	X				X	
c. Interfaced Equipment	X				X	
d. Lamps and LEDs	X				X	
e. Primary (Main) Power Supply	X				X	
f. Transponders	X				X	
8. Control Equipment: Fire Alarm Systems Unmonitored for Alarm, Supervisory, Trouble Signals						1
a. Functions	X		X			
b. Fuses	X		X			
c. Interfaced Equipment	X		X			
d. Lamps and LEDs	X		X			
e. Primary (Main) Power Supply	X		X			
f. Transponders	X		X			
9. Control Unit Trouble Signals	X				X	9
10. Emergency Voice/Alarm Communications Equipment	X				X	17
11. Engine-Driven Generator	X (WEEKLY)					
12. Fiber Optic Cable Power	X				X	19
13. Guard's Tour Equipment	X				X	
14. Initiating Devices						13
a. Duct Detectors	X				X	
b. Electromechanical Releasing Device	X				X	
c. Extinguishing System Switches	X				X	
d. Fire-Gas and Other Detectors	X				X	
e. Heat Detectors	X				X	
f. Fire Alarm Boxes	X				X	
g. Radiant Energy Fire Detectors	X				X	
h. Smoke Detectors - Functional	X				X	
i. Smoke Detectors - Sensitivity (See 7-3.2.1.)						
j. Supervisory Signal Devices	X		X			
k. Waterflow Devices	X		X			
15. Interface Equipment	X				X	18
16. Off-Premises Transmission Equipment	X		X			
17. Remote Annunciators	X				X	10
18. Retransmission Equipment	X (See 7-3.4.)					
19. Special Hazard Equipment	X				X	15
20. Special Procedures	X				X	20
21. System and Receiving Equipment -- Off-Premises						16
a. Operational						
1. Functional -- All	X				X	
2. Transmitters -- WF & Supervisory	X		X			
3. Transmitters -- All Others	X				X	
4. Receivers	X	X				
b. Standby Loading -- All Receivers	X	X				
c. Standby Power						
1. Receivers -- All	X	X				
2. Transmitters -- All	X				X	
d. Telephone Line -- All Receivers	X	X				
e. Telephone Line -- All Transmitters	X				X	

NOTE: For testing addressable and analog described devices, which are normally affixed to either a single molded assembly or twist lock type affixed to a base, TESTING SHALL BE DONE UTILIZING THE SIGNALING STYLE CIRCUITS (Styles 0.5 through 7). The addressable term was determined by the Technical Committee in Formal Interpretation 79-8 on NFPA 72D and Formal Interpretation 87-1 on NFPA 72A. Analog type detectors shall be tested with the same criteria.

[From NFPA 72H, 4-1 modified]

7-4.4.2 Digital Alarm Communicator Receiver (DACR).

(a) Verify that at least two separate incoming telephone lines are in a hunt group and are individually accessible. These lines shall be used for no other purpose than receiving signals from DACTs. These lines (numbers) shall be unlisted.

(b) The failure of any telephone line (number) connected to the DACR due to loss of line voltage shall be annunciated visually and audibly in the central station.

(c) The loading capacity for hunt group shall be in accordance to Table 4-2.3.2.2.2.3 or be capable of demonstrating a 90 percent probability of immediately answering the incoming call.

(d) Verify a signal is received on each individual incoming DARC line at least once every 24 hours.

(e) The verification of the 24-hour DARC line test should be done early enough in the day to allow repairs to be made by the telephone company.

7-4.4.3 Digital Alarm Radio System (DARS).

(a) When DARS is used, verify that when any DACT signal transmission is unsuccessful, the information is transmitted by means of the DART. The DACT shall continue its normal transmission as required.

(b) The failure of the telephone line at the protected premises shall result in a trouble signal being transmitted to the central station by means of the DART within 4 minutes of the detection of the fault.

(c) Each DART shall automatically initiate and complete a test transmission sequence to its associated DARR at least once every 24 hours. A successful DART signal transmission sequence of any other type shall be considered sufficient to fulfill the requirement to test integrity of the reporting system, if signal processing is automated so that 24-hour delinquencies must be acknowledged by central station personnel.

[From NFPA 71, 5-5]

7-4.4.3.1 Digital Alarm Radio Receiver (DARR).

Verify supervision in the central station of the following conditions:

- (a) Failure of ac power supplying the radio equipment
- (b) Receiver malfunction
- (c) Antenna and interconnecting cable malfunction
- (d) Indication of automatic switchover of the DARR
- (e) Data transmission line between the DARR and the central station.

[From NFPA 71, 5-7]

7-4.4.3.2 McCulloh Systems.

Verify that when end-to-end metallic continuity is present, proper signals shall be received from other points under one of the following signaling line fault conditions at one point in the line:

- (a) Open
- (b) Ground
- (c) Wire-to-wire short
- (d) Open group.

[From NFPA 71, 6-1]

7-5 Records.

[From NFPA 71, 1-10 modified]

7-5.1 Record of Inspection. A permanent record of all inspections, testing, and maintenance shall be provided, which includes the following information of periodic tests and all the applicable information requested in Figure 7-5.1.

- (a) Date
- (b) Test frequency
- (c) Name of property
- (d) Address
- (e) Name of person performing inspection, maintenance, and/or tests, affiliation, business address, and telephone number
- (f) Approving agency's(ies) name, address, and representative
- (g) Designation of the detector(s) tested ("Tests performed in accordance with Section _____.")
- (h) Functional test of detectors
 - (i) Check of all smoke detectors
 - (j) Loop resistance for all fixed temperature line type heat detectors
 - (k) Other tests as required by equipment manufacturers
 - (l) Other tests as required by the authority having jurisdiction
- (m) Signatures of tester and approved authority representative.

[New paragraphs]

7-5.2 Permanent Records. After successful completion of acceptance tests satisfactory to the authority having jurisdiction, a set of reproducible as-built installation drawings, operation and maintenance manuals, and a written sequence of operation shall be provided to the building owner or his designated representative. In addition, inspection, testing, and maintenance reports shall be provided for the owner or a designated representative. It shall be the responsibility of the owner to maintain these records for the life of system and to keep them available for examination by any authority having jurisdiction. Paper or electronic media shall be acceptable.

[From NFPA 72, 10-2.4, and NFPA 72H, 2-1 modified]

7-5.3 Where off-premise monitoring is provided, records of signals, tests, and operations recorded at the monitoring center shall be maintained for not less than 12 months. Upon request, a hardcopy record shall be available for examination by the authority having jurisdiction. Paper or electronic media shall be acceptable.

[From NFPA 71, 1-4.5 modified]

7-5.4 Where the operation of a device, circuit, control panel function, or special hazard system interface is simulated, it shall be noted on the certificate that the operation was simulated and who it was simulated by.

[New paragraph]

INSPECTION AND TESTING FORM

DATE: _____

TIME: _____

SERVICE ORGANIZATION

NAME: _____

ADDRESS: _____

REPRESENTATIVE: _____

LICENSE NO.: _____

TELEPHONE: _____

MONITORING ENTITY

CONTACT: _____

TELEPHONE: _____

MONITORING ACCOUNT REF. NO.: _____

TYPE TRANSMISSION

- ☐ - McCulloh
☐ - Multiplex
☐ - Digital
☐ - Reverse Priority
☐ - RF
☐ - Other (Specify) _____

PROPERTY NAME (USER)

NAME: _____

ADDRESS: _____

OWNER CONTRACT: _____

TELEPHONE: _____

APPROVING AGENCY

CONTACT: _____

TELEPHONE: _____

SERVICE

- ☐ - Weekly
☐ - Monthly
☐ - Quarterly
☐ - Semi-Annually
☐ - Annually
☐ - Other (Specify) _____

PANEL MANUFACTURE: _____

MODEL NO.: _____

CIRCUIT STYLES: _____

NO. OF CIRCUITS: _____

SOFTWARE REV.: _____

LAST DATE SYSTEM HAD ANY SERVICE PERFORMED: _____

LAST DATE THAT ANY SOFTWARE OR CONFIGURATION WAS REVISED: _____

ALARM INITIATING DEVICES AND CIRCUIT INFORMATION**QTY OF****CIRCUIT STYLE**

MANUAL STATIONS
ION DETECTORS
PHOTO DETECTORS
DUCT DETECTORS
HEAT DETECTORS
WATERFLOW SWITCHES
SUPERVISORY SWITCHES
OTHER: (SPECIFY) _____

Figure 7-5.1 Inspection and Testing Form.

[New figure]

ALARM INDICATING APPLIANCES AND CIRCUIT INFORMATION**QTY OF****CIRCUIT STYLE**

BELLS

HORNS

CHIMES

STROBES

SPEAKERS

OTHER: (SPECIFY) _____

NO. OF ALARM INDICATING CIRCUITS: _____

ARE CIRCUITS SUPERVISED? ☐ YES ☐ NO**SUPERVISORY SIGNAL INITIATING DEVICES AND CIRCUIT INFORMATION****QTY OF****CIRCUIT STYLE**

BUILDING TEMP.

SITE WATER TEMP.

SITE WATER LEVEL

FIRE PUMP POWER

FIRE PUMP RUNNING

FIRE PUMP AUTO POSITION

FIRE PUMP OR PUMP CONTROLLER TROUBLE

FIRE PUMP RUNNING

GENERATOR IN AUTO POSITION

GENERATOR OR CONTROLLER TROUBLE

SWITCH TRANSFER

GENERATOR ENGINE RUNNING

OTHER: _____

SIGNALING LINE CIRCUITS

Quantity and style (See NFPA 72, Table 3-6.1) of signaling line circuits connected to system:

Quantity _____ Style(s) _____

SYSTEM POWER SUPPLIES

a. Primary (Main): Nominal Voltage _____, Amps _____

Overcurrent Protection: Type _____, Amps _____

Location (Panel Number): _____

Disconnecting Means Location: _____

Figure 7-5.1 Inspection and Testing Form. (cont.)

[New figure]

b. Secondary (Standby):

_____ Storage Battery: Amp-Hr. Rating _____

Calculated capacity to operate system, in hours: _____ 24 _____ 60 _____

_____ Engine-driven generator dedicated to fire alarm system:

Location of fuel storage: _____

TYPE BATTERY☐ Dry Cell☐ Nickel Cadmium☐ Sealed Lead-Acid☐ Lead-Acid☐ Other (Specify) _____

c. Emergency or standby system used as a backup to primary power supply, instead of using a secondary power supply:

_____ Emergency system described in NFPA 70, Article 700

_____ Legally required standby described in NFPA 70, Article 701

_____ Optional standby system described in NFPA 70, Article 702, which also meets the performance requirements of Article 700 or 701.

PRIOR TO ANY TESTING

NOTIFICATIONS ARE MADE:	YES	NO	WHO	TIME
MONITORING ENTITY	☐	☐	_____	_____
BUILDING OCCUPANTS	☐	☐	_____	_____
BUILDING MANAGEMENT	☐	☐	_____	_____
OTHER (SPECIFY)	☐	☐	_____	_____
AHJ (NOTIFIED) OF ANY IMPAIRMENTS	☐	☐		

SYSTEM TESTS AND INSPECTIONS

TYPE	VISUAL	FUNCTIONAL	COMMENTS
CONTROL PANEL	☐	☐	_____
INTERFACE EQ.	☐	☐	_____
LAMPS/LEDS	☐	☐	_____
FUSES	☐	☐	_____
PRIMARY POWER SUPPLY	☐	☐	_____
TROUBLE SIGNALS	☐	☐	_____
DISCONNECT SWITCHES	☐	☐	_____
GROUND FAULT MONITORING	☐	☐	_____

SECONDARY POWER

TYPE	VISUAL	FUNCTIONAL	COMMENTS
BATTERY CONDITION	☐		_____
LOAD VOLTAGE		☐	_____
DISCHARGE TEST		☐	_____
CHARGER TEST		☐	_____
SPECIFIC GRAVITY		☐	_____

Figure 7-5.1 Inspection and Testing Form. (cont.)

[New figure]

TRANSIENT SUPPRESSORS	[]		_____
REMOTE ANNUNCIATORS	[]	[]	_____
NOTIFICATION APPLIANCES			
AUDIBLE	[]	[]	_____
VISUAL	[]	[]	_____
SPEAKERS	[]	[]	_____
VOICE CLARITY	[]		_____

INITIATING AND SUPERVISORY DEVICE TESTS AND INSPECTIONS

LOC. & S/N	DEVICE TYPE	VISUAL CHECK	FUNCTIONAL TEST	FACTORY SETTING	MEAS. SETTING	PASS	FAIL
_____	_____	[]	[]	_____	_____	[]	[]
_____	_____	[]	[]	_____	_____	[]	[]
_____	_____	[]	[]	_____	_____	[]	[]
_____	_____	[]	[]	_____	_____	[]	[]
_____	_____	[]	[]	_____	_____	[]	[]
_____	_____	[]	[]	_____	_____	[]	[]

COMMENTS: _____

	VISUAL	FUNCTIONAL	COMMENTS
EMERGENCY COMMUNICATIONS EQUIPMENT			
PHONE SET	[]	[]	_____
PHONE JACKS	[]	[]	_____
OFF-HOOK INDICATOR	[]	[]	_____
AMPLIFIER(S)	[]	[]	_____
TONE GENERATOR(S)	[]	[]	_____
CALL IN SIGNAL	[]	[]	_____
SYSTEM PERFORMANCE	[]	[]	_____

	VISUAL	DEVICE OPERATION	SIMULATED OPERATION
INTERFACE EQUIPMENT			
(SPECIFY) _____	[]	[]	[]
(SPECIFY) _____	[]	[]	[]
(SPECIFY) _____	[]	[]	[]
SPECIAL HAZARD SYSTEMS			
(SPECIFY) _____	[]	[]	[]
(SPECIFY) _____	[]	[]	[]
(SPECIFY) _____	[]	[]	[]

Figure 7-5.1 Inspection and Testing Form. (cont.)

[New figure]

SPECIAL PROCEDURES: _____

COMMENTS: _____

ON/OFF PREMISES MONITORING:

	YES	NO	TIME	COMMENTS
ALARM SIGNAL	[]	[]	_____	_____
ALARM RESTORAL	[]	[]	_____	_____
TROUBLE SIGNAL	[]	[]	_____	_____
SUPERVISORY SIGNAL	[]	[]	_____	_____
SUPERVISORY RESTORAL	[]	[]	_____	_____

NOTIFICATIONS THAT TESTING IS COMPLETE:

	YES	NO	WHO	TIME
BUILDING MANAGEMENT	[]	[]	_____	_____
MONITORING AGENCY	[]	[]	_____	_____
BUILDING OCCUPANTS	[]	[]	_____	_____
OTHER (SPECIFY)	[]	[]	_____	_____

THE FOLLOWING DID NOT OPERATE CORRECTLY: _____

SYSTEM RESTORED TO NORMAL OPERATION: DATE _____ TIME _____

THIS TESTING WAS PERFORMED IN ACCORDANCE WITH APPLICABLE NFPA STANDARDS.

NAME OF INSPECTOR: _____

DATE: _____

TIME: _____

SIGNATURE: _____

NAME OF OWNER OR REPRESENTATIVE: _____

DATE: _____

TIME: _____

SIGNATURE: _____

Figure 7-5.1 Inspection and Testing Form. (cont.)

[New figure]

Chapter 8 Referenced Publications

8-1 The following documents or portions thereof are referenced within this code and should be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

8-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1990 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1991 edition.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes*, 1991 edition.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height*, 1991 edition.

NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*, 1993 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 1992 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 1990 edition.

NFPA 54, *National Fuel Gas Code*, 1992 edition.

NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*, 1992 edition.

NFPA 70, *National Electrical Code*, 1993 edition.

NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, 1993 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems*, 1993 edition.

NFPA 601, *Standard on Guard Service in Fire Loss Prevention*, 1992 edition.

NFPA 780, *Lightning Protection Code*, 1992 edition.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Public Fire Service Communication Systems*, 1991 edition.

8-1.2 ANSI Publications. American National Standards Institute, 1430 Broadway, New York, NY 10036.

ANSI A-58.1-1982, *Building Code Requirements for Minimum Design Loads in Buildings and Other Structures*.

ANSI S-1.4a-1985, *Specifications for Sound Level Meters*.

ANSI S3.41-1990, *Audible Emergency Evacuation Signals*.

ANSI S12.31-1980, *Precision Methods for the Determination of Sound Power Levels of Broad Band Noise Sources in Reverberation Rooms*.

ANSI S12.32-1980, *Precision Methods for the Determination of Sound Power Levels of Discrete Frequency and Narrow Band Noise Sources in Reverberation Rooms*.

ANSI/ASME A17.1, *Safety Code for Elevators and Escalators*.

ANSI/IEEE C2, *The National Electrical Safety Code*.

ANSI/UL 217, *Single and Multiple Station Smoke Detectors*, Third Edition.

ANSI/UL 268, *Smoke Detectors for Fire Protective Signaling Systems*, Second Edition.

ANSI/UL 827-1988, *Central Stations for Watchman, Fire Alarm and Supervisory Service*.

8-1.3 EIA Publication. Electronic Industries Association, 2001 I Street NW, Washington, DC 20006.

EIA Tr 41.3, *Telephones*.

8-1.4 IES Publication. Illuminating Engineering Society of North America, 345 East 47th Street, New York, NY 10017.

IES RP-16-1987, *Nomenclature and Definitions for Illuminating Engineering*.

Appendix A Explanatory Material

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

A-1-2.1 In determining the performance criteria of circuits, consult the performance and capacity tables in Chapters 3 and 4. On modifying an existing system, the system should be tested to determine the style of each circuit for the proper description and understanding of the system.

[From NFPA 72 - 1990, A-1-2.1 modified]

A-1-5.2.6(c) An engine-driven generator without standby battery supplement is not assumed to be capable of reliable power transfer within 30 seconds of a primary power loss.

[From NFPA 71, A-2-2.1.6(c)]

A-1-5.2.6.1 UPS equipment often contains an internal bypass arrangement to supply the load directly from the line. These internal bypass arrangements are a potential source of failure. UPS equipment also requires periodic maintenance. It is therefore necessary to provide a means to promptly and safely bypassing and isolating the UPS equipment from all power sources while maintaining continuity of power supply to the equipment normally supplied by the UPS.

[From NFPA 71, A-2-2.1.8]

A-1-5.2.9 Rechargeable-(Storage-)Type Batteries. The following newer types of rechargeable batteries are normally used in protected premises applications:

(a) *Vented Lead-Acid, Gelled, or Starved Electrolyte Battery.* This rechargeable-type battery is generally used in place of primary batteries in applications having a relatively high current drain or requiring extended standby capability of much lower currents. Nominal voltage of a single cell is 2 volts, and the battery is available in multiples of 2 volts (2, 4, 6, 12, etc.). Batteries should be stored according to manufacturer's recommendations.

(b) *Nickel-Cadmium Battery.* The sealed-type nickel-cadmium battery generally used in applications where the battery current drain during a power outage is low to moderate (typically up to a few hundred milliamperes) and is fairly constant. Nickel-cadmium batteries are also available in much larger capacities for other applications. The nominal voltage per cell is 1.42 volts (12.78, 25.56, etc.). Batteries in storage can be stored in any state of charge for indefinite periods. However, battery in storage will lose capacity (will self-discharge) according to storage time and temperature. Typically, batteries stored more than 1 month will require an 8- to 14-hour charge period to restore capacity. In service, the battery should receive a continuous constant charging current sufficient to keep it fully charged (typically, the charge rate equals $1/10$ to $1/20$ of the ampere-hour rating of the battery). Because batteries are made up of individual cells connected in series, the possibility exists that during deep discharge one or more cells that may be low capacity will reach complete discharge prior to other cells. The cells with remaining life tend to charge the depleted cells, causing a polarity reversal resulting in permanent battery damage. This condition can be determined by measuring the open cell voltage of a fully charged battery (voltage should be a minimum of 1.28 volts per cell multiplied by the number of cells). Voltage depression effect is a minor change in discharge volt-

age level caused by constant current charging below the system discharge rate.

In some applications of nickel-cadmium batteries (for example, battery-powered shavers) a memory characteristic also exists. Specifically, if the battery is discharged for 1 minute a day, day after day, followed by a recharge, an attempt to have it operate for 5 minutes will not result in obtaining the rated ampere-hour output. The reason for this is that the battery has developed a 1-minute discharge memory.

(c) *Sealed Lead-Acid Battery.* In a sealed lead-acid battery, the electrolyte is totally absorbed by the separators, and no venting normally occurs. Gas evolved during recharge is internally recombined, resulting in minimal loss of capacity life. A high-pressure vent, however, is provided to avoid damage under abnormal conditions. Other battery characteristics are comparable to those described under A-1-5.2.11(a).

[From NFPA 71, A-2-2.3]

A-1-5.2.9.2(d) Batteries are trickle charged if they are off-line and waiting to be put under load in the event of a loss of power.

Float-charge batteries are fully charged and connected across the output of the rectifiers to smooth the output and serve as a standby source of power in the event of a loss of line power.

[From NFPA 71, A-2-2.3.4(d)]

A-1-5.2.11 Maximum Load. The maximum normal load of a No. 6 primary battery should not be more than 2 amperes per cell. No. 6 batteries should be replaced under the following conditions:

(a) An individual primary battery cell rated 1 volt should be replaced when a test load of 1 ohm reduces the potential below 1 volt.

(b) A unit assembly of primary battery cells rated 6 volts should be replaced when a test load of 4 ohms reduces the potential of the unit below 4 volts.

[From NFPA 71, A-2-2.5]

A-1-5.4.2.1 Coded Alarm Signal Designations. The following suggested coded signal assignment for buildings having four floors and multiple basements is provided as a guide:

Location	Coded Signal
4th floor	2-4
3rd Floor	2-3
2nd Floor	2-2
1st Floor	2-1
Basement	3-1
Sub-Basement	3-2

[From NFPA 72 - 1990, A-2-4.3]

A-1-5.4.7(b) A tamper switch, low pressure switch, or other device intended to cause a supervisory signal when actuated should not be connected in series with the end-of-line supervisory device of initiating device circuits unless a distinctive signal, different from a trouble signal, is indicated.

[From NFPA 72 - 1990, A-2-4.10(b)]

A-1-5.5.1(a) This requirement does not preclude transfer to secondary supply at less than 85 percent of nominal primary voltage as long as the requirements of 1-5.2.6 are met.

[From NFPA 72 - 1990, A-2-3.1(a)]

A-1-5.5.4 Wiring and Equipment. The installation of all fire alarm system wiring should take into account the fire alarm

system manufacturer's published installation instructions and the limitations of the applicable product listings or approvals.

[From NFPA 72 - 1990, A-2-1.4]

A-1-5.8.5.1 Backup amplifying and evacuation signal-generating equipment is recommended with automatic transfer upon primary equipment failure to ensure prompt restoration of service in the event of equipment failure.

A-1-7.2.1 The requirements of Chapter 7 should be used to perform the installation wiring and operational acceptance tests required when completing the certificate of compliance.

[From NFPA 72, A-2-2.2 modified]

A-1-7.2.2(a) The owner's manual and installation instructions should include the following:

(a) A detailed narrative description of the system inputs, evacuation signaling, ancillary functions, annunciation, intended sequence of operations, expansion capability, application considerations, and limitations.

(b) Operator instructions for basic system operations, including alarm acknowledgment, system reset, interpreting system output (LEDs, CRT display, and printout), operation of manual evacuation signaling and ancillary function controls, changing printer paper, etc.

(c) A detailed description of routine maintenance and testing as required and recommended and as would be provided under a maintenance contract, including testing and maintenance instructions for each type of device installed. This information should include the following:

1. A listing of the individual system components that require periodic testing and maintenance

2. Step-by-step instructions detailing the requisite testing and maintenance procedures and the intervals at which those procedures shall be performed, for each type of device installed

3. A schedule that correlates the testing and maintenance procedures required by paragraph (2) above with the listing required by paragraph (1) above.

(d) Detailed troubleshooting instructions for each trouble condition generated from the monitored field wiring, including opens, grounds, loop failures, etc. These instructions should include a list of all trouble signals annunciated by the system, a description of the condition(s) that will cause those trouble signals, and step-by-step instructions describing how to isolate those problems and correct them (or call for service, as appropriate).

(e) A service directory, including a list of names and telephone numbers for those who should be called to obtain service on the system. [From NFPA 72 - 1990, A-2-2.3(a)]

A-2 Household Fire Warning Protection.

(a) *Fire Danger in the Home.* Fire is the third leading cause of accidental death. Residential occupancies account for most fire fatalities, and most of these deaths occur at night during the sleeping hours.

Most fire injuries also occur in the home. Of the 300,000 Americans who are injured by fire every year, nearly 50,000 lie in hospitals for a period ranging from 6 weeks to 2 years. Many never resume normal lives.

The chances are that the average family will experience one serious fire every generation.

(b) *Fire Safety in the Home.* This code is intended to provide reasonable fire safety for persons in family living units. Reasonable fire safety can be produced through a three-point program:

1. Minimizing fire hazards
2. Providing a fire warning system
3. Having and practicing an escape plan.

(c) *Minimizing Life Safety Hazards.* This code cannot protect all persons at all times. For instance, the application of this code may not protect against the three traditional fire killers:

1. Smoking in bed
2. Leaving children home alone
3. Cleaning with flammable liquids such as gasoline.

But Chapter 2 can lead to reasonable safety from fire when the three items under A-2(b) are observed.

(d) *Fire Warning System.* There are two extremes of fire to which household fire warning equipment must respond. One is the rapidly developing, high heat fire. The other is the slow, smoldering fire. Either can produce smoke and toxic gases.

Household fires are especially dangerous at night when the occupants are asleep. Fires produce smoke and deadly gases that can overcome occupants while they are asleep. Further, dense smoke reduces visibility. Most fire casualties are victims of smoke and gas inhalation rather than burns. To warn against a fire, Chapter 2 requires smoke detectors in accordance with 2-2.1.1.1 and recommends heat or smoke detectors in all other major areas. (See 2-2.1.1.1.)

(e) *Family Escape Plan.* There often may be very little time between detection of a fire and the time it becomes deadly. This interval may be as little as 1 or 2 minutes. Thus, this code requires detection means to give a family some advance warning of the development of conditions that will become dangerous to life within a short period of time. Such warning, however, may be wasted unless the family has planned in advance for rapid exit from their residence. Therefore, in addition to the fire warning system, this code requires exit plan information to be furnished.

Planning and practicing for fire conditions with focus on rapid exit from the residence are important. Drills should be held so that all family members know what to do. Each person should plan for the possibility that exit out of the bedroom window may be necessary. An exit out of the residence without requiring the opening of a bedroom door is essential.

(f) *Special Provisions for the Disabled.* For special circumstances where life safety of some occupant(s) depends upon prompt rescue by others, the fire warning system should include means of prompt, automatic notification to those who are to be depended upon for rescue.

[From NFPA 74 - 1989, Appendix C]

A-2-1.1 Chapter 2 does not attempt to cover all equipment, methods, and requirements that may be necessary or advantageous for the protection of lives and property from fire.

This is what is known as a "minimum code" and it provides a number of requirements related to household fire warning equipment that are deemed to be the practical and necessary minimum for average conditions at the present state-of-the-art.

[From NFPA 74 - 1989, A-1-1]

A-2-2.1.1 Experience has shown that all hostile fires in family living units generate smoke to a greater or lesser degree. The same statement can be made with respect to heat buildup from fires. But the results of full-scale experiments conducted over the past several years in the U.S., using typical fires in family living units, indicate that detectable quantities of smoke precede detectable levels of heat in nearly all cases. In addition, slowly

developing, smoldering fires may produce smoke and toxic gases without a significant increase in the room's temperature. Again, the results of experiments indicate that detectable quantities of smoke precede the development of hazardous atmospheres in nearly all cases.

For the above reasons, the required protection in this code utilizes smoke detectors as the primary life safety equipment that provides a reasonable level of protection against fire.

Of course, it is possible to install a lesser number of detectors than required in this code. It may be argued that the installation of only one fire detector, be it a smoke or heat detector, offers some life-saving potential. While this is true, it is the opinion of the committee that developed Chapter 2 that the smoke detector requirements as stated in 2-2.1.1 are the minimum that should be considered.

The installation of additional detectors of either the smoke or heat type should result in a higher degree of protection. Adding detectors to rooms that are normally closed off from the required detectors will increase the escape time because the fire need not build to a higher level needed to force smoke out of the closed room to the required detector. As a consequence, it is recommended that the householder consider the installation of additional fire protection devices. But it should be understood that Chapter 2 does not require additional detectors over and above those called for in 2-2.1.1.

A-2-2.2 At times, depending upon conditions, the audibility of detection devices may be seriously impaired to occupants within the bedroom area. For instance, there may be a noisy window air conditioner or room humidifier that may generate an ambient noise level of 55 dBA or higher. The detection devices' alarms must be able to penetrate through the closed doors and be heard over the bedroom's noise levels with sufficient intensity to awaken sleeping occupants therein. Test data indicate that detection devices having sound pressure ratings of 85 dBA of 10 ft (3 m) and installed outside the bedrooms can produce about 15 dBA over ambient noise levels of 55 dBA in the bedrooms. This should be sufficient to awaken the average sleeping person.

Detectors located remote from the bedroom area may not be loud enough to awaken the average person. In such cases, it is recommended that detectors be interconnected in such a way that the operation of the remote detector will cause an alarm of sufficient intensity to penetrate the bedrooms. The interconnection may be accomplished by the installation of a fire detection system, by the wiring together of multiple station alarm devices, or by the use of line carrier or radio frequency transmitters/receivers.

[From NFPA 74 - 1989, A-2-2]

A-2-2.2.2 The use of the distinctive three-pulse temporal pattern fire alarm evacuation signal required by 3-7.2(a) had previously been recommended for this purpose by this code since 1979. It has since been adopted as both an American National Standard (ANSI S3.41, *Audible Emergency Evacuation Signal*) and an International Standard (ISO 8201, *Audible Emergency Evacuation Signal*).

Copies of both of these standards are available from the Standards Secretariat, Acoustical Society of America, 335 East 45th Street, New York, NY 10017-3483. Telephone 212-661-9404 ext. 562.

The standard fire alarm evacuation signal is a three-pulse temporal pattern using any appropriate sound. The pattern consists of an "on" phase (a) lasting 0.5 second $\pm$

10 percent followed by an "off" phase (b) lasting 0.5 second $\pm$ 10 percent, for three successive "on" periods, which is then followed by an "off" phase (c) lasting 1.5 seconds $\pm$ 10 percent. [See Figures A-2-2.2.2(a) and (b).] The signal should be repeated for a period appropriate for the purposes of evacuation of the building, but for not less than 180 seconds. A single-stroke bell or chime sounded at "on" intervals lasting 1 second $\pm$ 10 percent, with a 2-second $\pm$ 10 percent "off" interval after each third "on" stroke, is acceptable. [See Figure A-2-2.2.2(c).]

The minimum repetition time may be manually interrupted.

[New paragraphs]

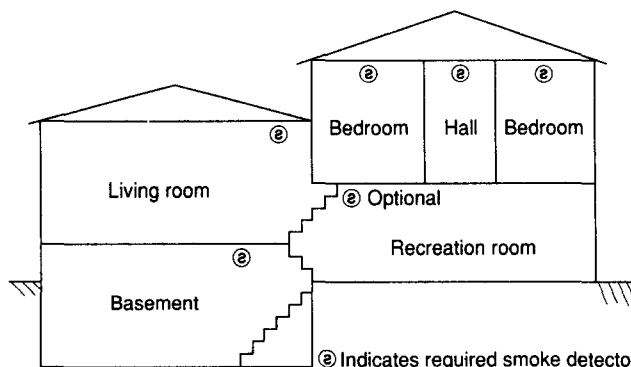


Figure A-2.2.1.1.2 Split level arrangement. Smoke detectors are required where shown. Smoke detectors are optional if door is not provided between living and recreation rooms.

[From NFPA 74 - 1989, A-2-1.1]

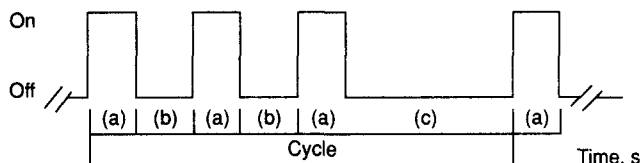


Figure A-2.2.2.2(a) Temporal pattern parameters.
[From NFPA 72 - 1990, Figure A-2-4.10(a)(1)]

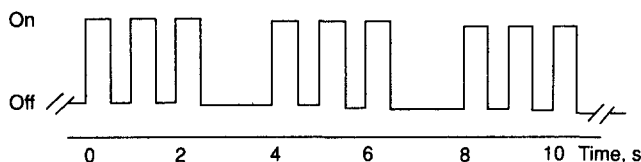


Figure A-2.2.2.2(b) Temporal pattern imposed on signaling appliances that emit a continuous signal while energized.

[From NFPA 72 - 1990, Figure A-2-4.10(a)(2)]

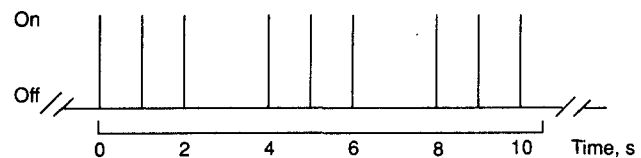


Figure A-2.2.2.2(c) Temporal pattern imposed on a single stroke bell or chime.

[From NFPA 72 - 1990, Figure A-2-4.10(a)(3)]

A-2-4.3 The linear space rating is the maximum allowable distance between heat detectors. The linear space rating is also a measure of their response time to a standard test fire when tested at the same distance. The higher the rating, the faster the response time. This code recognizes only those heat detectors with ratings of 50 ft (15 m) or more.

[From NFPA 74 - 1989, A-4-3]

A-2-4.3.1 A heat detector with a temperature rating somewhat in excess of the highest normally expected ambient temperature is specified in order to avoid the possibility of premature operation of the heat detector to nonfire conditions.

Some areas or rooms of the family living unit can experience ambient temperatures considerably higher than in the normally occupied living spaces. Examples are unfinished attics, the space near hot air registers, and some furnace rooms. This fact should be considered in the selection of the appropriate temperature rating for fixed temperature heat detectors to be installed in these areas or rooms.

[From NFPA 74 - 1989, A-4-3.1]

A-2-5.1.2.1 One of the common problems associated with residential smoke detectors is the unwanted alarms that are usually triggered by products of combustion from cooking, smoking, or other household particulates. While an alarm for such a condition would be anticipated and tolerated by the occupant of a family living unit through routine living experience, the alarm would not be acceptable if it also sounded alarms in other family living units or in common use spaces. Unwanted alarms from cooking are a very common occurrence, and inspection authorities should be aware of the ramifications that could result if the coverage is extended beyond the limits of the family living unit.

[From NFPA 74 - 1989, A-5-1.2.1]

A-2-5.2 One of the most critical factors of any fire alarm system is the location of the fire detecting devices. This appendix is not a technical study. It is an attempt to state some fundamentals on detector location. For simplicity, only those types of detectors recognized by Chapter 2, i.e., smoke and heat detectors, will be discussed. In addition, special problems requiring engineering judgment, such as locations in attics and in rooms with high ceilings, will not be covered.

[From NFPA 74 - 1989, B-1.1]

A-2-5.2.1 Smoke Detection.

(a) *Where to Locate the Required Smoke Detectors in Existing Construction.* The major threat from fire in a family living unit is at night when everyone is asleep. The principal threat to persons in sleeping areas comes from fires in the remainder of the unit; therefore, smoke detector(s) are best located between the bedroom areas and the rest of the unit. In units with only one bedroom area on one floor, the smoke detector should be located as shown in Figure A-2-5.2.1(a).

In family living units with more than one bedroom area or with bedrooms on more than one floor, more than one smoke detector will be needed, as shown in Figure A-2-5.2.1(b).

In addition to smoke detectors outside of the sleeping areas, Chapter 2 requires the installation of a smoke detector on each additional story of the family living unit, including the basement. These installations are shown in Figure A-2-5.2.1(c). The living area smoke detector should be installed in the living room and/or near the stairway to

the upper level. The basement smoke detector should be installed in close proximity to the stairway leading to the floor above. If installed on an open-joisted ceiling, the detector should be placed on the bottom of the joists. The detector should be positioned relative to the stairway so as to intercept smoke coming from a fire in the basement before the smoke enters the stairway.

[From NFPA 74 - 1989, B-2]

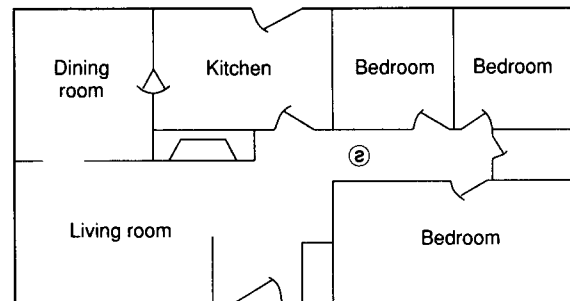


Figure A-2-5.2.1(a) A smoke detector should be located between the sleeping area and the rest of the family living unit.

[From NFPA 74, Figure B-2.1.1]

(b) *Where to Locate the Required Smoke Detectors in New Construction.* All of the smoke detectors specified in (a) for existing construction are required, and, in addition, a smoke detector is required in each bedroom.

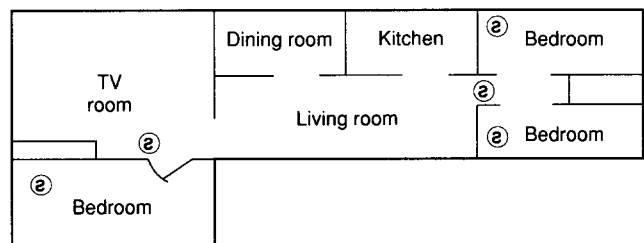


Figure A-2-5.2.1(b) In family living units with more than one sleeping area, a smoke detector should be provided to protect each sleeping area in addition to detectors required in bedrooms.

[From NFPA 74, Figure B-2.1.2]

(c) *Are More Smoke Detectors Desirable?* The required number of smoke detectors may not provide reliable early warning protection for those areas separated by a door from the areas protected by the required smoke detectors. For this reason, it is recommended that the householder consider the use of additional smoke detectors for those areas for increased protection. The additional areas include: basement, bedrooms, dining room, furnace room, utility room, and hallways not protected by the required smoke detectors. The installation of smoke detectors in kitchens, attics (finished or unfinished), or in garages is not normally recommended, as these locations occasionally experience conditions that may result in improper operation.

A-2-5.2.1.6 Smoke Detector Mounting — Dead Air Space. The smoke from a fire generally rises to the ceiling, spreads out across the ceiling surface, and begins to bank down from the ceiling. The corner where the ceiling and

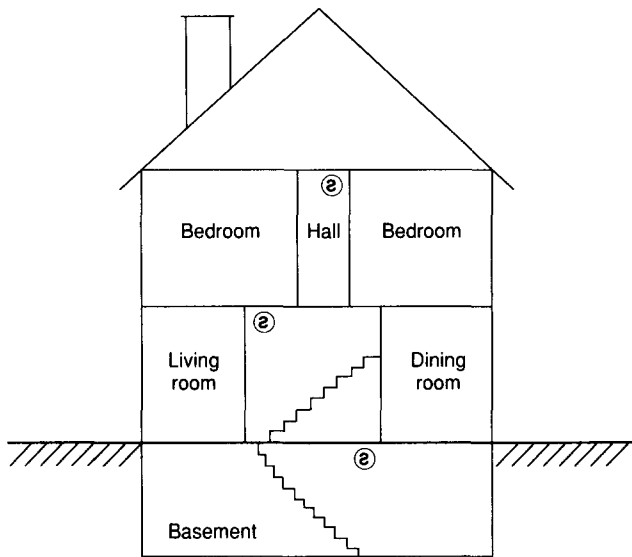


Figure A-2-5.2.1(c) A smoke detector should be located on each story.
[From NFPA 74, Figure B-2.1.3]

wall meet is an air space into which the smoke may have difficulty penetrating. In most fires, this dead air space measures about 4 in. (0.1 m) along the ceiling from the corner and about 4 in. (0.1 m) down the wall as shown in Figure A-2-5.2.2(b). Detectors should not be placed in this dead air space.

[From NFPA 74 - 1989, B-2]

Smoke and heat detectors should be installed in those locations recommended by the manufacturer, except in those cases where the space above the ceiling is open to the outside and little or no insulation is present over the ceiling. Such cases result in the ceiling being excessively cold in the winter or excessively hot in the summer. Where the ceiling is significantly different in temperature from the air space below, smoke and heat has difficulty reaching the ceiling and a detector that may be placed there. In this situation, placement of the detector on a side wall, with the top 4 in. to 12 in. (0.1 m to 0.3 m) from the ceiling, is preferred.

The situation described above for uninsulated or poorly insulated ceilings may also exist, but to a lesser extent, with outside walls. While the recommendation is to place the smoke detector on a side wall, if the side wall is an exterior wall with little or no insulation, then an interior wall should be selected. It should be recognized that the condition of inadequately insulated ceilings and walls can exist in multifamily housing (apartments), single-family housing, and mobile homes.

In those family living units employing radiant heating in the ceiling, the wall location is the preferred location. Radiant heating in the ceiling can create a hot-air, boundary layer along the ceiling surface, which can seriously restrict the movement of smoke and heat to a ceiling-mounted detector.

[From NFPA 74 - 1989, A-5-2.1.6]

A-2-5.2.2 Heat Detection.

(a) *General.* While Chapter 2 does not require heat detectors as part of the basic protection scheme, it is rec-

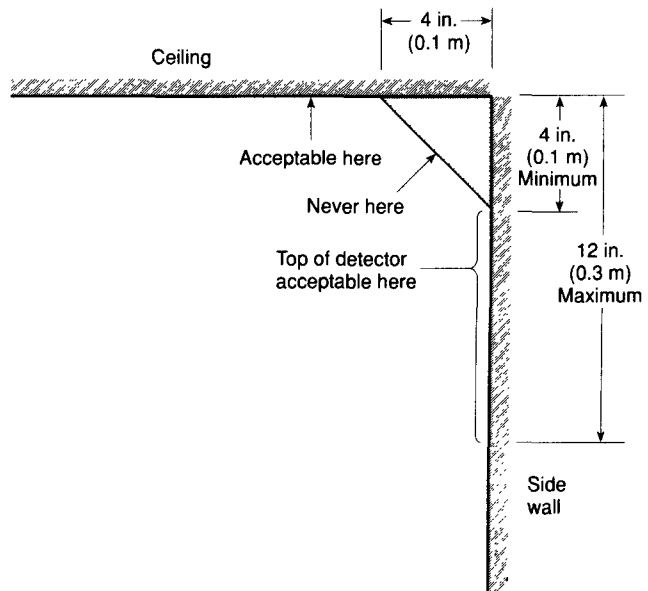
ommended that the householder consider the use of additional heat detectors for the same reasons presented under A-2-5.2.1(c). The additional areas lending themselves to protection with heat detectors are: kitchen, dining room, attic (finished or unfinished), furnace room, utility room, basement, and integral or attached garage. For bedrooms, the installation of a smoke detector is preferable to the installation of a heat detector for protection of the occupants from fires in their bedrooms.

(b) *Heat Detector Mounting — Dead Air Space.* Heat from a fire rises to the ceiling, spreads out across the ceiling surface, and begins to bank down from the ceiling. The corner where the ceiling and the wall meet is an air space into which heat has difficulty in penetrating. In most fires, this dead air space measures about 4 in. (0.1 m) along the ceiling from the corner and 4 in. (0.1 m) down the wall as shown in Figure A-2-5.2.2(b). Heat detectors should not be placed in this dead air space.

The placement of the detector is critical if maximum speed of fire detection is desired. Thus, a logical location for a detector is the center of the ceiling. At this location, the detector is closest to all areas of the room.

If the detector cannot be located in the center of the ceiling, an off-center location may be used on the ceiling.

The next logical location for mounting detectors is on the side wall. Any detector mounted on the side wall should be located as near as possible to the ceiling. A detector mounted on the side wall should have the top of the detector between 4 in. and 12 in. (0.1 m and 0.3 m) from the ceiling.



NOTE: Measurements shown are to the closest edge of the detector.

Figure A-2-5.2.2(b) Example of proper mounting for detectors.

[From NFPA 74, Figure B-3.2.1]

(c) *The Spacing of Detectors.* In a room too large for protection by a single detector, several detectors should be used. It is important that they be properly located so all parts of the room are covered. For further information on the spacing of detectors see Chapter 5.

(d) *When the Distance Between Detectors Should Be Further Reduced.* The distance between detectors is based on data obtained from the spread of heat across a smooth ceiling. If the ceiling is not smooth, then the placement of the detector will have to be tailored to the situation.

For instance, with open wood joists heat travels freely down the joist channels so that the maximum distance between detectors [50 ft (15 m)] can be used. Heat, however, has trouble spreading across the joists, so the distance in this direction should be one-half the distance allowed between detectors, as shown in Figure A-2-5.2.2(d), and the distance to the wall is reduced to $12\frac{1}{2}$ ft (3.8 m). Since $\frac{1}{2} \times 50$ ft (15 m) is 25 ft (7.6 m), the distance between detectors across open wood joists should not exceed 25 ft (7.6 m), as shown in Figure A-2-5.2.2(d), and the distance to the wall is reduced [$\frac{1}{2} \times 25$ ft (7.6 m)] to 12.5 ft (3.8 m). Paragraph 2-5.2.2.4 requires that detectors be mounted on the bottom of the joists and not up in joist channels.

Walls, partitions, doorways, ceiling beams, and open joists interrupt the normal flow of heat, thus creating new areas to be protected.

[From NFPA 74 - 1989, B-3]

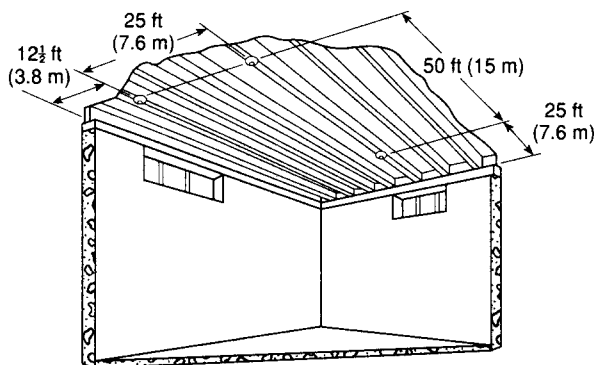


Figure A-2-5.2.2(d) Open joists, attics, and extra high ceilings are some of the areas that require special knowledge for installation.

[From NFPA 74, Figure B-3.4.2]

A-2-5.2.2.3 The same comments apply here as under A-2-5.2.1.6.

[From NFPA 74 - 1989, A-5-2.2.3]

A-2-5.2.2.5 In addition to the special requirements for heat detectors installed on ceilings with exposed joists, reduced spacing may also be required due to other structural characteristics of the protected area, possible drafts, or other conditions that may affect detector operation.

[From NFPA 74 - 1989, A-5-2.2.5]

A-2-6.1 Good fire protection requires that the equipment be periodically maintained. If the householder is unable to perform the required maintenance, a maintenance agreement should be considered.

[From NFPA 74 - 1989, A-6-1]

A-2-6.2 It is a good practice to establish a specific schedule for these tests.

[From NFPA 74 - 1989, A-6-2]

A-3-2.4 This requirement is intended to limit damage to a fire alarm system, resulting from a fire, to the area in

which the fire occurs. The concern is maintaining the operability of the system in areas beyond, but threatened by, the fire.

Conformance to this requirement may entail that:

(a) Where common risers or trunk circuits are used:

1. Separately routed, redundant risers or trunk circuits be provided, arranged so that one or more circuit faults on one riser or trunk circuit causes the system to automatically switch over to its associated, alternate circuit without loss of function. This capability should permit full system operation with a damaged or severed riser or trunk circuit.

2. Primary and alternate conductors for redundant circuits be separated by 2-hour fire resistive construction.

(b) Where multiple individual circuits are routed in a common riser, conduit, raceway, cable, bundle of conductors, or other arrangement resulting in close physical proximity and resultant susceptibility to common misfortune, such circuits be Class A, capable of full operation over a single open or single ground fault.

(c) Where Class A circuits are required, that they be installed so that the supply and return conductors are routed separately. Supply and return risers should be separated by at least 2-hour rated fire construction.

[New paragraphs]

A-3-4.1 Class A and Class B circuit designations have been added to this edition of the code because they are still preferred by some specifiers and authorities having jurisdiction to the style designations introduced into the code in the late 1970s. The committee had discontinued the use of the Class A and Class B designations because, with the introduction of signaling line circuits, they were no longer adequate for describing the required performance of new technology systems under all fault conditions.

Class A circuits are considered more reliable than Class B circuits because they remain fully operational during the occurrence of a single open or a single ground fault, while Class B circuits only remain operational up to the location of an open fault. However, neither Class A nor Class B circuits remain operational during a wire-to-wire short.

For both Class A and Class B initiating device circuits, a wire-to-wire short was permitted to cause an alarm on the system on the rationale that a wire-to-wire short was the result of a double fault (e.g., both circuit conductors have to become grounded), while the code only considered the consequences of single faults. For many applications, an alarm caused by a wire-to-wire short is unacceptable and being limited to a simple Class A designation was not adequate. Introducing the style designation made it possible to specify the exact performance required during a variety of possible fault conditions.

A more serious problem existed for signaling line circuits. Though a Class A signaling line circuit remains fully operational during the occurrence of a single open or single ground fault, a wire-to-wire short disables the entire circuit. The risk of such a catastrophic failure was not acceptable to many system designers, users, and authorities having jurisdiction. Here again, introducing the style designation made it possible to specify either full system operation during a wire-to-wire short (Style 7), or performance

in between that of a Style 7 and a minimum function Class A circuit (Style 2).

As revised, the specifier now can simply specify a circuit as either Class A or Class B where system performance during wire-to-wire shorts is of no concern, or by the appropriate style designation where the system performance during a wire-to-wire short and other multiple fault conditions is of concern.

A-3-4.2 Where installed within the protected premises, the integrity and reliability of the interconnecting signaling paths (circuits) are influenced by the following:

- (a) The transmission media utilized
- (b) The length of the circuit conductors
- (c) The total building area covered by and the quantity of initiating devices and notification appliances connected to a single circuit
- (d) The nature of the hazard present within the protected premises
- (e) The functional requirements of the system necessary to provide the level of protection desired by the system.

A-3-5.1 and A-3-6.1 Using Tables 3-5.1 and 3-6.1:

- (a) Determine whether the initiating devices are:
 - 1. Directly connected to the initiating device circuit
 - 2. Directly connected to a signaling line circuit interface on a signaling line circuit
 - 3. Directly connected to an initiating device circuit, which in turn is connected to a signaling line circuit interface on a signaling line circuit.
- (b) Determine the style of signaling performance required. The columns marked A through E α in Table 3-5.1, and 0.5 through 7 α in Table 3-6.1 are arranged in ascending order of performance and capacities.
- (c) Upon determining the style of the system, the charts singularly or together will specify the maximum number of devices, equipment, premises, and buildings allowed to be incorporated into an actual protected premises installation.
- (d) In contrast, where the number of devices, equipment, premises, and buildings (in addition to signaling ability) in an installation is known, a required system style can be determined.
- (e) The prime purpose of the tables is to enable identification of minimum performance for styles of initiating device circuits and signaling line circuits. It is not the intention that the styles be construed as grades. That is, a Style 3 system is not better than a Style 2, or vice versa. In fact, a particular style may better provide adequate and reliable signaling for an installation than a more complex style number. The quantities tabulated under each style do, unfortunately, tend to imply that one style is better than the one to its left. The increased quantities for the higher style numbers are based on the ability to signal an alarm during an abnormal condition in addition to signaling the same abnormal condition.
- (f) The tables allow users, designers, manufacturers, and the authority having jurisdiction to identify minimum performance of present and future systems by determining the

trouble and alarm signals received at the control unit for the specified abnormal conditions.

(g) The overall system reliability is considered to be equal from style to style when the capacities are at the maximum allowed.

(h) Upon determining the style of the system, the tables indicate the maximum number of devices, equipment, protected buildings, etc., allowed to be incorporated into an actual installation for a protected premises fire alarm system.

(i) The number of automatic fire detectors connected to an initiating device circuit is limited by good engineering practice. If a large number of detectors are connected to one initiating device circuit covering a widespread area, pinpointing the source of alarm becomes difficult and time consuming.

On certain types of detectors, a trouble signal results from faults in the detector. Where this occurs with a large number of detectors on an initiating device circuit, locating the faulty detector also becomes difficult and time consuming.

[From NFPA 72 - 1990, A-2-6.2 and A-2-7.2 modified]

A-3-7.2(a) The use of the distinctive three-pulse temporal pattern fire alarm evacuation signal required by 3-7.2(a) had previously been recommended for this purpose by this code since 1979. It has since been adopted as both an American National Standard (ANSI S3.41, *Audible Emergency Evacuation Signal*) and an International Standard (ISO 8201, *Audible Emergency Evacuation Signal*).

Copies of both of these standards are available from the Standards Secretariat, Acoustical Society of America, 335 East 45th Street, New York, NY 10017-3483. Telephone 212-661-9404 ext. 562.

The standard fire alarm evacuation signal is a three-pulse temporal pattern using any appropriate sound. The pattern consists of an "on" phase (a) lasting 0.5 second $\pm$ 10 percent followed by an "off" phase (b) lasting 0.5 second $\pm$ 10 percent, for three successive "on" periods, which is then followed by an "off" phase (c) lasting 1.5 seconds $\pm$ 10 percent. [See *Figures A-3-7.2(a)(1) and (2)*.] The signal should be repeated for a period appropriate for the purposes of evacuation of the building, but for not less than 180 seconds. A single-stroke bell or chime sounded at "on" intervals lasting 1 second $\pm$ 10 percent, with a 2-second $\pm$ 10 percent "off" interval after each third "on" stroke, is acceptable. [See *Figure A-3-7.2(a)(3)*.]

The minimum repetition time may be manually interrupted.
[New paragraphs]

A-3-8.2.3 The alarm verification feature should not be used as a substitute for proper detector location/applications or regular system maintenance. Alarm verification features are intended to reduce the frequency of false alarms caused by transient conditions. They are not intended to compensate for design errors or lack of maintenance.

A-3-8.3.4 The bypass means is intended to enable automatic or manual day/night/weekend operation.

[From NFPA 72 - 1990, A-3-3.6.5]

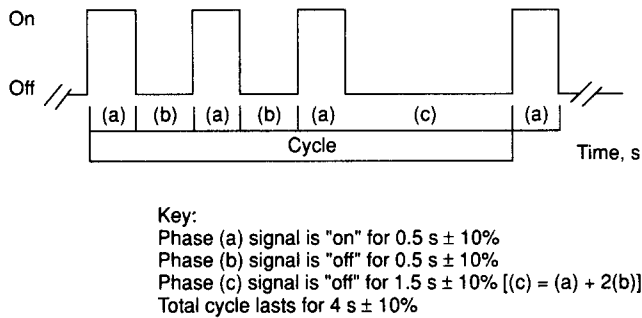


Figure A-3-7.2(a)(1) Temporal pattern parameters.

[From NFPA 72 - 1990, Figure A-2-4.10(a)(1)]

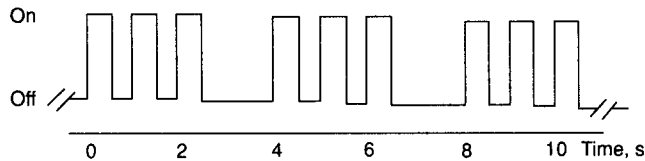


Figure A-3-7.2(a)(2) Temporal pattern imposed on signaling appliances that emit a continuous signal while energized.

[From NFPA 72 - 1990, Figure A-2-4.10(a)(2)]

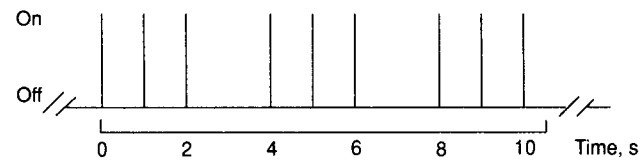


Figure A-3-7.2(a)(3) Temporal pattern imposed on a single stroke bell or chime.

[From NFPA 72 - 1990, Figure A-2-4.10(a)(3)]

A-3-8.4 Embossed plastic tape, pencil, ink, crayon, etc., should not be considered a permanently attached placard.

[From NFPA 72 - 1990, A-3-3.7]

A-3-8.7.2 Supervisory systems are not intended to provide indication of design, installation, or functional defects in the supervised systems or system components and are not a substitute for regular testing of those systems in accordance with the applicable standard.

Supervised conditions should include but not be limited to:

- (a) Control valves $1\frac{1}{2}$ in. (38.1 mm) or larger
- (b) Pressure:
 - Dry pipe system air
 - Pressure tank air
 - Precision system supervisory air
 - Steam for flooding systems
 - Public water
- (c) Water tanks:
 - Level
 - Temperature
- (d) Building temperature (including valve closet, fire pump house, etc.)
- (e) Fire pumps:
 - Electric:
 - Running (alarm or supervisory)

- Power failure
- Phase reversal
- Engine-driven:
 - Running (alarm or supervisory)
 - Failure to start
 - Controller off "automatic"
 - Trouble (low oil, high temperature, overspeed, etc.)
- Steam turbine:
 - Running (alarm or supervisory)
 - Steam pressure
 - Steam control valves

(f) Fire suppression systems appropriate to the system employed.

[New paragraph]

A-3-8.11.2 Sealing or locking such a valve in the open position or removing the handle from the valve does not meet the intent of this requirement.

A-3-8.14.1 The provisions of this section apply to the types of equipment used in common for fire alarm systems (such as fire alarm, sprinkler supervisory, or guard's tour service) and for other systems (such as burglar alarm or coded paging systems) and to methods of circuit wiring common to both types of systems.

[From NFPA 72 - 1990, A-3-4.3.]

A-3-8.15.1 Dedicated fire alarm system control units are required for elevator recall by 3-8.15.1 in order that the elevator recall systems be monitored for integrity and have primary and secondary power meeting the requirements of this code.

The control unit used for this purpose should be located in an area that is normally occupied and should have audible and visible indicators to annunciate supervisory (elevator recall) and trouble conditions; however, no form of general occupant notification or evacuation signal is required or intended by 3-8.15.1.

[New paragraph]

A-3-8.15.4 It is recommended that the installation be in accordance with the following figures. Use Figure A-3-8.15.4(a) when the elevator is installed at the same time as the building fire alarm system. Use Figure A-3-8.15.4(b) when the elevator is installed after the building fire alarm system.

[From NFPA 72 - 1990, A-3-7.3.5(a) and (b)]

A-3-8.16.1 A lower response time index is intended to provide detector response prior to the sprinkler, since a lower temperature rating alone may not provide earlier response. The listed spacing rating of the heat detector should be 25 ft (7.6 m) or greater.

A-3-8.16.3 Care should be taken to ensure that elevator power will not be interrupted due to water pressure surges in the sprinkler system.

A-3-10.6 Automatic fire suppression systems referred to in 3-10.6 include, but are not limited to, preaction and deluge sprinkler systems, carbon dioxide systems, halon systems, and dry chemical systems.

[New paragraph]

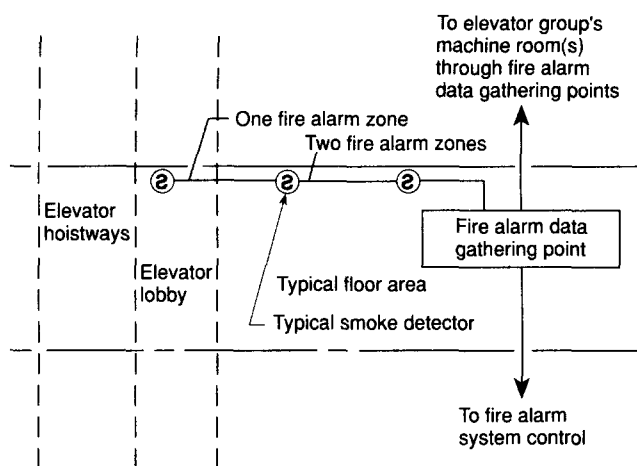


Figure A-3-8.15.4(a) Elevator zone — elevator and fire alarm system installed at same time.

[From NFPA 72 - 1990, Figure A-3-7.3.5(a)]

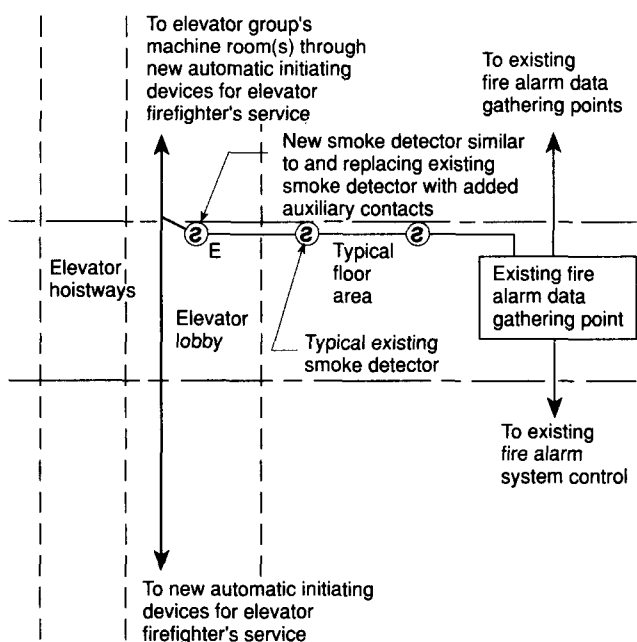


Figure A-3-8.15.4(b) Elevator zone — elevator installed after fire alarm system.

[From NFPA 72 - 1990, Figure A-3-7.3.5(b)]

A-3-11 This code contemplates field installations interconnecting two or more listed control units, possibly from different manufacturers, which together fulfill the requirements of this code.

Such an arrangement should preserve the reliability, adequacy, and integrity of all alarm, supervisory, and trouble signals and interconnecting circuits intended to be in accordance with the provisions of this code.

Where interconnected control units are in separate buildings, consideration should be given to protecting the interconnecting wiring from electrical and radio frequency interference.

[New paragraphs]

A-3-12.4.1 It is not the intention that emergency voice/alarm communications service be limited to English-speaking populations. Emergency messages should be provided in the language of the predominant building population. Where there is a possibility of isolated groups that do not speak the predominant language, multilingual messages should be provided. It is expected that small groups of transients unfamiliar with the predominant language will be picked up in the traffic flow in the time of emergency, and are not likely to be in an isolated situation.

[From NFPA 72 - 1990, A-10-4.1]

A-3-12.4.6.2 Placement of loudspeakers should give consideration to interference with normal use of emergency telephones and microphones in the area.

A-3-12.6.3 Consideration should be given to the type of fire fighters' telephone handset used in areas where high ambient noise levels exist or areas where high noise levels may exist during a fire condition. Push-to-talk handsets, handsets containing directional microphones, or handsets containing other suitable noise-canceling features may be used.

A-3-13 Special Requirements for Low Power Radio (Wireless) Systems.

(a) The term "wireless" has been replaced with "low power radio" to eliminate potential confusion with other transmission media such as optical fiber cables.

(b) Low power radio devices are required to comply with the applicable low power requirements of Title 47, *Code of Federal Regulations*, Part 15.

[New paragraphs]

A-4-2.3.1.2 Where derived channels are used, normal operating conditions of the telephone equipment will not inhibit or impair the successful transmission of signals. These normal conditions include, but are not limited to, the following:

- (a) Intraoffice calls with a transponder on the originating end
- (b) Intraoffice calls with a transponder on the terminating end
- (c) Intraoffice calls with transponders on both ends
- (d) Receipt and origination of long-distance calls
- (e) Calls to announcement circuits
- (f) Permanent signal receiver off-hook tone
- (g) Ringing with no answer, with transponder on either the originating or the receiving end
- (h) Calls to tone circuits, i.e., service tone, test tone, busy, and/or reorder
- (i) Simultaneous with voice source
- (j) Simultaneous with data source
- (k) Tip and ring reversal
- (l) Cable identification equipment.

[From NFPA 71, A-4-3.1]

A-4-2.3.1.2.3(b) Derived channel systems comprise Type 1 and Type 2 systems only.

[From NFPA 71, A-4-2.1.3(b)]

A-4-2.3.2.1.3 In order to give the DACT the ability to disconnect an incoming call to the protected premises, telephone service must be of the type that provides for timed-release disconnect. In some telephone systems (step-by-step offices), timed-release disconnect may not be provided.

[From NFPA 71, A-5-2.3, and NFPA 72, A-8-7.2.3]

A-4-2.3.2.1.5 A DACT may be programmed to originate calls to the DACR telephone lines (numbers) in any alternating sequence. The sequence can consist of single or multiple calls to one DACR telephone line (number), followed by single or multiple calls to a second DACR telephone line (number), or any combination thereof that is consistent with the minimum/maximum attempt requirements in 4-2.3.2.1.5.

[From NFPA 71, A-5-2.5 modified, and NFPA 72, A-8-7.2.5 modified]

A-4-2.3.2.1.7 Most failures of a telephone line may be detected by supervising the presence of the telephone line voltage. A loss of voltage indicates failure. Where the telephone line is also used for telephone communication, the voltage will drop when the telephone is in use. The presence of current will also indicate a normal line condition during this period.

[From NFPA 71, A-5-2.7, and NFPA 72, A-8-7.2.7]

A-4-2.3.2.1.11 Since call forwarding requires equipment at a telephone company central office that might occasionally interrupt the call forwarding feature, a signal should be initiated whereby the integrity of the forwarded telephone line (number) that is being called by DACTs is verified every 4 hours. This may be accomplished by a single DACT either in service or used solely for verification that automatically initiates and completes a transmission sequence to its associated DACR every 4 hours. A successful signal transmission sequence of any other type within the same 4-hour period should be considered sufficient to fulfill this requirement.

Call forwarding should not be confused with WATS or 800 service. The latter, differentiated by dialing the 800 prefix, is a dedicated service used mainly for its toll-free feature; all calls are pre-determined to terminate at a fixed telephone line (number) or to a dedicated line.

[New paragraphs]

A-4-2.3.2.2.2.1 The timed-release disconnect considerations as outlined in A-4-2.3.2.1.3 apply to the telephone lines (numbers) connected to a DACR at the supervising station.

It may be necessary to consult with appropriate telephone service personnel to ensure that numbers assigned to the DACR can be individually accessed even though they may be connected in rotary (a hunt group).

[From NFPA 71, A-5-3.3.1 modified, and NFPA 72, A-8-7.3.3.1 modified]

A-4-2.3.2.2.2.3 In determining system loading, Table 4-2.3.2.2.2.3 may be used, or it may be demonstrated that there is a 90 percent probability of incoming line availability. Table 4-2.3.2.2.2.3 is based on an average distribution of calls and an average connected time of 30 seconds for a message. Therefore, when it is proposed to use Table 4-2.3.2.2.2.3 to determine system loading, if any factors are

disclosed that will extend DACR connect time so as to increase the average connect time, this will dictate that the alternate method of determining system loading be used. Higher (or possibly lower) loadings may be appropriate in some applications. Some factors that may increase (or decrease) the capacity of a hunt group are listed below.

(a) Shorter (or longer) average message transmission time.

(b) The use of audio monitoring (listen-in) slow scan video or other similar equipment may significantly increase the connected time for a signal and reduce effective hunt group capacity.

(c) The clustering of active burglar alarm signals may generate high peak loads at certain hours.

(d) Inappropriate scheduling of 24-hour test signals may generate excessive peak loads.

Demonstration of a 90-percent probability of incoming line availability can be accomplished by the following in-service monitoring of line activity:

1. Incoming lines are assigned to telephone hunt groups. When a DACT calls the main number of a hunt group, it can connect to any currently available line in that hunt group.

2. The receiver continuously monitors the "available" status of each line. A line is available if it is waiting for an incoming call. A line is unavailable for any of the following reasons:

(i) Currently processing a call

(ii) Line in trouble

(iii) Audio monitoring (listen-in) in progress

(iv) Any other condition that makes the line input unable to accept calls.

3. The receiver monitors the "available" status of the hunt group. A hunt group is available if any line in it is available.

4. A message is emitted by the receiver if a hunt group is unavailable for more than 1 minute in 10. This message references the hunt group and the degree of overload.

[From NFPA 71, A-5-3.3.3 modified, and NFPA 72, A-8-7.3.3.3 modified]

A-4-2.3.2.2.2.4 The verification of the 24-hour DACR line test should be done early enough in the day to allow repairs to be made by the telephone company.

[From NFPA 71, A-5-3.3.4, and NFPA 72, A-8-7.3.3.4]

A-4-2.3.3.1.2 The following suggested coded signal assignments for a building having four floors and basements are provided as a guide:

Location	Coded Signal
4th Floor	2-4
3rd Floor	2-3
2nd Floor	2-2
1st Floor	2-1
Basement	3-1
Sub-Basement	3-2

[From NFPA 71, A-6-2.1.2, and NFPA 72, A-2-4.3 modified]

A-4-2.3.3.2.5(c) Though rare, it is understood that the occurrence of a wire-to-wire short on the primary trunk facility near the supervising station could disable the transmission system without immediate detection.

[From NFPA 71, A-6-3.4.1(c) modified]

A-4-2.3.3.2.6(d)(3) Though rare, it is understood that the occurrence of a wire-to-wire short on the primary trunk facility near the supervising station could disable the transmission system without immediate detection.

[From NFPA 71, A-6-3.4.2(d)(3) modified]

A-4-2.3.3.3.5 Verify by test at time of system acceptance.

[From NFPA 71, A-6-4.3.1]

A-4-2.3.4.4 The intent of the plurality of control sites is to safeguard against damage caused by lightning and to minimize the effect of interference on the receipt of signals.

[From NFPA 71, A-7-3.1.4]

A-4-2.3.5.2 It is intended that each RAT communicate with two or more independently located RARSRs. The location of such RARSRs should be such that they do not share common facilities.

NOTE: All probability calculations required for the purposes of Chapter 4 should be made in accordance with established communications procedures, should assume the maximum channel loading parameters specified, and should further assume that 25 RATs are actively in alarm and are being received by each RARSR.

[From NFPA 71, A-8-1.2.3 modified]

A-4-2.3.7.2(b) Transmitters should be operated alternately, 16 hours on, 16 hours off.

[From NFPA 72, A-9-5.2(b)]

A-4-2.4.1 The signal information may be provided in coded form. Records may be used to interpret these codes.

[From NFPA 71, A-5-3.2.1, and NFPA 72, A-8-7.3.2.1]

A-4-2.4.2 In order to expedite repairs, it is recommended that spare modules, such as printed circuit boards, CRT displays, printers, etc., be stocked at the supervising station.

[From NFPA 71, A-4-1.2.3 modified and A-7-1.2.3 modified]

A-4-2.4.3 For all forms of transmission, the maximum time to process an alarm signal should be 90 seconds. The maximum time to process a supervisory signal should be 4 minutes. The time to process an alarm or supervisory signal is defined as that time from which a signal is received to the time that retransmission or subscriber contact is initiated.

When the level of traffic in a supervising station system reaches a magnitude such that delayed response is possible, even though the loading tables or loading formulas of this code are not exceeded, it is envisioned that it will be necessary to employ an enhanced method of processing.

For example, in a system where a single DACR instrument provided fire and burglar alarm service is connected to multiple telephone lines, it is conceivable that during certain periods of the day, fire alarm signals may be

delayed by the security signaling traffic such as opening and closing signals. Such an enhanced system would be one that, upon receipt of signal would:

(a) Automatically process the signals, differentiating between those that require immediate response by supervising station personnel and those that need only be logged

(b) Automatically provide relevant subscriber information to assist supervising station personnel in their response

(c) Maintain a timed, unalterable log of the signals received and the response of supervising station personnel to such signals.

[From NFPA 71, A-1-7.1 modified]

A-4-3.2.2 There are related types of contract service that often are provided from or controlled by a central station, but that are neither anticipated by nor consistent with the provisions of 4-3.2.2. Although 4-3.2.2 does not preclude such arrangements, a central station company is expected to recognize, provide for, and preserve the reliability, adequacy, and integrity of those supervisory and alarm services intended to be in accordance with the provisions of 4-3.2.2.

[From NFPA 71, A-1-2.2 modified]

A-4-3.2.4 It is the responsibility of the prime contractor to remove all compliance markings (certification markings or placards) when a service contract goes into effect that conflicts in any way with the requirements of 4-3.2.4.

[From NFPA 71, A-1-2.4 modified]

A-4-3.2.5 The prime contractor should be aware of statutes, public agency regulations, or certifications regarding fire alarm systems that may be binding on the subscriber. The prime contractor should identify for the subscriber which agencies could be an authority having jurisdiction and, where possible, advise the subscriber of any requirements or approvals being mandated by these agencies.

The subscriber has the responsibility for notifying the prime contractor of those private organizations that are being designated as an authority having jurisdiction. The subscriber also has the responsibility to notify the prime contractor of changes in the authority having jurisdiction, such as where there is a change in insurance companies. Although the responsibility is primarily the subscriber's, the prime contractor should also take responsibility to seek out these "private" authorities having jurisdiction through the subscriber. The prime contractor has the responsibility for maintaining current records on the authority(ies) having jurisdiction for each protected premises.

The most prevalent public agency involved as an authority having jurisdiction with regard to fire alarm systems is the local fire department or fire prevention bureau. These are normally city or county agencies with statutory authority and may be required to approve fire alarm system installations. At the state level, the fire marshal's office would be most likely to serve as the public regulatory agency.

The most prevalent private organizations involved as authorities having jurisdiction are insurance companies. Others include insurance rating bureaus, insurance brokers and agents, and private consultants. It is important to note that these organizations have no statutory authority and become authorities having jurisdiction only when designated by the subscriber.

With both public and private concerns to satisfy, it is not uncommon to find multiple authorities having jurisdiction involved with a particular protected premises. It is necessary to identify all authorities having jurisdiction in order to obtain all the necessary approvals for a central station fire alarm system's installation.

[From NFPA 71, A-1-4.1 modified]

A-4-3.4.4 Two telephone lines at the central station connected to the public switched telephone network, each having its own telephone instrument connected, and two telephone numbers available at the public fire service communication center to which a central station operator may retransmit an alarm meets the intent of this requirement.

[New paragraph]

A-4-3.4.4.2 The following methods have been used successfully for supervising retransmission circuits (channels):

(a) An electrically supervised circuit (channel) provided with suitable code sending and automatic recording equipment.

(b) A supervised circuit (channel) providing suitable voice transmitting, receiving, and automatic recording equipment. The circuit may be a telephone circuit that:

1. Cannot be used for any other purpose;
2. Is provided with a two-way ring down feature for supervision between the fire department communications center and the central station;
3. Is provided with terminal equipment located on the premises at each end; and
4. Is provided with 24-hour standby power provided.

Exception: Local on-premises circuits need not be supervised.

(c) Radio facilities using transmissions over a supervised channel with supervised transmitting and receiving equipment. Circuit continuity ensured at intervals not exceeding 8 hours by any means is satisfactory.

[From NFPA 71, A-1-7.2.2 modified]

A-4-3.6.1.1(a) Use of the term "immediately" in this context is intended to mean "without unreasonable delay." Routine handling should take a maximum of 90 seconds from receipt of an alarm signal by the central station until the initiation of retransmission to the public fire service communication center.

[New paragraph]

A-4-3.6.1.3 It is anticipated that the central station will first attempt to notify designated personnel at the protected premises. When such notification cannot be made, it may be appropriate to notify law enforcement and/or the fire department. For example, if a valve supervisory signal is received where protected premises are not occupied, it may be appropriate to notify police.

[From NFPA 71, A-1-10.2.3 modified]

A-4-3.6.1.3(a) Use of the term "immediately" in this context is intended to mean "without unreasonable delay." Routine handling should take a maximum of 4 minutes from receipt of a supervisory signal by the central station until initiation of communication with person(s) designated by the subscriber.

[New paragraph]

A-4-3.6.1.4(a) Use of the term "immediately" in this context is intended to mean "without unreasonable delay." Routine handling should take a maximum of 4 minutes from receipt of a trouble signal by the central station until initiation of the investigation by telephone.

[New paragraph]

A-4-3.6.1.5(b) Use of the term "immediately" in this context is intended to mean "without unreasonable delay." Routine handling should take a maximum of 4 minutes from receipt of a trouble signal by the central station until initiation of the investigation by telephone.

[From NFPA 71, A-1-10.2.5(b) modified]

A-4-4.2.3 The following functions are in Appendix A to provide guidelines for utilizing building systems and equipment in addition to proprietary fire alarm equipment to provide life safety and property protection.

Building functions that may be initiated or controlled during a fire alarm condition include, but are not limited to, the following:

(a) Elevator operation consistent with ANSI A17.1, *Safety Code for Elevators, Dumbwaiters, Escalators, and Moving Walks*.

(b) Unlocking stairwell and exit doors. Refer to NFPA 80, *Standard for Fire Doors and Fire Windows*, and NFPA 101, *Life Safety Code*.

(c) Release of fire and smoke dampers. Refer to NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, and NFPA 90B, *Standard for the Installation of Warm Air Heating and Air Conditioning Systems*.

(d) Monitoring and initiating of self-contained automatic fire extinguishing systems and equipment. Refer to NFPA 11, *Standard for Low Expansion Foam and Combined Agent Systems*; NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*; NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*; NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*; NFPA 12B, *Standard on Halon 1211 Fire Extinguishing Systems*; NFPA 13, *Standard for the Installation of Sprinkler Systems*; NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*; NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*; and NFPA 17, *Standard for Dry Chemical Extinguishing Systems*.

(e) Lighting control necessary to provide essential illumination during fire alarm conditions. Refer to NFPA 70, *National Electrical Code*, and NFPA 101, *Life Safety Code*.

(f) Emergency shutoff of hazardous gas.

(g) Control of building environmental heating, ventilating, and air conditioning equipment to provide smoke control. Refer to NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*.

(h) Control of process, data processing, and similar equipment as necessary during fire alarm conditions.

[From NFPA 72, A-9-1]

A-4-4.6.5 It is the intent of this code that the operator within the proprietary supervising station should have a secure means of immediately retransmitting any signal indicative of a fire to the public fire department communication center. Automatic retransmission using an approved method installed in accordance with Sections 4-3, 4-4, 4-5, 4-6, and 4-7 is no doubt the best method for proper retransmission. However, a manual means may be used, consisting of either a manual connection following the requirements of Sections 4-3, 4-5, and 4-7, or, for proprietary supervising stations serving only contiguous properties, in the form of a municipal fire alarm box installed within 50 ft (15 m) of the proprietary supervising station in accordance with Section 4-6.

[From NFPA 72, A-9-3.2]

A-4-4.6.6 No matter what type of retransmission facility is used, telephone communication between the proprietary supervising station and the fire department should be available at all times and should not depend on a switch-board operator.

[From NFPA 72, A-9-3.3]

A-4-5.3 As a minimum, the room or rooms containing the remote supervising station equipment should have a 1-hour fire rating, and the entire structure should be protected by an alarm system complying with Chapter 3.

[New paragraph]

A-4-6.4.7 Indicating Lights.

(a) Current supply for designating lamps at street boxes should preferably be secured at lamp locations from the local electric utility company.

(b) Alternating current power may be superimposed on metallic fire alarm circuits for supplying designating lamps or for control or actuation of equipment devices for fire alarm or other emergency signals, provided:

1. Voltages between any wire and ground or between one wire and any other wire of the system shall not exceed 150 volts; the total resultant current in any line circuit shall not exceed $\frac{1}{4}$ amp.

2. Coupling capacitors, transformers, chokes, coils, etc., shall be rated for 600-volt working voltage and have a breakdown voltage of at least twice the working voltage plus 1000 volts.

3. There is not interference with fire alarm service under any conditions.

[From NFPA 1221 - 1991, A-4-1.4.1.5 modified]

A-4-6.6 If the intent is for complete coverage, then it will not be necessary to travel in excess of one block or 500 ft (150 m) to reach a box. In residential areas, it will not be necessary to travel in excess of 2 blocks or 800 ft (240 m) to reach a box.

[From NFPA 1221, 4-1.4.3.2 modified]

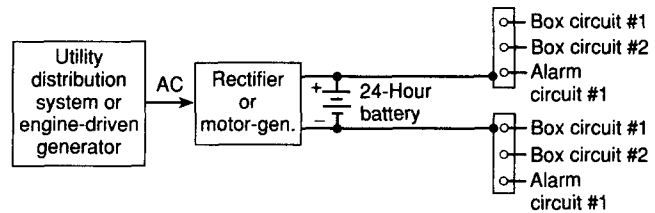


Figure A-4-6.7.1.7(a) Form 2A.

[From NFPA 1221, Figure B-4-1.5.3.1.1(a)]

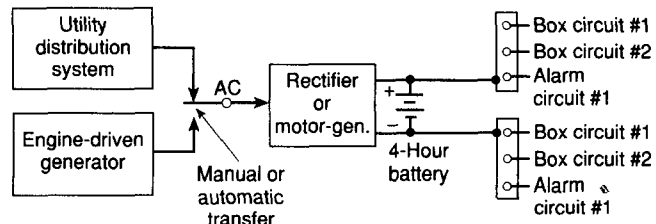


Figure A-4-6.7.1.7(b)(1) Form 2B-1.

[From NFPA 1221, Figure B-4-1.5.3.1.1(b)(1)]

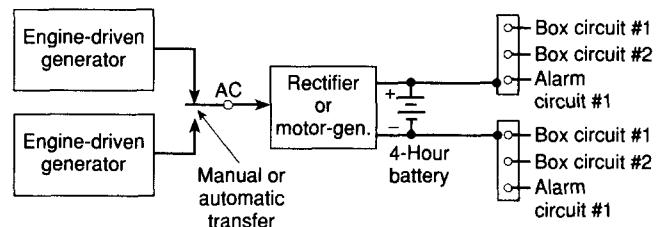


Figure A-4-6.7.1.7(b)(2) Form 2B-2.

[From NFPA 1221, Figure B-4-1.5.3.1.1(b)(2)]

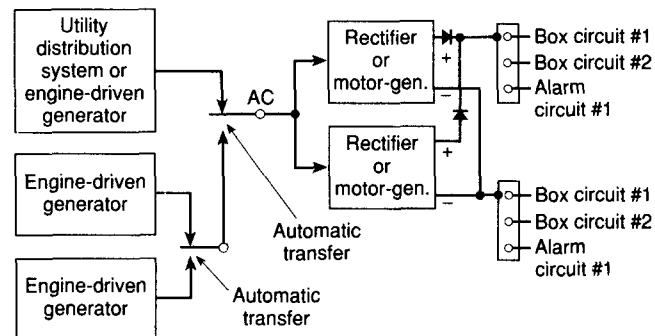


Figure A-4-6.7.1.7(c) Form 2C.

[From NFPA 1221, Figure B-4-1.5.3.1.1(c)]

A-4-6.9.1.4 All requirements for circuit protection do not apply to coded radio reporting systems. These systems do not use metallic circuits.

[New paragraph]

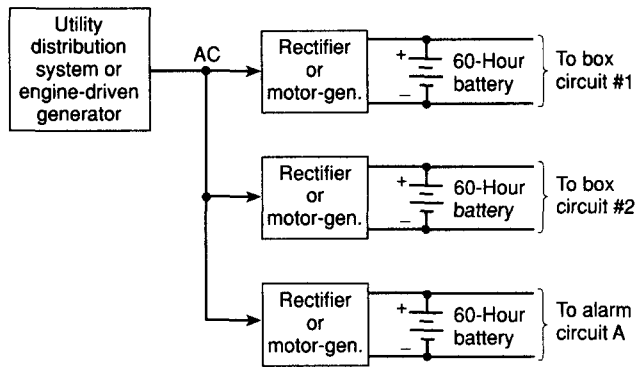


Figure A-4-6.7.1.8(a) Form 3A.

[From NFPA 1221, Figure B-4-1.5.3.1.2(a)]

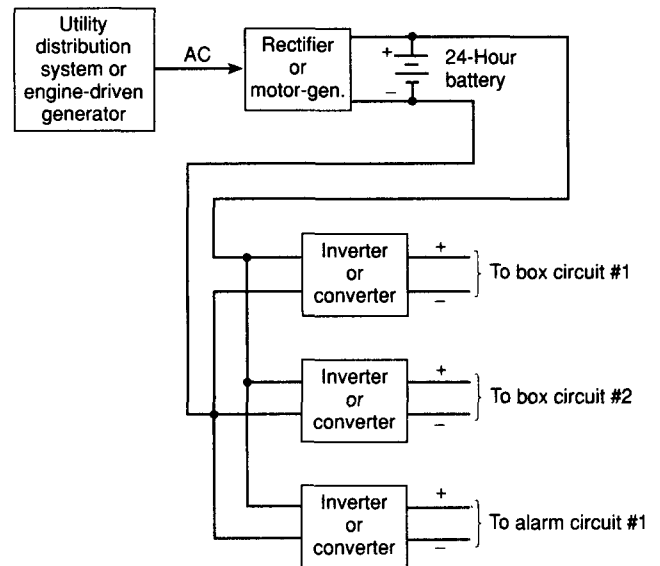


Figure A-4-6.7.1.9(a) Form 4A.

[From NFPA 1221, Figure B-4-1.5.3.1.3(a)]

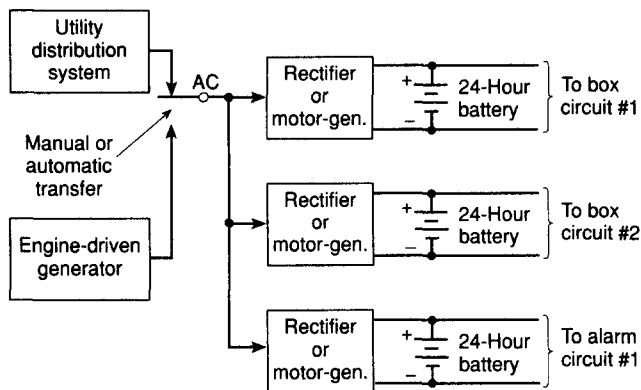


Figure A-4-6.7.1.8(b)(1) Form 3B-1.

[From NFPA 1221, Figure B-4-1.5.3.1.2(b)(1)]

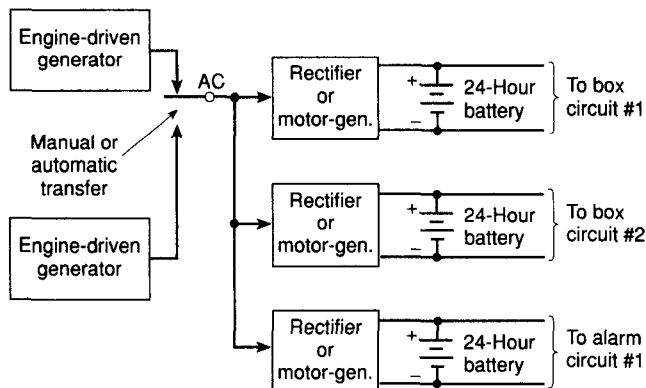


Figure A-4-6.7.1.8(b)(2) Form 3B-2.

[From NFPA 1221, Figure B-4-1.5.3.1.2(b)(2)]

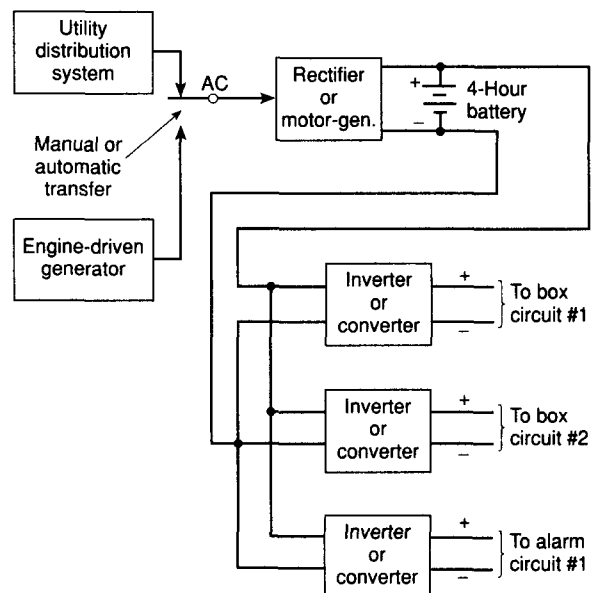


Figure A-4-6.7.1.9(b)(1) Form 4B-1.

[From NFPA 1221, Figure B-4-1.5.3.1.3(b)(1)]

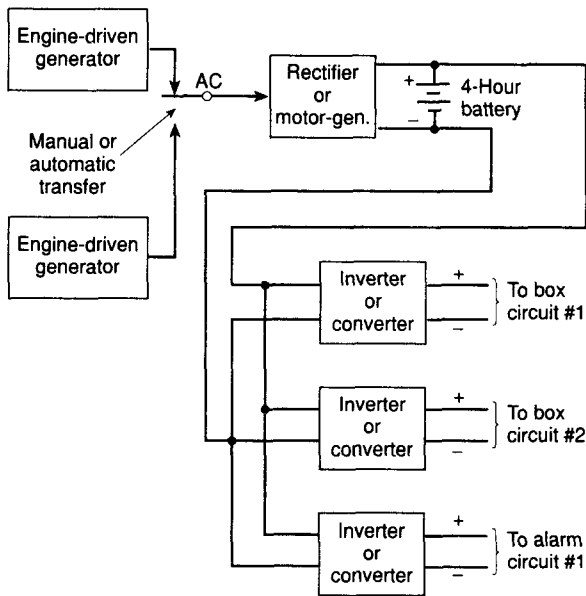


Figure A-4-6.7.1.9(b)(2) Form 4B-2.
[From NFPA 1221, Figure B-4-1.5.3.1.3(b)(2)]

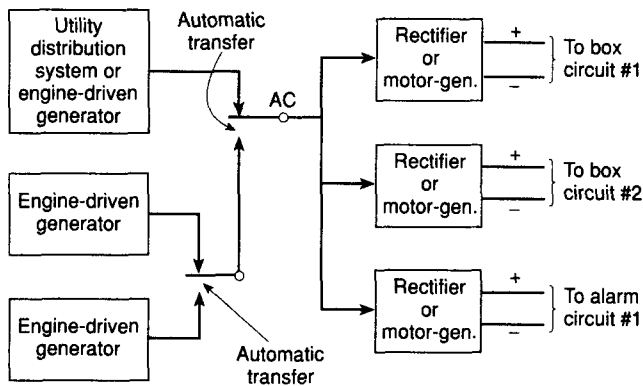


Figure A-4-6.7.1.9(c) Form 4C.
[From NFPA 1221, Figure B-4-1.5.3.1.3(c)]

Poling required for transpondance (two-way) type systems only.

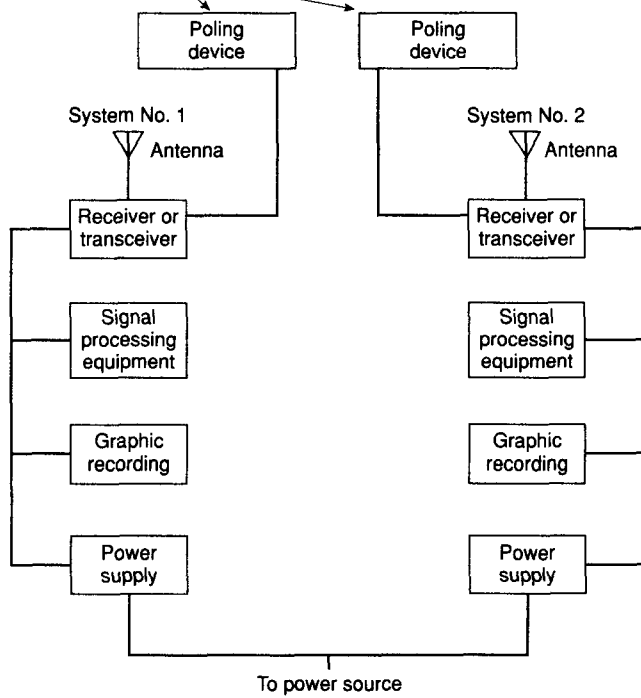


Figure A-4-6.14.3.1.1
[From NFPA 1221, Figure B-4-3.4.2.1]

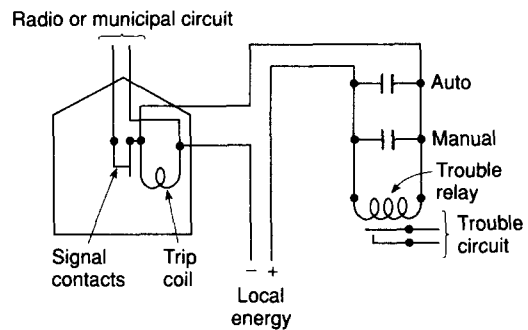


Figure A-4-7.4.1(a)(1)
[From NFPA 72, Figure A-7-3(a)(1)]

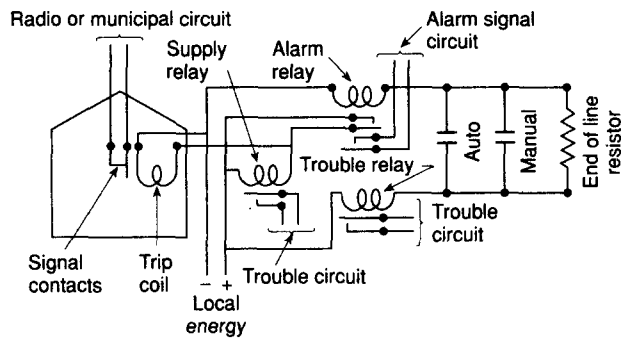


Figure A-4-7.4.1(a)(2)
[From NFPA 72, Figure A-7-3(a)(2)]

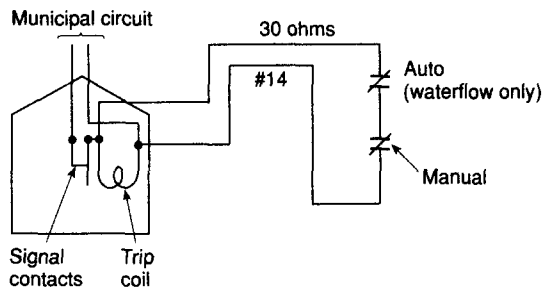


Figure A-4-7.4.1(b)(1)
[From NFPA 72, Figure A-7-3(b)(1)]

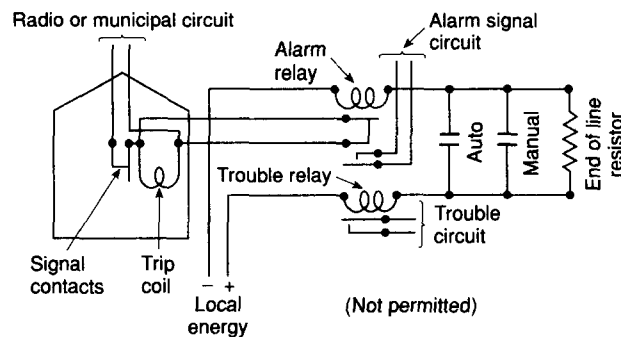


Figure A-4-7.4.1(b)(2)
[From NFPA 72, Figure A-7-3(b)(2)]

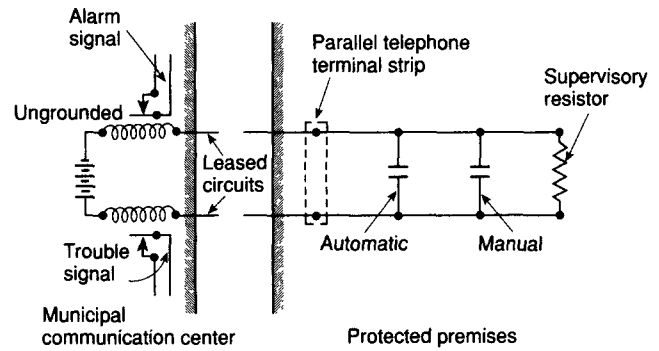


Figure A-4-7.4.1(c)
[From NFPA 72, Figure A-7-3(c)]

A-5-1.3.5 Detectors may be required under large benches, shelves, or tables, and inside cupboards or other enclosures.

[From NFPA 72E - 1990, 2-7.5]

A-5-1.4 Refer to Figures A-5-1.4(a) and (b) for proper connections of automatic fire detectors to fire alarm systems initiating device circuits and power supply circuits.

[From NFPA 72E - 1990, A-2-7.7]

A-5-2.4.2 The linear space rating is the maximum allowable distance between heat detectors. The linear space rating is also a measure of the heat detector response time to a standard test fire where tested at the same distance. The higher the rating, the faster the response time. This code recognizes only those heat detectors with ratings of 50 ft (15 m) or more.

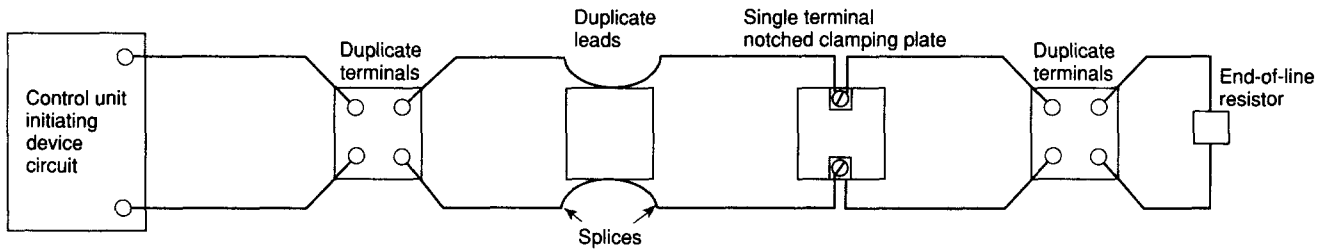
[From NFPA 74, A-4-3]

A-5-2.6 A heat detector with a temperature rating somewhat in excess of the highest normally expected ambient temperature is specified in order to avoid the possibility of premature operation of the heat detector to nonfire conditions.

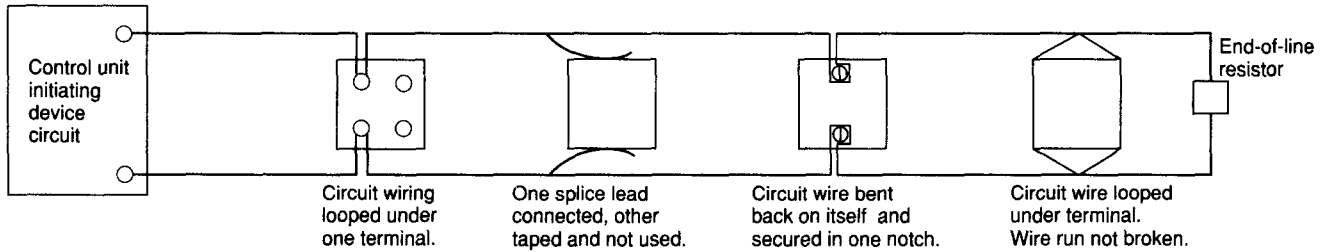
[From NFPA 74, A-4-3.1]

A-5-2.7 In addition to the special requirements for heat detectors installed on ceilings with exposed joists, reduced spacing may also be required due to other structural characteristics of the protected area, possible drafts, or other conditions that may affect detector operation.

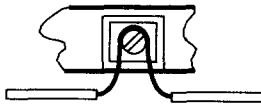
[From NFPA 74, A-5-2.2.5]



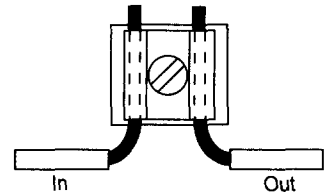
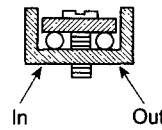
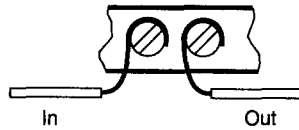
Correct wiring method – Two wire detectors



Incorrect wiring method – Two wire detectors



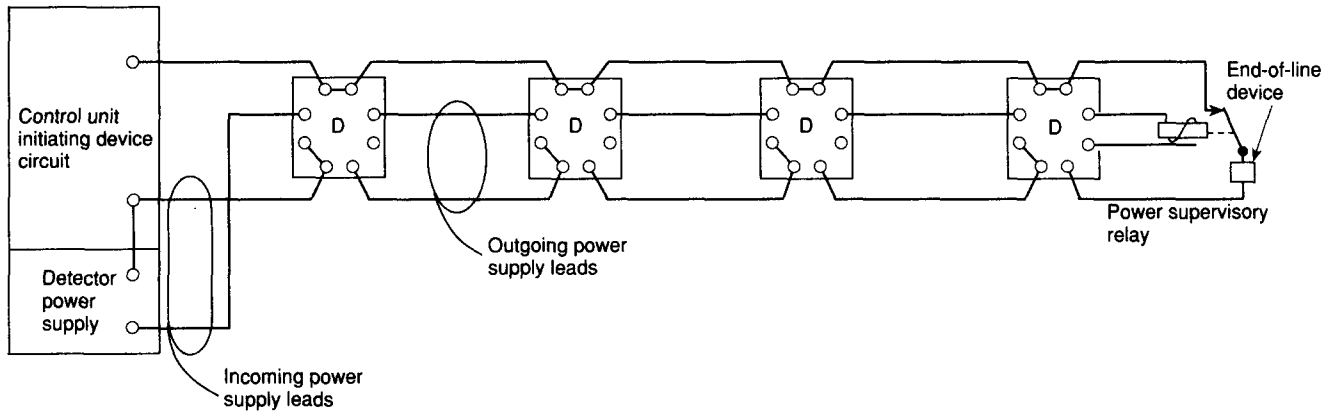
Incorrect



Correct – Separate incoming and outgoing conductors

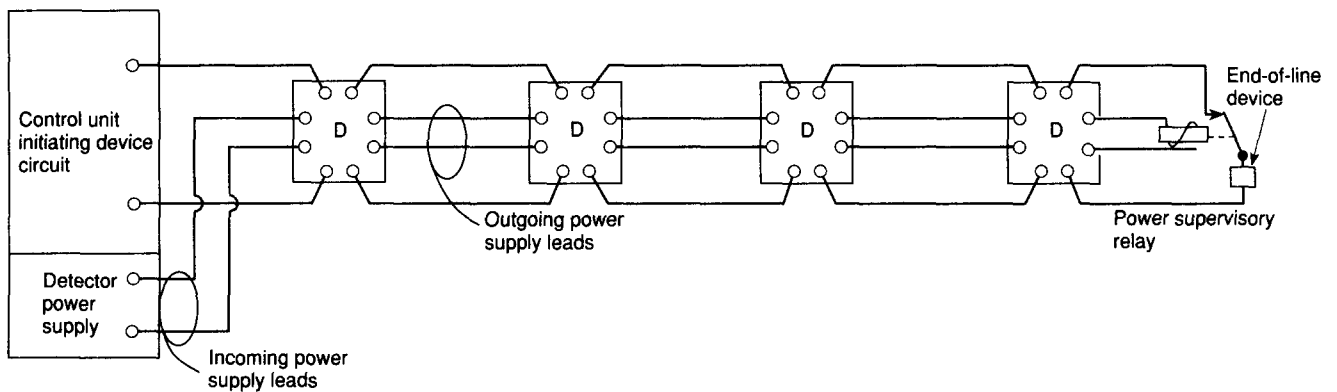
Figure A-5-1.4(a) Correct wiring methods — four-wire detectors with separate power supply.

[From NFPA 72E - 1990, A-2-7.7(a)]



D = Detector

Illustrates 4-wire smoke detector employing a 3-wire connecting arrangement. One side of power supply is connected to one side of initiating device circuit. Wire run broken at each connection to smoke detector to provide supervision.

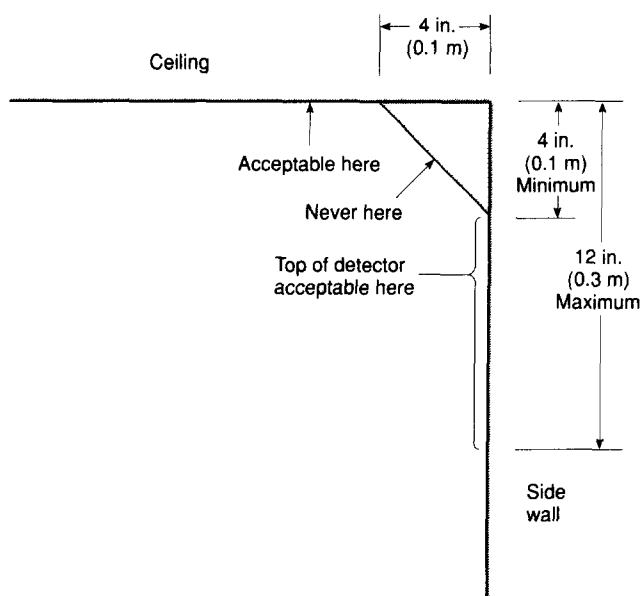


D = Detector

Illustrates 4-wire smoke detector employing a 4-wire connecting arrangement. Incoming and outgoing leads or terminals for both initiating device and power supply connections. Wire run broken at each connection to provide supervision.

Figure A-5-1.4(b)

[From NFPA 72E - 1990, Figure A-2-7.7(b)]



NOTE: Measurements shown are to the closest edge of the detector.

Figure A-5-2.5.1 Example of proper mounting for detectors.

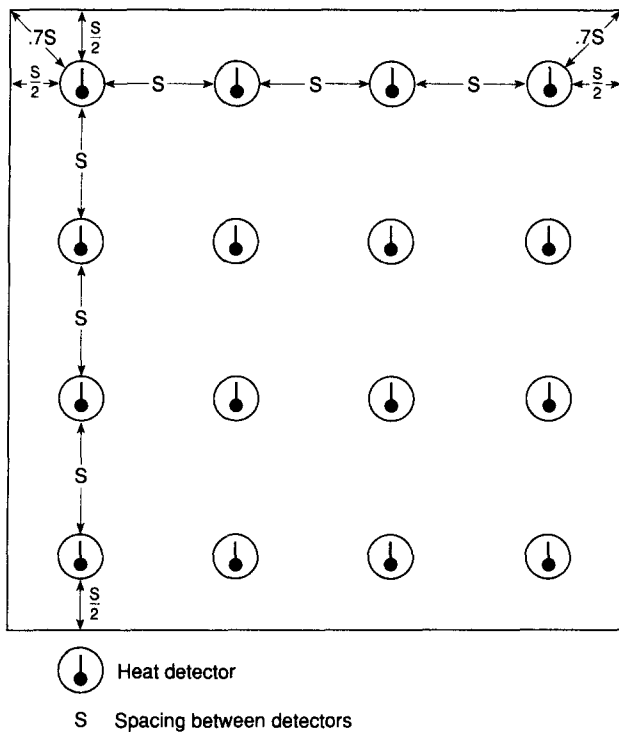


Figure A-5-2.7.1(a) Spot-type heat detectors.

[From NFPA 72E - 1990, Figure A-3-4.1]

A-5-2.7.1 Maximum linear spacings on smooth ceilings for spot-type heat detectors are determined by full-scale fire tests. These tests assume that the detectors are to be installed in a pattern of one or more squares, each side of which equals the maximum spacing as determined in the test. This is illustrated in Figure A-5-2.7.1(a). The detectors to be tested are placed at one corner of the square, which is the furthest distance it can be from the fire while still within the square. Thus the distance from the detector ("D") to the fire ("F") is always the test spacing multiplied by 0.7 and can be set up in the following tables:

Test Spacing	Maximum Test Distance from Fire to Detector ($0.7 \times D$)
50 × 50 ft	35 ft
40 × 40 ft	28 ft
30 × 30 ft	21 ft
25 × 25 ft	17.5 ft
20 × 20 ft	14 ft
15 × 15 ft	10.5 ft

For SI Units: 1 ft = 0.305 m.

Once the correct maximum test distance has been determined, then it is valid to interchange the positions of the fire ("F") and the detector ("D"). The detector is now in the middle of the square, and what the listing actually says is that the detector is adequate to detect a fire that occurs anywhere within that square — even out to the farthest corner.

In laying out detector installations, designers speak in terms of rectangles, as building areas are generally rectan-

gular in shape. The pattern of heat spread from a fire source, however, is not rectangular in shape. On a smooth ceiling, heat will spread out in all directions, in an ever-expanding circle. Thus, the coverage of a detector is not in fact a square, but rather a circle whose radius is the linear spacing multiplied by 0.7.

This is graphically illustrated in Figure A-5-2.7.1(b). With the detector as the center, by rotating the square, an infinite number of squares can be laid out, the corners of which will plot a circle whose radius is 0.7 times the listed spacing. The detector will cover any of these squares and, consequently, any point within the confines of the circle.

So far this explanation has considered squares and circles. In practical applications, very few areas turn out to be exactly square, and circular areas are rare indeed. Designers deal generally with rectangles of odd dimensions and corners of rooms or areas formed by wall intercepts, where spacing to one wall is less than one-half the listed spacing. To simplify the rest of this explanation, consider the use of a detector with a listed spacing of 30 ft by 30 ft (9.1 m by 9.1 m). The principles derived will be equally applicable to other types.

Figure A-5-2.7.1(c) illustrates the derivation of this concept. A detector is placed in the center of a circle with a radius of 21 ft (0.7×30 ft) [6.4 m (0.7×9.1 m)]. A series of rectangles with one dimension less than the permissible maximum of 30 ft (9.1 m) is constructed within the circle. The following conclusions can be drawn:

(a) As the smaller dimension decreases, the longer dimension can be increased beyond the linear maximum spacing of the detector with no loss in detection efficiency.

(b) A single detector will cover any area that will fit within the circle. For a rectangle, a single properly located detector will suffice if the diagonal of the rectangle does not exceed the diameter of the circle.

(c) Relative detector efficiency will actually be increased, because the area coverage in sq ft is always less than the 900 sq ft (83.6 m^2) permissible if the full 30 ft by 30 ft (9.1 m by 9.1 m) square were to be utilized. The principle illustrated here allows equal linear spacing between the detector and the fire, with no recognition for the effect of reflection from walls or partitions, which in narrow rooms or corridors will be of additional benefit. For detectors that are not centered, the longer dimension should always be used in laying out the radius of coverage.

Areas so large that they exceed the rectangular dimensions given in Figure A-5-2.7.1(c) require additional detectors. Often proper placement of detectors can be facilitated by breaking down the area into multiple rectangles of the dimensions that fit most appropriately. [See Figure A-5-2.7.1(d).] For example, see Figure A-5-2.7.1(c). A corridor 10 ft (3 m) wide and up to 82 ft (25 m) long can be covered with two 30-ft (9.1-m) detectors. An area 40 ft (12.2 m) wide and up to 74 ft (22.6 m) long can be covered with four detectors. Irregular areas will take more careful planning to make sure that no spot on the ceiling is more than 21 ft (6.4 m) away from a detector. These points can be determined by striking arcs from the remote corner. Where any part of the area lies beyond the circle with a radius of 0.7 times the listed spacings, additional detectors are required.

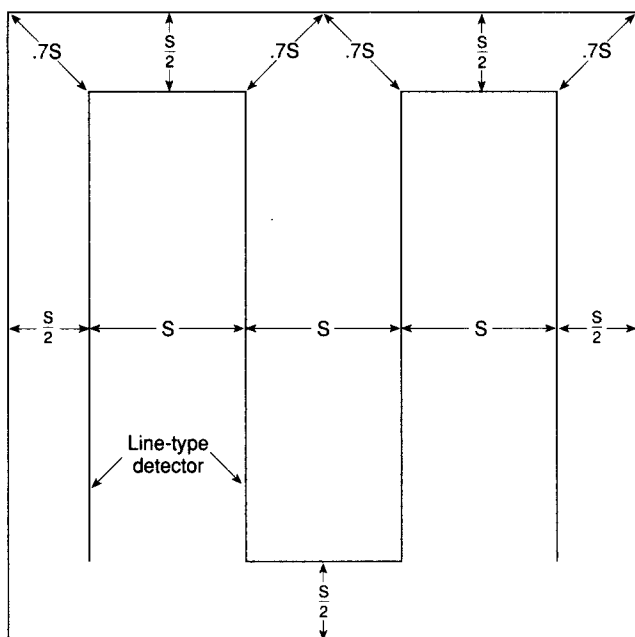


Figure A-5-2.7.1(b) Line-type detectors — spacing layouts, smooth ceiling.
[From NFPA 72E - 1990, Figure A-3-5.1]

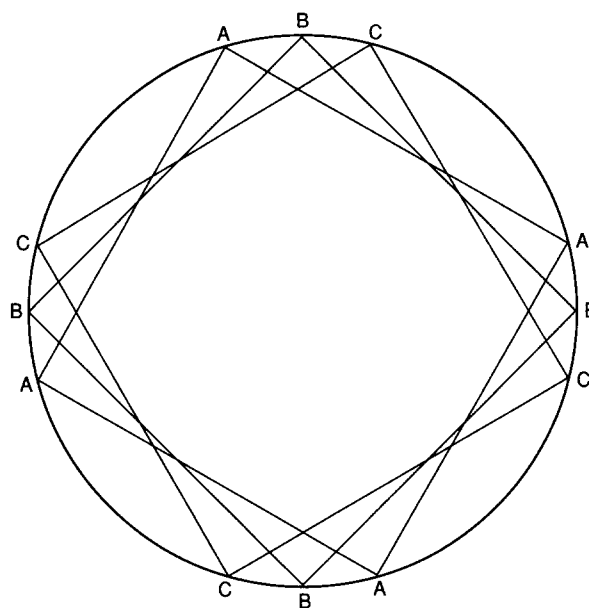
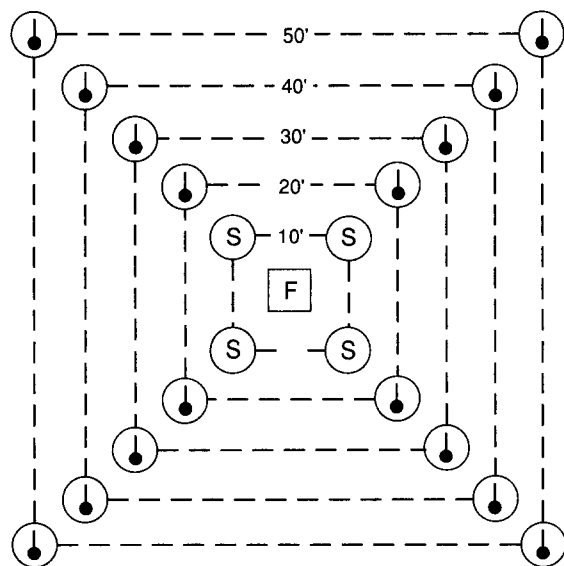


Figure A-5-2.7.1(d) A detector will cover any square laid out in the confines of a circle whose radius is 0.7 times the listed spacing.
[From NFPA 72E - 1990, A-3-5.1(b)]

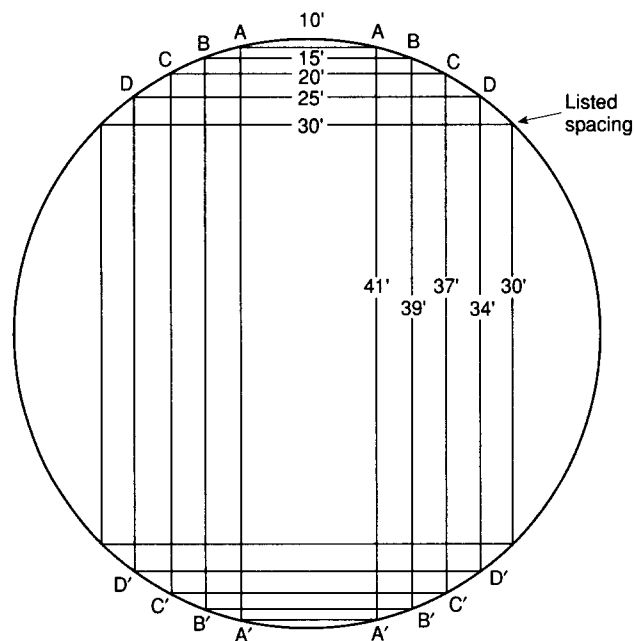


Legend

- F —Test fire, denatured alcohol, 190-proof. Pan located approximately 3 ft (0.9 m) above floor.
- S —Indicates normal sprinkler spacings on 10-ft (3-m) schedules.
- —Indicates normal heat detector spacing on various spacing schedules.

For SI Units: 1 ft = 0.305 m.

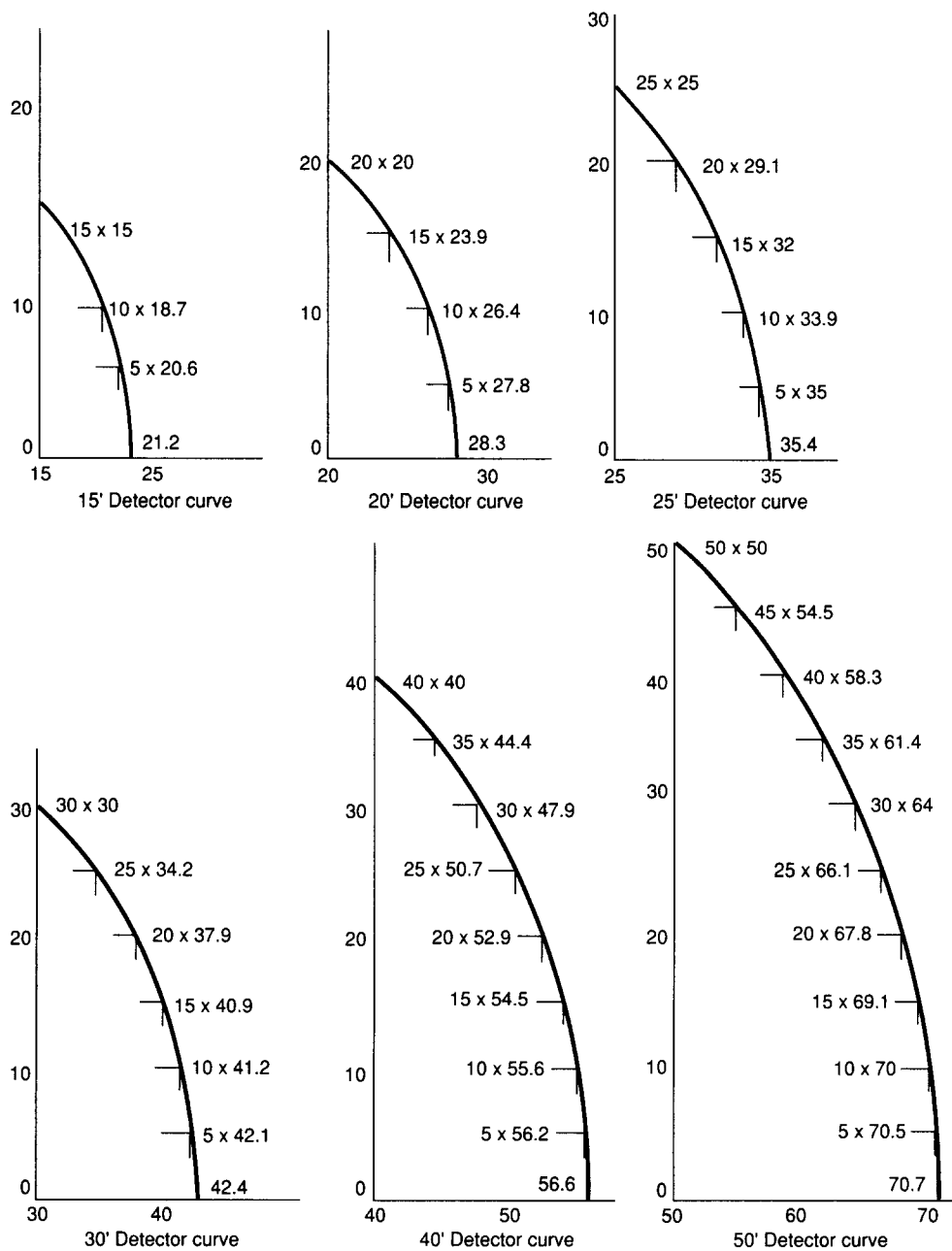
Figure A-5-2.7.1(c) Fire test layout.
[From NFPA 72E - 1990, A-3-5.1(a)]



- Rectangle A = 10' x 41' = 410 sq ft
- B = 15' x 39' = 585 sq ft
- C = 20' x 37' = 740 sq ft
- D = 25' x 34' = 850 sq ft
- Listed spacing = 30' x 30' = 900 sq ft

For SI Units: 1 ft = 0.305 m.

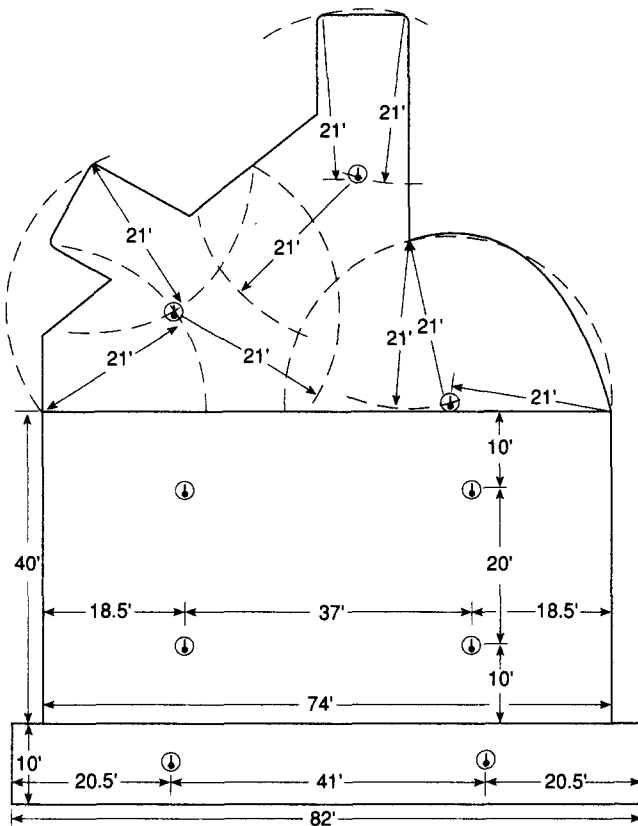
Figure A-5-2.7.1(e) Detector spacing, rectangular areas.
[From NFPA 72E - 1990, Figure A-3-5.1(c)]



For SI Units: 1 ft = 0.305 m.

Figure A-5-2.7.1(f) Typical rectangles for detector curves of 15 - 50 ft.

[From NFPA 72E - 1990, Figure A-3-5.1(d)]



For SI Units: 1 ft = 0.305 m.

Figure A-5-2.7.1.1 Detector spacing layout, irregular areas.

[From NFPA 72E - 1990, Figure A-3-5.1.1]

A-5-2.7.1.2 Both 5-2.7.1.2 and Table 5-2.7.1.2 are constructed to provide essentially the equivalent detector performance on higher ceilings [to 30 ft (9.1 m) high]] as that which would exist with detectors on a 10-ft (3-m) ceiling.

The Fire Detection Institute Fire Test Report (see references in Appendix C), used as a basis for Table 5-2.7.1.2, does not include data on integration-type detectors. Pending development of such data, the manufacturer's recommendations provide guidance.

[From NFPA 72E - 1990, A-3-5.1.2]

A-5-2.7.3 Location and spacing of heat detectors should consider beam depth, ceiling height, beam spacing, and fire size.

(a) If the ratio of beam depth (D) to ceiling height (H) (D/H) is greater than 0.10 and the ratio of beam spacing (W) to ceiling height (H) (W/H) is greater than 0.40, heat detectors should be located in each beam pocket.

(b) If either the ratio of beam depth to ceiling height (D/H) is less than 0.10 or the ratio of beam spacing to ceiling height (W/H) is less than 0.40, heat detectors should be installed on the bottom of the beams.

[From NFPA 72E - 1990, A-3-5.3]

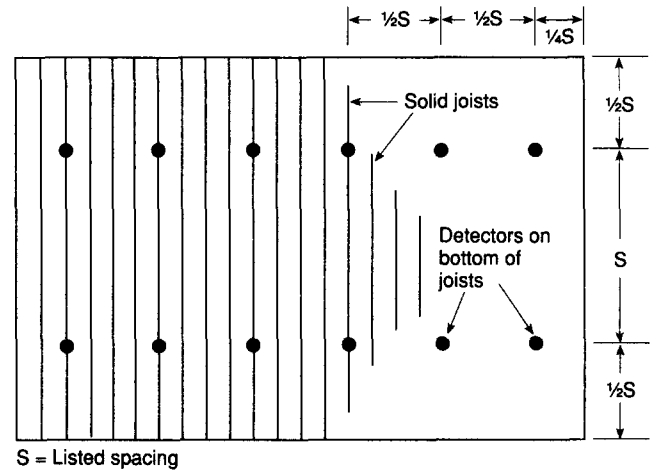
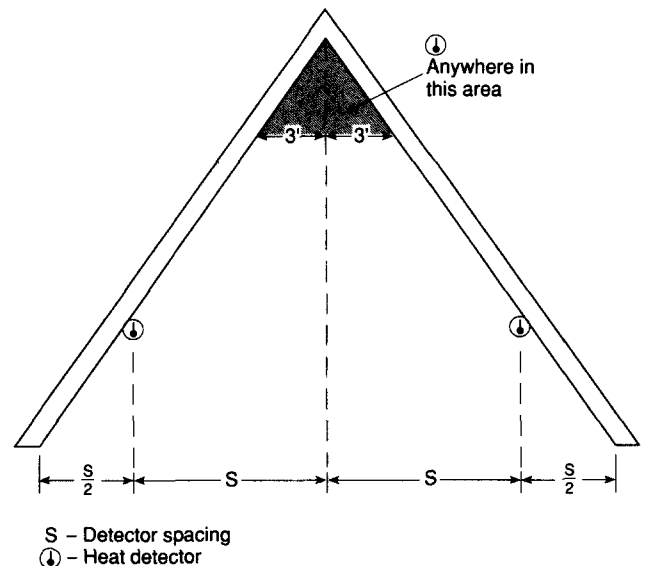


Figure A-5-2.7.2 Detector spacing layout, solid joist construction.

[From NFPA 72E - 1990, A-3-5.2]



For SI Units: 1 ft = 0.305 m.

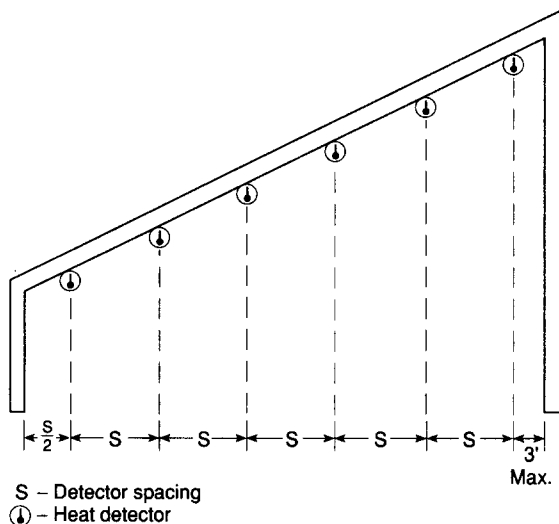
Figure A-5-2.7.4.1 Detector spacing layout, sloped ceilings (peaked type).

[From NFPA 72E - 1990, A-3-5.4.1]

A-5-3.1.1 The addition of a heat detector to a smoke detector does not enhance its performance as an early warning device.

[From NFPA 72E - 1990, A-4-1.1]

A-5-3.2 The person designing an installation should keep in mind that in order for a smoke detector to respond, the smoke must travel from the point of origin to the detector. In evaluating any particular building or location, likely fire locations should first be determined. From each of these points of origin, paths of smoke travel should be determined. Wherever practical, actual field tests should be conducted. The most desired location for smoke detectors would be the common points of intersection of smoke travel from fire locations throughout the building.



For SI Units: 1 ft = 0.305 m.

Figure A-5-2.7.4.2 Detector spacing layout, sloped ceilings (shed type).
 [From NFPA 72E - 1990, A-3-5.4.2]

NOTE: This is one of the reasons that specific spacing is not assigned to smoke detectors by the testing laboratories.
 [From NFPA 72E - 1990, A-4-1.3]

A-5-3.3.2 Most light-scattering detectors use a high intensity pulsed light source with silicon photodiode or phototransistor light sensors, resulting in excellent response to most smoldering fires and good response to most flaming fires.

[From NFPA 72E - 1990, A-4-2.2]

A-5-3.3.3 Projected beam detectors respond to the sum of the smoke obscuration in the beam path along its entire length between the transmitting unit and the receiving unit. A reduction in the received light initiates an alarm signal. A total and sudden loss of received light initiates a trouble signal indicating beam blockage or the need for service. Some projected beam detectors have signal-processing circuits to compensate for transient conditions and the effect of dust on sensitivity.

[From NFPA 72E - 1990, A-4-2.3]

A-5-3.5.1 For operation, all types of smoke detectors depend on smoke entering the sensing chamber or light beam. Where sufficient concentration is present, operation is obtained. Since the detectors are usually mounted on the ceiling, response time depends on the nature of the fire. A hot fire will rapidly drive the smoke up to the ceiling. A smoldering fire, such as in a sofa, produces little heat; therefore, the time for smoke to reach the detector will be increased.

[From NFPA 72E - 1990, A-4-4.1]

A-5-3.5.1.2 Stratification. Stratification of air in a room may hinder air containing smoke particles or gaseous combustion products from reaching ceiling-mounted smoke or fire-gas detectors.

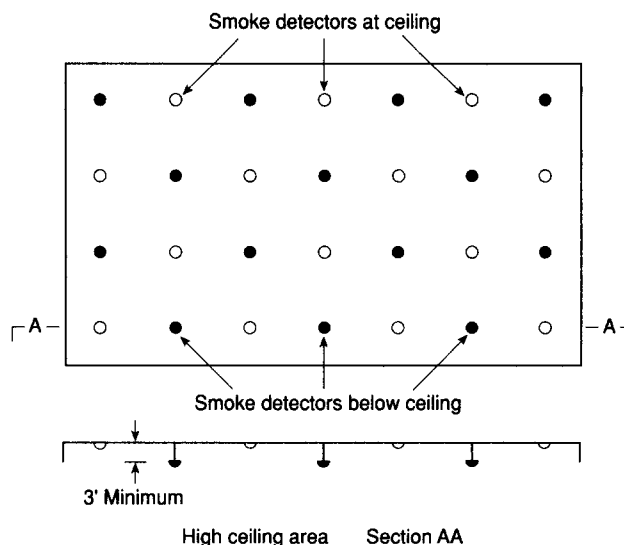
Stratification occurs when air containing smoke particles or gaseous combustion products is heated by smoldering

or burning material and, becoming less dense than surrounding cooler air, rises until it reaches a level at which there is no longer a difference in temperature between it and the surrounding air.

Stratification may also occur when evaporative coolers are used, because moisture introduced by these devices may condense on smoke, causing it to fall toward the floor. Therefore, to ensure rapid response, smoke detectors may need to be installed on sidewalls or at locations below the ceiling.

In installations where detection of smoldering or small fires is desired and where the possibility of stratification exists, consideration should be given to mounting a portion of the detectors below the ceiling. In high ceiling areas, projected beam-type or air sampling-type detectors at different levels should also be considered.

[From NFPA 72E - 1990, A-4-4.1.2]



For SI Units: 1 ft = 0.305 m.

Figure A-5-3.5.1.2 Smoke detector layout accounting for stratification.
 [From NFPA 72E - 1990, Figure A-4-4.1.2]

A-5-3.5.2 In high ceiling areas, such as atriums, where spot-type smoke detectors are not accessible for periodic maintenance and testing, projected beam-type or air sampling-type detectors should be considered where access can be provided.

[From NFPA 72E - 1990, A-4-4.2]

A-5-3.5.5.1.1 This will be useful in calculating locations in corridors or irregular areas. (See A-5-2.7.1 and Figure A-5-2.7.1.1.) For irregularly shaped areas, the spacing between detectors may be greater than the selected spacing, provided the maximum spacing from a detector to the farthest point of a sidewall or corner within its zone of protection is not greater than 0.7 times the selected spacing (0.7S). (See Figure A-5-2.7.1.1.)

[New paragraph]

A-5-3.5.5.2 On smooth ceilings, a spacing of not more than 60 ft (18.3 m) between projected beams and not more than one-half that spacing between a projected beam and a

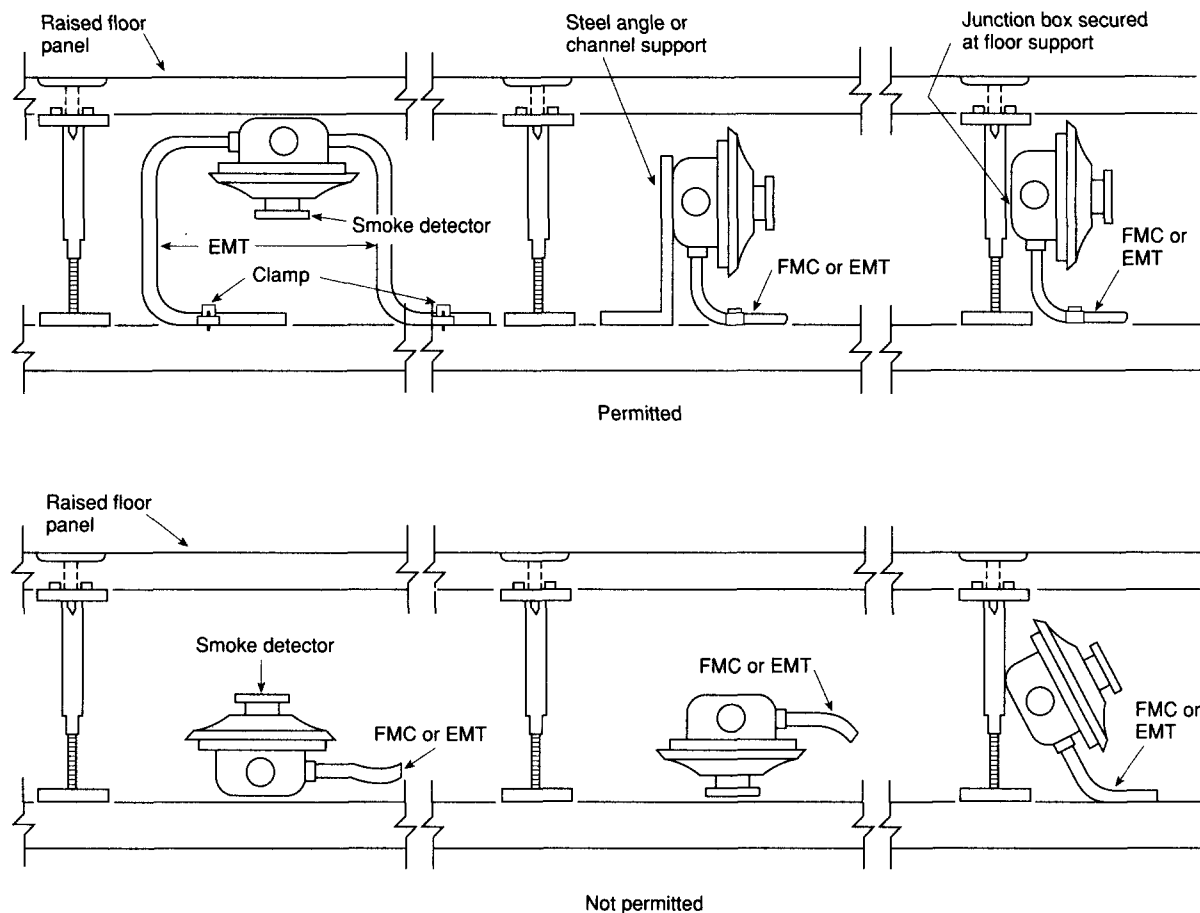


Figure A-5-3.5.2.1 Mounting installations, permitted (top) and not permitted (bottom).

[From NFPA 72E - 1990, Figure A-4-4.3.1.1]

sidewall (wall parallel to the beam travel) may be used as a guide. Other spacing may be determined depending on ceiling height, airflow characteristics, and response requirements.

In some cases, the light beam projector will be mounted on one end wall, with the light beam receiver mounted on the opposite wall. However, it is also permissible to suspend the projector and receiver from the ceiling at a distance from the end walls not exceeding one-quarter the selected spacing. For an illustration of this, see Figure A-5-3.5.5.2.

[From NFPA 72E - 1990, A-4-4.5.2]

A-5-3.5.6 Detectors are placed at reduced spacings at right angles to joists or beams in an attempt to ensure that detection time is equivalent to that which would be experienced on a flat ceiling. It takes longer for the combustion products (smoke or heat) to travel at right angles to beams or joists, because of the phenomenon wherein a plume from a relatively hot fire with significant thermal lift tends to fill the pocket between each beam or joist before moving to the next one.

Though it is true that this phenomenon may not be significant in a small smoldering fire where there is only enough thermal lift to cause stratification at the bottom of the joists, reduced spacing is still recommended to ensure

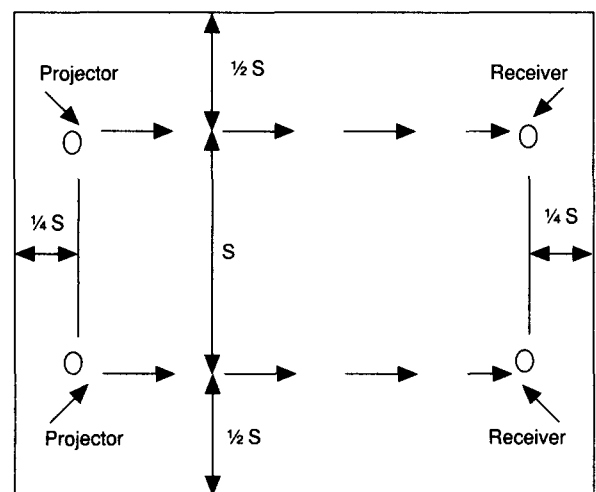


Figure A-5-3.5.5.2 Maximum distance that ceiling-suspended light beam projector and receiver may be positioned from end wall is $\frac{1}{4}$ selected spacing (S).

[From NFPA 72E - 1990, Figure A-4-4.5.2]

that detection time is equivalent to that which would exist on a flat ceiling, even in the hotter type of fire.

[From NFPA 72E - 1990, A-4-4.6]

A-5-3.5.7.4 To detect flaming fires (strong plumes), detectors should be installed as follows:

(a) If the ratio of the beam depth (D) to ceiling height (H) (D/H) is greater than 0.10 and the ratio of beam spacing (W) to ceiling height (H) (W/H) is greater than 0.40, detectors should be located in each beam pocket.

(b) If either the ratio of beam depth to ceiling height (D/H) is less than 0.10 or the ratio of beam spacing to ceiling height (W/H) is less than 0.40, detectors should be installed on the bottom of the beams.

To detect smoldering fires (weak or no plumes), detectors should be installed as follows:

(a) If air mixing into beam pockets is good (e.g., air-flow parallel to long beams) and condition (a) exists as above, detector should be located in each beam pocket.

(b) If air mixing into beam pockets is limited or condition (b) exists as above, detectors should be located on the bottom of the beams.

Research on plumes and ceiling jets indicates that the radius of a plume where it impinges on the ceiling is approximately 20 percent of the ceiling height above the fire source (p. 2H) and the minimum depth of the ceiling jet (at its turning point) is approximately 10 percent of the ceiling height above the fire source (y. 0.10H). For ceilings with beams deeper than the jet depth and spaced wider than the plume width, detectors will respond faster in the beam pocket because they will be in either the plume or ceiling jet. For ceilings with beams of less depth than ceiling jet or spaced closer than the plume width, detector response will not be enhanced by placing detectors in each beam pocket, and the detectors may perform better on (for spot-type detectors) or below (for beam detectors) the bottom of the beams.

Where plumes are weak, ventilation and mixing into the beam pockets will determine detector response. Where beams are closely spaced and airflow is perpendicular to the beam, mixing into the beam pocket is limited and detectors will perform better on or below the bottom of the beams.

[From NFPA 72E - 1990, A-4-4.7.4]

A-5-3.6.1 Detectors should not be located in a direct air-flow nor closer than 3 ft (900 mm) from an air supply diffuser.

[From NFPA 72E - 1990, A-4-5.1]

A-5-3.7.1.1 Product-listing standards include tests for temporary excursions beyond normal limits. In addition to temperature, humidity, and velocity variations, smoke

detectors should operate reliably under such common environmental conditions as mechanical vibration, electrical interference, and other environmental influences. Tests for these conditions are also conducted by the testing laboratories in their listing program. In those cases in which environmental conditions approach the limits shown in Table A-5-3.7.1.1, consult the detector manufacturer for additional information and recommendations.

[From NFPA 72E - 1990, A-4-6.1.1]

A-5-3.7.1.2 Smoke detectors may be affected by electrical and mechanical influences and by aerosols and particulate matter found in protected spaces. Location of detectors should be such that the influences of aerosols and particulate matter from sources such as those in Table A-5-3.7.1.2(a) are minimized. Similarly, the influences of electrical and mechanical factors shown in Table A-5-3.7.1.2(b) should be minimized. While it may not be possible to totally isolate environmental factors, an awareness of these factors during system layout and design will favorably affect detector performance.

[From NFPA 72E - 1990, A-4-6.1.2]

A-5-3.7.2.2 Airflow through holes in the rear of a smoke detector may interfere with smoke entry to the sensing chamber. Similarly, air from the conduit system may flow around the outside edges of the detector and again interfere with smoke reaching the sensing chamber. Additionally, holes in the rear of a detector provide a means for entry of dust, dirt, and insects, each of which can adversely affect the detector's performance.

[From NFPA 72E - 1990, A-4-6.2.2]

A-5-3.7.4.1 Air Sampling-Type Detectors. A single pipe network has a shorter transport time than a multiple pipe network of similar length pipe; however, a multiple pipe system provides a faster smoke transport time than a single pipe system of the same total length. As the number of sampling holes in a pipe increases, the smoke transport time increases. Where practical, pipe run lengths in a multiple pipe system should be nearly equal or the system should be otherwise pneumatically balanced.

A-5-3.7.4.2 The air sampling-type detector system should be able to withstand dusty environments by either air filtering or electronic discrimination of particle size. The detector should be capable of providing optimal time delays of alarm outputs to eliminate nuisance alarms due to transient smoke conditions. The detector should also provide facilities for the connection of monitoring equipment for

Table A-5-3.7.1.1 Environmental Conditions that Influence Detector Response

Detection Protection	Air Velocity > 300'/min	Atm. Pressure Above Sea Level	> 3000' Humidity > 93%	Temp. < 32°F > 100°F	Color of Smoke
Ion	X	X	X	X	O
Photo	O	O	X	X	X
Beam	O	O	X	X	O
Air Sampling	O	O	X	X	O

X = May affect detector response.

O = Generally does not affect detector response.

[From NFPA 72E - 1990, Table A-4-6.1.4]

Table A-5-3.7.1.2(a) Common Sources of Aerosols and Particulate Matter Moisture**Moisture**

Live steam
Steam tables
Showers
Humidifiers
Slop sink
Humid outside air
Water spray

Excessive tobacco smoke
Heat treating
Corrosive atmospheres
Dust or lint
Linen/bedding handling
Sawing, drilling, and grinding
Pneumatic transport
Textile and agricultural processing

Combustion Products and Fumes

Cooking equipment
Ovens
Dryers
Fireplaces
Exhaust hoods
Cutting, welding, and brazing

Engine Exhaust

Gasoline forklift trucks
Diesel trucks and locomotives
Engines not vented to the outside

Machining
Paint spray
Curing
Chemical fumes
Cleaning fluids

Heating element with abnormal conditions

Dust accumulations
Improper exhaust
Incomplete combustion

Table A-5-3.7.1.2(b) Sources of Electrical and Mechanical Influences on Smoke Detectors**Electrical Noise and Transients**

Vibration or shock
Radiation
Radio frequency
Intense light
Lightning
Electrostatic discharge

Airflow

Gusts
Excessive velocity
Power supply

[From NFPA 72E, Table A-4-6.1.5(b)]

the recording of background smoke level information necessary in setting alert and alarm levels and delays.

[New paragraphs]

A-5-3.7.5 High Rack Storage. For most effective detection of fire in high rack storage areas, detectors should be located on the ceiling above each aisle and at intermediate levels in the racks. This is necessary to detect smoke that may be trapped in the racks at an early stage of fire development, when insufficient thermal energy is released to carry the smoke to the ceiling. Earliest detection of smoke is achieved by locating the intermediate level detectors adjacent to alternate pallet sections as shown in Figures A-5-3.7.5(a) and (b). Detector manufacturer's recommendations and engineering judgment should be followed for specific installations.

A protected beam-type detector may be used in lieu of a single row of individual spot-type smoke detectors.

[From NFPA 72E - 1990, A-4-6.4]

Sampling ports of an air sampling-type detector may be located above each aisle to provide coverage equivalent to the location of spot-type detectors. Manufacturer's recommendations and engineering judgment should be followed for specific installation.

[New paragraph]

[From NFPA 72E, Table A-4-6.1.5(a)]

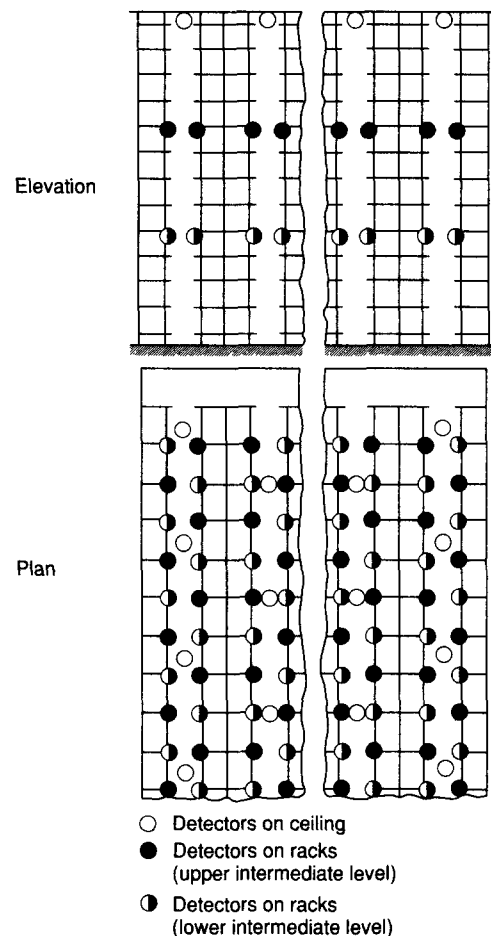


Figure A-5-3.7.5(a) For solid storage (closed rack) in which transverse and longitudinal flue spaces are irregular or nonexistent, as for slatted or solid shelved storage.

[From NFPA 72E - 1990, Figure A-4-6.1.8(a)]

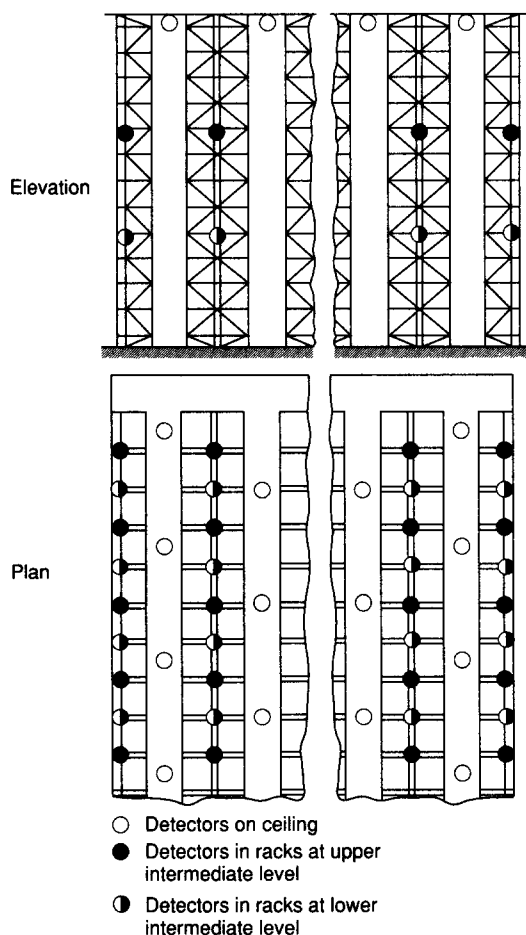


Figure A-5-3.7.5(b) For palletized storage (open rack) or no shelved storage in which regular transverse and longitudinal flue spaces are maintained.

[From NFPA 72E - 1990, Figure A-4-6.1.8(b)]

A-5-4.2.1 Ember. Class A and Class D combustibles will burn as embers under conditions where the typical flame associated with fire does not necessarily exist. This glowing combustion yields radiant emissions in radically different parts of the radiant energy spectrum than flaming combustion. Specialized detectors, specifically designed to detect those emission, should be used in applications where this type of combustion is expected. In general, flame detectors are not intended for the detection of embers.

[From NFPA 72E - 1990, A-5-2.1.1]

A-5-4.2.1 Spark. The overwhelming majority of applications involving the detection of Class A and Class D combustibles with radiant energy-sensing detectors involves the transport of particulate solid materials through pneumatic conveyor ducts or mechanical conveyors. It is common in the industries that include such hazards to call a moving piece of burning material a "spark" and systems for the detection of such fires "spark detection systems."

[From NFPA 72E - 1990, A-5-2.1.6]

A-5-4.2.1 Wavelength. The concept of wavelength is extremely important in selecting the proper detector for a particular application. There is a precise interrelation between the wavelength of light being emitted from a

flame and the combustion chemistry producing the flame. Specific sub-atomic, atomic, and molecular events yield radiant energy of specific wavelengths. For example, ultraviolet photons are emitted as the result of the complete loss of electrons or very large changes in electron energy levels. During combustion, molecules are violently torn apart by the chemical reactivity of oxygen, and electrons are released in the process, recombining at drastically lower energy levels, thus giving rise to ultraviolet radiation. Visible radiation is generally the result of smaller changes in electron energy levels within the molecules of fuel, flame intermediates, and products of combustion. Infrared radiation comes from the vibration of molecules or parts of molecules when they are in the superheated state associated with combustion. Each chemical compound exhibits a group of wavelengths at which it is resonant. These wavelengths constitute the chemical's infrared spectrum, which is usually unique to that chemical.

This interrelationship between wavelength and combustion chemistry affects the relative performance of various types of detectors to various fires.

[From NFPA 72E - 1990, A-5-2.1.9]

A-5-4.3.1 The radiant energy from a flame or spark/ember is comprised of emissions in various bands of the ultraviolet, visible, and infrared portions of the spectrum. The relative quantities of radiation emitted in each part of the spectrum are determined by the fuel chemistry, the temperature, and the rate of combustion. The detector should be matched to the characteristics of the fire.

Almost all materials that participate in flaming combustion will emit ultraviolet radiation to some degree during flaming combustion, whereas only carbon-containing fuels will emit significant radiation at the 4.35 micron (carbon dioxide) band used by many detector types to detect a flame.

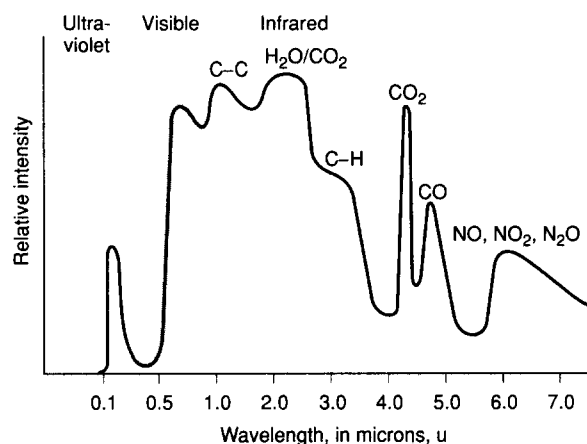


Figure A-5-4.3.1 Spectrum of a "typical" flame (free burning gasoline).

[New]

The radiant energy emitted from an ember is determined primarily by the fuel temperature (Planck's Law Emissions) and the emissivity of the fuel. Radiant energy from an ember is primarily infrared and, to a lesser degree, visible in wavelength. In general, embers do not emit ultraviolet energy in significant quantities (0.1 percent of total emissions) until the ember achieves temperatures

of 2000°K (1727°C or 3240°F). In most cases, the emissions will be included in the band of 0.8 to 2.0 microns, corresponding to temperatures of approximately 750°F (398°C) to 1830°F (1000°C).

Most radiant energy detectors have some form of qualification circuitry within them that uses time to help distinguish between spurious, transient signals and legitimate fire alarms. These circuits become very important when one considers the anticipated fire scenario and the ability of the detector to respond to that anticipated fire. For example, a detector that utilizes an integration circuit or a timing circuit to respond to the flickering light from a fire may not respond well to a deflagration resulting from the ignition of accumulated combustible vapors and gases, or where the fire is a spark that is traveling up to 100 meters per second past the detector. Under these circumstances, a detector that has a high speed response capability would be most appropriate. On the other hand, in applications where the development of the fire will be slower, a detector that utilizes time for the confirmation of repetitive signals would be appropriate. Consequently, the fire growth rate should be considered in selecting the detector. The detector performance should be selected to respond to the anticipated fire.

The radiant emissions are not the only criteria to be considered. The medium between the anticipated fire and the detector is also very important. Different wavelengths of radiant energy are absorbed with varying degrees of efficiency by materials suspended in the air or that may accumulate on the optical surfaces of the detector. Generally, aerosols and surface deposits reduce the sensitivity of the detector. The detection technology utilized should take into account those normally occurring aerosols and surface deposits to minimize the reduction of system response between maintenance intervals. Note that the smoke evolved from the combustion of middle and heavy fraction petroleum distillates is highly absorptive in the ultraviolet end of the spectrum. Where using this type of detection, the system should be designed to minimize the interference of smoke on the response of the detection system.

The environment and ambient conditions anticipated in the area to be protected will impact on the choice of detector. All detectors have limitations on the range of ambient temperatures over which they will respond, consistent with their tested or approved sensitivities. The designer should make certain that the detector is compatible with the range of ambient temperatures anticipated in the area in which it is installed. In addition, rain, snow, and ice will attenuate both ultraviolet and infrared radiation to varying degrees. Where anticipated, provisions should be made to protect the detector from accumulations of these materials on the optical surfaces.

[From NFPA 72E - 1990, A-5-3.1 modified]

A-5-4.4.1.1 All optical detectors respond according to the following theoretical equation:

$$S = \frac{Kpe^{\zeta d}}{d^2}$$

Where:

- k = proportionality constant for the detector
- p = radiant power emitted by the fire

e = Naperian logarithm base (2.7183)

ζ = the extinction coefficient of air

d = the distance between the fire and the detector

S = radiant power reaching the detector.

The sensitivity (S) would typically be measured in nanowatts. This equation yields a family of curves similar to the one shown in Figure A-5-4.4.1.1.

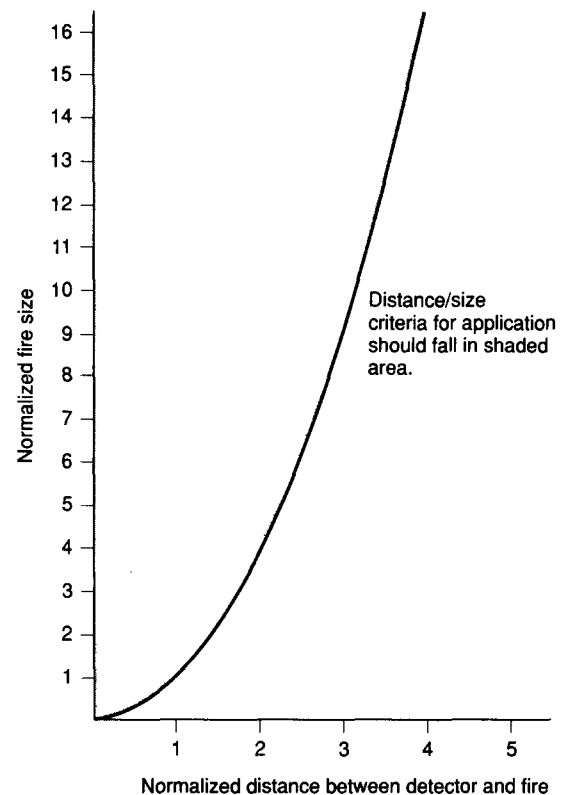


Figure A-5-4.4.1.1 Generalized fire size vs. distance.

[From NFPA 72E - 1990, A-5-4.1.1]

The curve defines the maximum distance at which the detector consistently detects a fire of defined size and fuel. Detectors should only be employed in the shaded area beneath the curve.

Under the best of conditions, with no atmospheric absorption, the radiant power reaching the detector is reduced by a factor of four if the distance between the detector and the fire is doubled. For the consumption of the atmospheric extinction, the exponential term, Zeta (ζ) is added to the equation. Zeta is a measure of the clarity of the air at the wavelength under consideration. Zeta will be affected by humidity, dust, and any other contaminants in the air that are absorbent at the wavelength in question. Zeta generally has values between .001 and .1 for normal ambient air.

[From NFPA 72E - 1990, A-5-4.1.1 modified]

A-5-4.4.2.1 The types of application for which flame detectors are suitable are:

- (a) High ceiling, open spaced buildings such as warehouses and aircraft hangers

(b) Outdoor or semi-outdoor areas where winds or draughts may prevent smoke reaching a heat or smoke detector

(c) Risks where rapidly developing flaming fires may occur, such as aircraft hangers, petrochemical production, storage and transfer areas, natural gas installations, paint shops, solvent areas, etc.

(d) Spot protection of high fire risk machinery or installations, often coupled with an automatic gas extinguishing system

(e) Environments that are unsuitable for other types of detectors.

Some extraneous sources of radiant emissions that have been identified as interfering with the stability of flame detectors include:

- (a) Sunlight
- (b) Lightning
- (c) X-rays
- (d) Gamma rays
- (e) Cosmic rays
- (f) Ultraviolet radiation from arc welding
- (g) Electromagnetic interference (EMI, RFI)
- (h) Hot objects
- (i) Artificial lighting.

[From NFPA 72E - 1990, A-5-4.2.1 modified]

A-5-4.4.2.3 The greater the angular displacement of the fire from the optical axis of the detector, the larger the fire must become before it is detected. This phenomenon establishes the field of view of the detector. Figure A-5-4.4.2.3 shows an example of the effective sensitivity versus angular displacement of a flame detector.

[From NFPA 72E - 1990, A-5-4.2.3 modified]

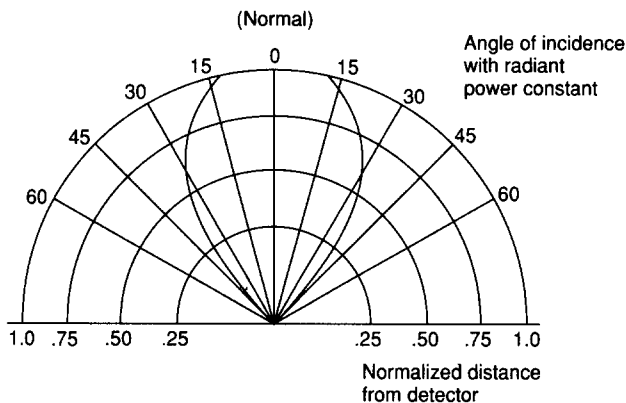


Figure A-5-4.4.2.3 Normalized sensitivity vs. angular displacement.

[From NFPA 72E - 1990, A-5-4.2.3]

A-5-4.4.2.4 Virtually all radiant energy-sensing detectors exhibit some kind of fuel specificity. Different fuels when burned at uniform rates (joules/second or watts) will emit different levels of radiant power in the ultraviolet, visible, and infrared portions of the spectrum. Under free-burn

conditions, a fire of given surface area but of different fuels will burn at different rates (joules/second or watts) and emit varying levels of radiation in each of the major portions of the spectrum. Most radiant energy detectors designed to detect flame are qualified based upon a defined fire under specific conditions. Where employing these detectors for fuels other than the defined fire, the designer should make certain that the appropriate adjustments to the maximum distance between the detector and the fire are made consistent with the fuel specificity of the detector.

[From NFPA 72E - 1990, A-5-4.2.4]

A-5-4.4.2.6 The means by which this requirement has been satisfied include:

- (a) Lens clarity monitoring and cleaning where a contaminated lens signal is rendered
- (b) Lens air purge.

[From NFPA 72E - 1990, A-5-4.2.6]

A-5-4.5.1 Spark/ember detectors are installed primarily to detect sparks and embers that may, if allowed to continue to burn, precipitate a much larger fire or explosion. Spark/ember detectors are typically mounted on some form of duct or conveyor, monitoring the fuel as it passes by. Usually, it is necessary to enclose the portion of the conveyor where the detectors are located as these devices generally require a dark environment. Extraneous sources of radiant emissions that have been identified as interfering with the stability of spark/ember detectors include:

- (a) Ambient light
- (b) Electromagnetic interference (EMI, RFI)
- (c) Electrostatic discharge in the fuel stream.

[From NFPA 72E - 1990, A-5-4.3.1 modified]

A-5-4.5.2 There is a minimum ignition power (watts) for all combustible dusts. If the spark or ember is incapable of delivering that quantity of power to the adjacent combustible material (dust), an expanding dust fire will not occur. The minimum ignition power is determined by the fuel chemistry, fuel particle size, fuel concentration in air, and ambient conditions such as temperature and humidity.

[From NFPA 72E - 1990, A-5-4.3.2]

A-5-4.5.5 The greater the displacement of the fire from the optical axis of the detector, the larger the fire must become before it is detected. This phenomenon establishes the field of view of the detector. Figure A-5-4.4.2.3 shows an example of the effective sensitivity versus angular displacement of a flame detector.

[From NFPA 72E-1990, A-5-4.3.5]

A-5-4.5.6 The means by which this requirement has been satisfied include:

- (a) Lens clarity monitoring and cleaning where a contaminated lens signal is rendered
- (b) Lens air purge.

[From NFPA 72E - 1990, A-5-4.3.6]

A-5-5.1 Many gases may be produced by a fire. Fire-gas detectors are instruments that are triggered into alarm by one or more fire gases. Fire-gas detectors need not be able to differentiate among the various fire gases. Depending on the material being burned and the oxygen supply available, the quantity and composition of gases given off can vary greatly.

If ordinary cellulosic material such as wood or paper is burned with an abundance of oxygen, the gases given off are primarily carbon dioxide and water vapor. If, however, the same material is burned or smolders with a limited supply of oxygen, a host of additional gases will be evolved.

[From NFPA 72E - 1990, A-6-1.1.1]

A-5-5.6.1 Fire-gas detectors depend on fire gases reaching the sensing element. Where sufficient concentration is present, operation is obtained. Since the detectors are usually mounted on or near the ceiling, response time depends on the nature of the fire. A hot fire will drive fire gases up to the ceiling more rapidly. A smoldering fire produces little heat, and, therefore, the detection time will be increased.

[From NFPA 72E - 1990, A-6-3.1]

A-5-5.6.3 Gas transport to the sensor of a fire-gas detector may occur by diffusion where migration results from concentration gradients or by sampling if pumps, fans, or aspirators are employed.

[From NFPA 72E - 1990, A-6-3.3]

A-5-5.6.6.3 Location and spacing of fire-gas detectors should consider beam depth, ceiling height, beam spacing, and anticipated fire type and location. For ceiling configurations where mixing of air into beam pockets is inhibited by ventilation systems, detectors will perform better if installed on the bottom of beams.

To detect flaming fires (strong plumes), detectors should be installed as follows:

(a) If the ratio of the beam depth (D) to ceiling height (H) (D/H) is greater than 0.10 and the ratio of beam spacing (W) to ceiling height (H) (W/H) is greater than 0.40, detectors should be located in each beam pocket.

(b) If either ratio of beam depth to ceiling height (D/H) is less than 0.10 or the ratio of beam spacing to ceiling height (W/H) is less than 0.40, detectors should be installed on the bottom of the beams.

To detect smoldering fires (weak or no plumes), detectors should be installed as follows:

(a) If air mixing into beam pockets is good (e.g., air-flow parallel to long beams) and condition (a) exists as above, a detector should be located in each beam pocket.

(b) If air mixing into beam pockets is limited or condition (b) exists as above, detectors should be located on the bottom of the beams.

[From NFPA 72E - 1990, A-6-3.6.3]

A-5-5.7.1 Detectors should not be located in a direct air-flow nor closer than 3 ft (900 mm) from an air supply diffuser.

[From NFPA 72E - 1990, A-6-4.1]

A-5-5.8.1.3 Product-listing standards include tests for temporary excursions beyond normal limits. In addition to temperature, humidity, and velocity variations, fire-gas detectors should operate reliably under such common environmental conditions as mechanical vibration, electrical interference, and other environmental influences. These conditions are also included in tests conducted by the listing agencies.

[From NFPA 72E - 1990, A-6-5.1.3]

A-5-7.2 The waterflow device should be field adjusted so that an alarm will be initiated in no more than 90 seconds after a sustained flow of at least 10 gpm (40 L/min).

Features that should be investigated to minimize alarm response time include elimination of trapped air in the sprinkler system piping, use of an excess pressure pump, use of pressure drop alarm-initiating devices, or a combination thereof.

Care should be taken when choosing waterflow alarm-initiating devices for hydraulically calculated looped systems and those systems using small orifice sprinklers. Such systems may incorporate a single point flow significantly less than 10 gpm (40 L/min). In such cases, additional waterflow alarm-initiating devices or use of pressure drop-type waterflow alarm-initiating devices may be necessary.

Care should be taken, where choosing waterflow alarm initiating devices for sprinklers utilizing on-off sprinklers, to ensure that an alarm will be initiated in the event of a waterflow condition. On-off sprinklers open at a predetermined temperature and close when the temperature reaches a predetermined lower temperature. With certain types of fires, waterflow may occur in a series of short bursts of 10 to 30 seconds' duration each. An alarm-initiating device with retard may not detect waterflow under these conditions. It is recommended that an excess pressure system or one that operates on pressure drop be considered to facilitate waterflow detection on sprinkler systems utilizing on-off sprinklers.

Excess pressure systems may be used with or without alarm valves. The following is a description of one type of excess pressure system with an alarm valve.

An excess pressure system with an alarm valve consists of an excess pressure pump with pressure switches to control the operation of the pump. The inlet of the pump is connected to the supply side of the alarm valve, and the outlet is connected to the sprinkler system. The pump control pressure switch is of the differential type, maintaining the sprinkler system pressure above the main pressure by a constant amount. Another switch monitors low sprinkler system pressure to initiate a supervisory signal in the event of a failure of the pump or other malfunction. An additional pressure switch may be used to stop pump operation in the event of a deficiency in water supply. Another pressure switch is connected to the alarm outlet of the alarm valve to initiate a waterflow alarm signal when waterflow exists. This type of system also inherently prevents false alarms due to water surges. The sprinkler retard chamber should be eliminated to enhance the detection capability of the system for short duration flows.

[From NFPA 72, A-3-4.1.2, and NFPA 71, A-3-4.2.1 modified]

A-5-8.1 Appropriate means may involve:

- (a) Foam systems: Flow of water
- (b) Pump activation
- (c) Differential pressure detectors
- (d) Halon: Pressure detector
- (e) Carbon dioxide: Pressure detector.

In any case, an alarm that activates the extinguishing system may be initiated from the detection system.

[From NFPA 71, A-3-4.3]

A-5-9.1.3 Coded Signal Designations. The following suggested coded signal assignment for buildings having four floors and multiple basements is provided as a guide:

Location	Coded Signal
4th Floor	2-4
3rd Floor	2-3
2nd Floor	2-2
1st Floor	2-1
Basement	3-1
Sub-Basement	3-2

[New paragraph and table]

A-5-9.2.9 Current supply for location-designating lights at street boxes should preferably be secured at lamp locations from the local electric utility company.

Alternating current power may be superimposed on metallic fire alarm circuits for supplying designating lamps, or for control or actuation of equipment devices for fire alarm or other emergency signals, provided:

(a) Voltage between any wire and ground or between one wire and any other wire of the system shall not exceed 150 volts. The total resultant current in any line circuit shall not exceed $\frac{1}{4}$ amp.

(b) Coupling capacitors, transformers, choke, coils, etc., shall be rated for 600-volt working voltage and have a breakdown voltage of at least twice the working voltage plus 1000 volts.

(c) There is no interference with fire alarm service under any conditions.

[From NFPA 1221, A-4-1.4.1.5]

A-5-9.2.12.3 FCC Rules and Regulations, Vol. V, Part 90, March 1979: "Except for test purposes, each transmission must be limited to a maximum of 2 seconds and may be automatically repeated not more than two times at spaced intervals within the following 30 seconds; thereafter, the authorized cycle may not be reactivated for 1 minute."

[From NFPA 1221, A-4-3.3.2.2 modified]

A-5-11.1 Smoke detectors located in the open area(s) are preferred to duct-type detectors because of the dilution effect in air ducts. Active smoke management systems installed in accordance with NFPA 92A, *Recommended Practice for Smoke-Control Systems*, or NFPA 92B, *Guide for Smoke Management Systems in Malls, Atria, and Large Areas*, should be controlled by total coverage open area detection.

[From NFPA 72E - 1990, A-9-1.1 modified]

A-5-11.2 Dilution of smoke-laden air by clean air from other parts of the building or dilution by outside air intakes may allow high densities of smoke in a single room with no

appreciable smoke in the air duct at the detector location. Smoke may not be drawn from open areas where air conditioning systems or ventilating systems are shut down.

[From NFPA 72E - 1990, A-9-1.2(a) and (b)]

A-5-11.5.2.2 Detectors listed for the air velocity present may be installed at the opening where the return air enters the common return air system. The detectors should be installed up to 12 in. (0.3 m) in front of or behind the opening and spaced according to the following opening dimensions [see Figure A-5-11.5.2.2(a)]:

(a) *Width.*

- Up to 36 in. (914 mm) — One detector centered in opening
- Up to 72 in. (1829 mm) — Two detectors located at the $\frac{1}{4}$ -points of the opening
- Over 72 in. (1829 mm) — One additional detector for each full 24 in. of opening.

(b) *Depth.* The number and spacing of the detector(s) in the depth (vertical) of the opening should be the same as those given for the width (horizontal) above.

(c) *Orientation.* Detectors should be oriented in the most favorable position for smoke entry with respect to the direction of air flow. The path of a projected beam-type detector across the return air openings should be considered equivalent in coverage to a row of individual detectors.

[From NFPA 72E - 1990, A-9-3.2.2]

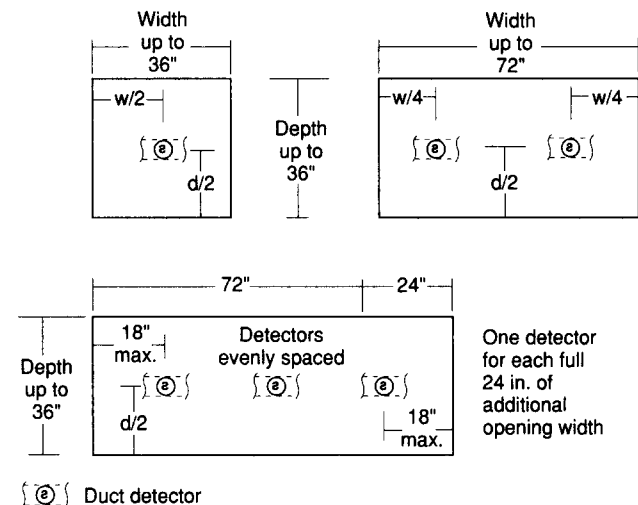


Figure A-5-11.5.2.2(a) Location of smoke detector(s) in return air systems for selective operation of equipment.

[From NFPA 72E - 1990, A-9-3.2.2(a)]

A-5-11.6.2 Where duct detectors are used to initiate the operation of smoke dampers, they should be located so that the detector is between the last inlet or outlet upstream of the damper and the first inlet or outlet downstream of the damper.

In order to obtain a representative sample, stratification and dead air space should be avoided. Such conditions may be caused by return duct openings, sharp turns or connections, as well as by long, uninterrupted straight runs. For this reason, duct smoke detectors should be located in the zone between 6 and 10 duct equivalent

diameters of straight, uninterrupted run. In return air systems, the requirements of 5-11.5.2.2 take precedence over these considerations. [See Figure A-5-11.6.2(b).]

[New paragraph]

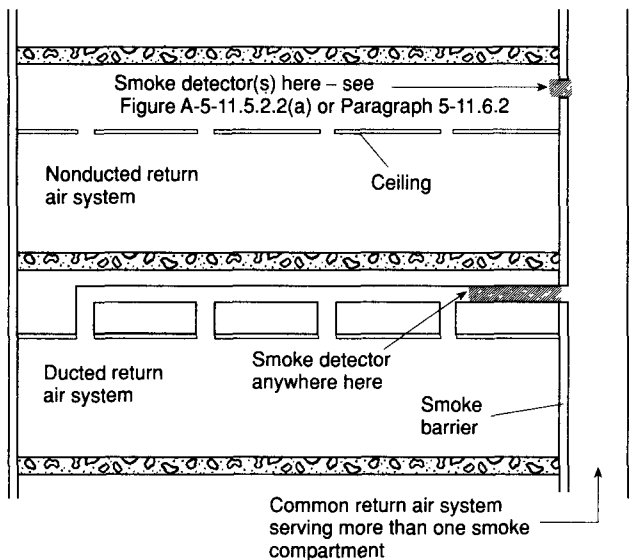


Figure A-5-11.5.2.2(b) Location of smoke detector(s) in return air systems for selective operation of equipment.

[From NFPA 72E - 1990, A-9-3.2.2(b) and A-9-3.2.2]

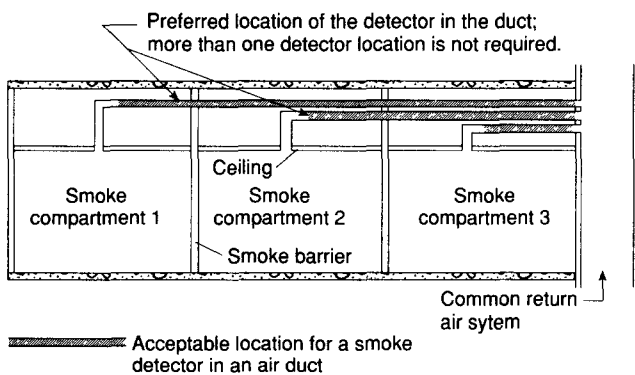


Figure A-5-11.5.2.2(c) Detector location in a duct that passes through smoke compartments not served by the duct.

[From NFPA 72E - 1990, A-9-3.2.2(c)]

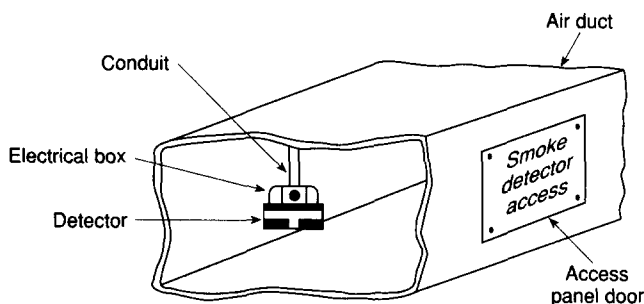


Figure A-5-11.6.2(a) Pendant mounting air duct installation.

[From NFPA 72E - 1990, A-9-4.8(a)]

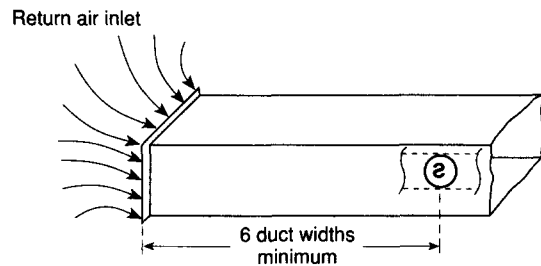
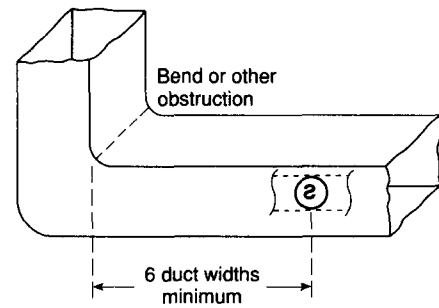


Figure A-5-11.6.2(b) Typical duct detector placement.

[From NFPA 72E - 1990, A-9-4.8(b) modified]

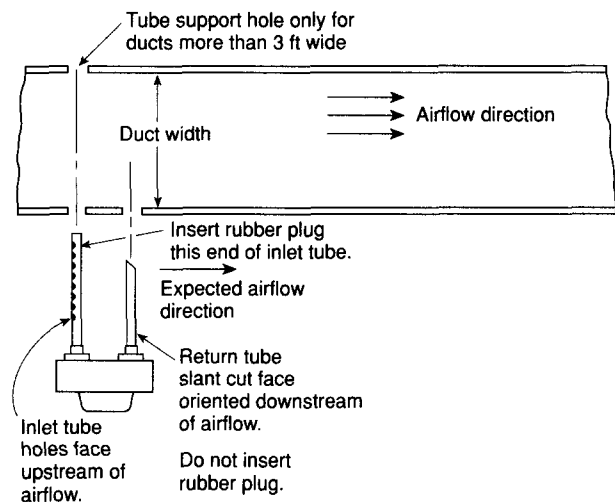
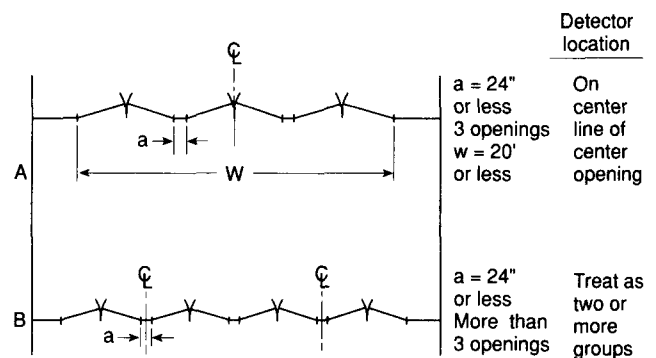


Figure A-5-11.6.2(c) Inlet tube orientation.

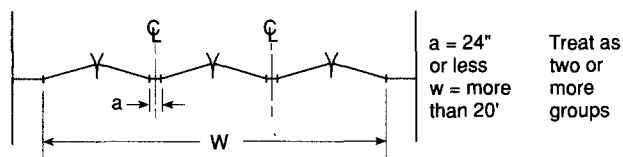
[From NFPA 72E - 1990, A-9-4.8(c)]



For SI Units: 1 in. = 25.4 mm; 1 ft = 0.305 m.

Figure A-5-11.7.4.3.2

[From NFPA 72E - 1990, A-9-5.4.3.2]



For SI Units: 1 in. = 25.4 mm; 1 ft = 0.305 m.

Figure A-5-11.7.4.3.3

[From NFPA 72E - 1990, A-9-5.4.3.3]

A-6-3.1 The typical average ambient sound level for the following occupancies are intended only for design guidance purposes:

Locations	Average Ambient Sound Level
Business occupancies	55 dBA
Educational occupancies	45 dBA
Industrial occupancies	80 dBA
Institutional occupancies	50 dBA
Mercantile occupancies	40 dBA
Piers and water-surrounded structures	40 dBA
Places of assembly	55 dBA
Residential occupancies	35 dBA
Storage occupancies	30 dBA
Thoroughfares, high density urban	70 dBA
Thoroughfares, medium density urban	55 dBA
Thoroughfares, rural and suburban	40 dBA
Tower occupancies	35 dBA
Underground structures and windowless buildings	40 dBA
Vehicles and vessels	50 dBA

[From NFPA 72G, 3-1.1.4]

The typical average ambient sound levels noted should not be used in lieu of actual sound level measurements.

A-6-4.4.1 Areas so large that they exceed the rectangular dimensions given in Figures A-6-4.4.1(a), (b), and (c) require additional appliances. Often, proper placement of appliances can be facilitated by breaking down the area into multiple squares and dimensions that fit most appropriately. [See Figures A-6-4.4.1(a), (b), (c), and (d).] An area 40 ft (12.2 m) wide and 74 ft (22.6 m) long can be covered with two 60-cd appliances. Irregular areas will take more careful planning to make sure that at least one 15-cd appliance is installed per 20 ft by 20 ft (6.09 m by 6.09 m) room.

[New paragraph]

A-6-4.4.3 Effective intensity is the conventional method of equating the brightness of a flashing light to that of a steady burning light as seen by a human observer. The units of effective intensity are expressed in candelas. For example, a flashing light that has an effective intensity of 15 candelas has the same apparent brightness to an observer as a 15-candela steady burning light source.

A-7-2.1 Where the authority having jurisdiction strongly suspects significant deterioration or otherwise improper operation by a central station, a surprise inspection to test the operation of the central station may be made but requires extreme precaution. This test will be conducted without advising the central station, but the public fire service communication center must definitely be contacted

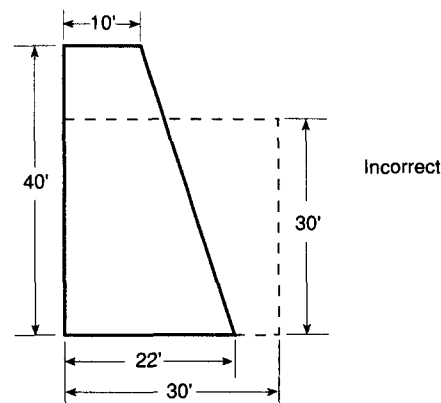
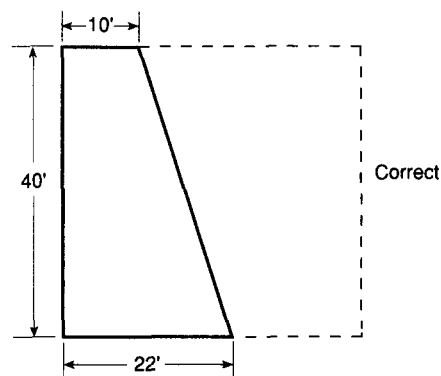
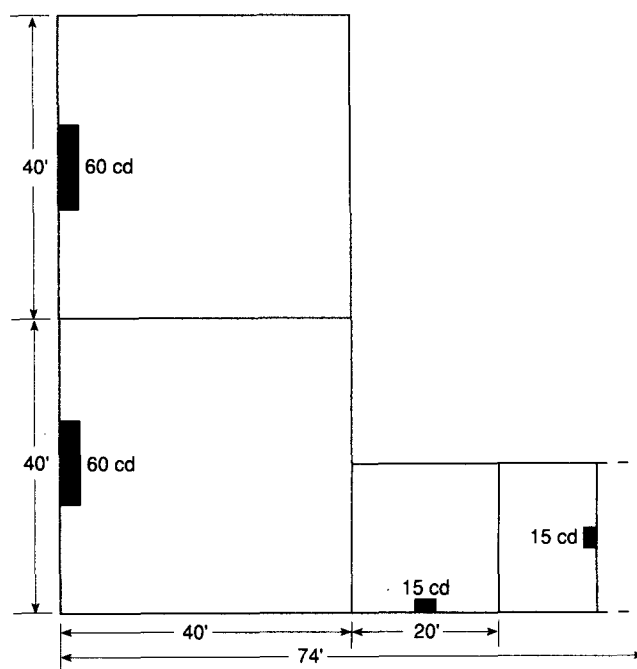


Figure A-6-4.4.1(a)



NOTE: Dashed lines represent imaginary walls.

Figure A-6-4.4.1(b) Room spacing allocation for ceiling-mounted visible appliances.

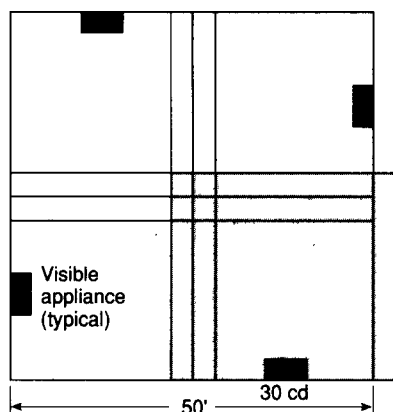
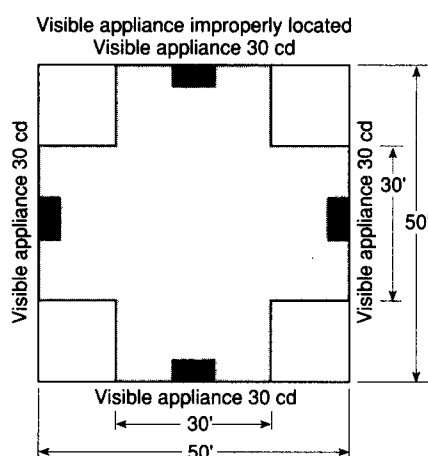


Figure A-6-4.4.1(c) Room spacing allocation — correct.



NOTE: See Table 6-4.4.1(a) for correction.

Figure A-6-4.4.1(d) Room spacing allocation — incorrect.

when manual, waterflow alarms, or automatic fire detection systems are tested so that the fire department will not respond. In addition, persons normally receiving calls for supervisory alarms should be notified when gate valves, pump power, etc., are tested. Confirmation of the authenticity of the test procedure is recommended and should be a matter for resolution between plant management and the central station.

[From NFPA 71, 1-9.5]

A-7-2.2 Test Methods. The following wiring diagrams are representative of typical circuits encountered in the field and are not intended to be all-inclusive.

The noted styles are as indicated in Table 3-5.1, 3-6.1, 3-7.1, and 4-2.3.2.2.3.

The noted systems are as indicated in NFPA 170, *Standard for Firesafety Symbols*.

Since ground-fault detection is not required for all circuits, tests for ground-fault detection should be limited to those circuits equipped with ground-fault detection.

An individual point-identifying (addressable) initiating device operates on a signaling line circuit and not on a Style A, B, C, D, or E (Class B and Class A) initiating device circuit.

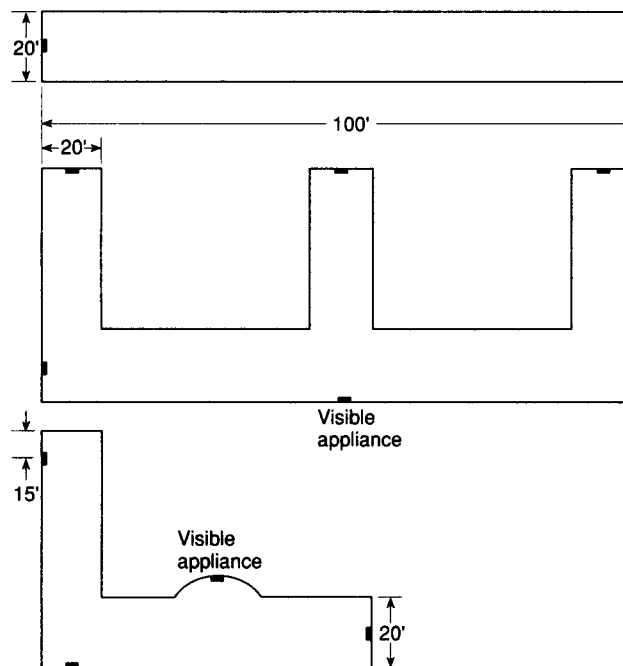


Figure A-6-4.4.2 Corridor and elevator area spacing allocation.

All of the following initiating device circuits are illustrative of either alarm or supervisory signaling. Alarm and supervisory initiating devices are not permitted on the same initiating device circuit.

In addition to losing its ability to receive an alarm from an initiating device located beyond an open fault, a Style A (Class B) initiating device circuit also loses its ability to receive an alarm when a single ground fault is present.

Style C and Style E (Class B and Class A) initiating device circuits can discriminate between an alarm condition and a wire-to-wire short. In these circuits, a wire-to-wire short provides a trouble indication. However, a wire-to-wire short will prevent alarm operation. Shorting-type initiating devices cannot be used without an additional current or voltage limiting element.

Directly connected system smoke detectors, commonly referred to as two-wire detectors, should be listed as being electrically and functionally compatible with the control unit and the specific subunit or module to which they are connected. If the detectors and the units or modules are not compatible, it is possible that, during an alarm condition, the detector's visible indicator will illuminate, but no change of state to the alarm condition will occur at the control unit. Incompatibility can also prevent proper system operation at extremes of operating voltage, temperature, and other environmental conditions.

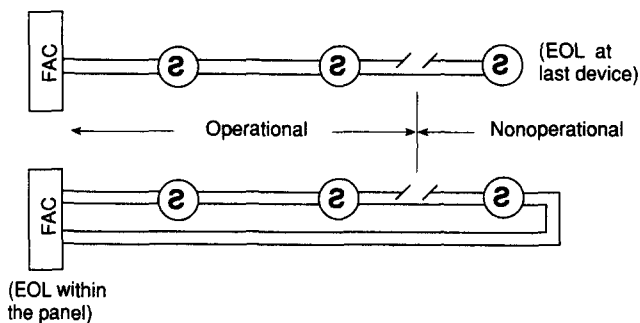
If two or more two-wire detectors with integral relays are connected to a single initiating device circuit and their relay contacts are used to control essential building functions (e.g., fan shutdown, elevator recall, etc.), it should be clearly noted that the circuit may be capable of supplying only enough energy to support one detector/relay combination in an alarm mode. If control of more than one building function is required, each detector/relay combination used to control separate functions should be connected to separate initiating device circuits, or they should

be connected to an initiating device circuit that will provide adequate power to permit all the detectors connected to the circuit to be in the alarm mode simultaneously. During acceptance and reacceptance testing, this feature should always be tested and verified.

A speaker is an alarm indicating appliance, and, when used in the following diagrams, the principle of operation and supervision is the same as for other audible alarm indicating appliances (e.g., bells, horns, etc.).

Wiring Diagrams.

NOTE: Where testing circuits, verify the correct wiring size, insulation type, and conductor fill in accordance with the requirements in NFPA 70, *National Electrical Code*.

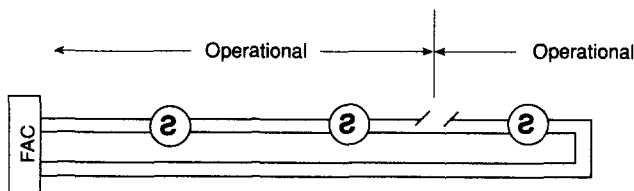


EOL - End-of-line device
FAC - Fire alarm control unit

Disconnect conductor at device or control unit, then reconnect. Temporarily connect a ground to either leg of conductors, then remove ground. Both operations should indicate audible and visual trouble with subsequent restoral at control unit. Conductor-to-conductor short should initiate alarm, Style A and Style B (Class B) indicate trouble Style C (Class B). Style A (Class B) will not initiate alarm while in trouble condition.

Figure A-7-2.2(a)

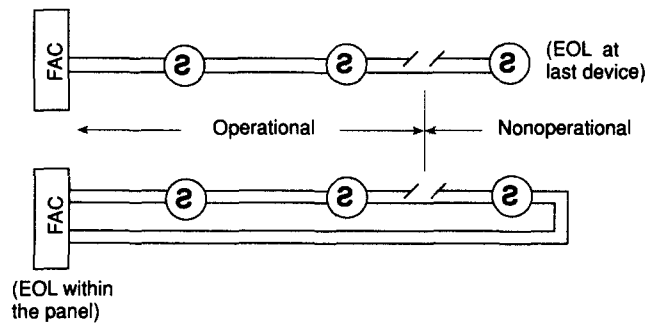
[From NFPA 72H, Figure 7-2 modified]



Disconnect a conductor at a device mid-point in the circuit. Operate a device on either side of device with disconnected conductor. Reset control unit and reconnect conductor. Repeat test with a ground applied to either conductor in place of the disconnected conductor. Both operations should indicate audible and visual trouble, then alarm or supervisory indication with subsequent restoral.

Figure A-7-2.2(b)

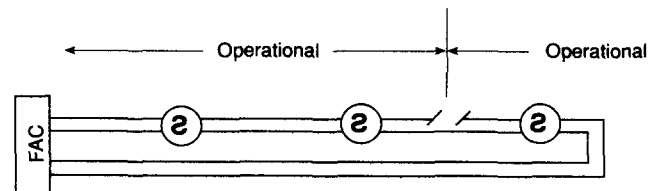
[From NFPA 72H, Figure 7-3 modified]



Remove smoke detector if installed with plug-in base or disconnect conductor beyond first device from control unit. Activate smoke detector per manufacturer's recommendations between control unit and circuit break. Restore detector and/or circuit. Control unit should indicate trouble where fault occurs and alarm where detectors are activated between the break and the control unit.

Figure A-7-2.2(c)

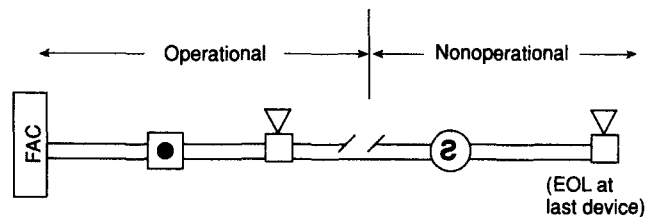
[From NFPA 72H, Figure 7-4 modified]



Disconnect conductor at a smoke detector or remove if installed with a plug-in base mid-point in the circuit. Operate a device on either side of device with the fault. Reset control unit and reconnect conductor or detector. Repeat test with a ground applied to either conductor in place of the disconnected conductor or removed device. Both operations should indicate audible and visual trouble, then alarm indication with subsequent restoral.

Figure A-7-2.2(d)

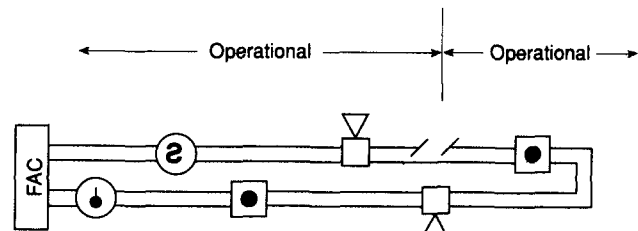
[From NFPA 72H, Figure 7-5 modified]



Disconnect a conductor either at indicating or initiating device. Activate initiating device between fault and control unit. Activate additional smoke detectors between device first activated and control unit. Restore circuit, initiating devices, and control unit. Confirm that all indicating appliances on the circuit operate from the control unit up to the fault and that all smoke detectors tested and their associated ancillary functions, if any, operated.

Figure A-7-2.2(e)

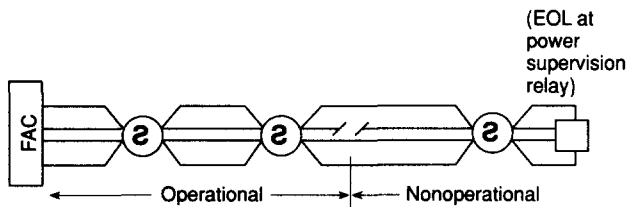
[From NFPA 72H, Figure 7-6 modified]



Testing of the circuit is similar to that described above. Confirm all indicating appliances operate on either side of fault.

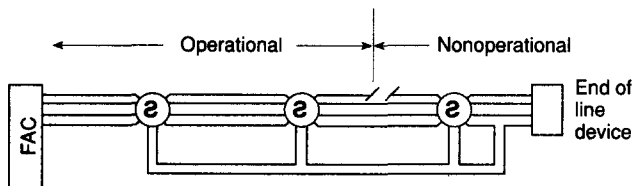
Figure A-7-2.2(f)

[From NFPA 72H, Figure 7-7 modified]



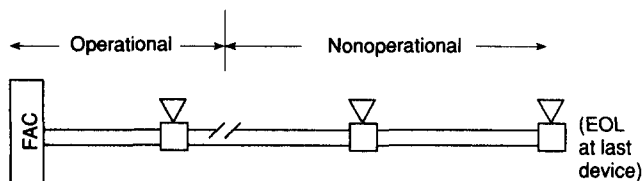
Testing of the circuit is similar to that described in A-7-2.2(c) and A-7-2.2(d). Disconnect a leg of the power supply circuit beyond the first device on the circuit. Activate initiating device between fault and control unit. Restore circuits, initiating devices, and control unit. Audible and visual trouble should indicate at the control unit where either initiating or power circuit is faulted. All initiating devices between the circuit fault and the control unit should activate. In addition, removal of a smoke detector from a plug-in type base can also break the power supply circuit. When circuits contain various powered and nonpowered devices on the same initiating circuit, verify that the nonpowered devices beyond the power circuit fault can still initiate an alarm. A return loop should be brought back to the last powered device and the power supervisory relay to incorporate into the end-of-line device.

Figure A-7-2.2(g)
[From NFPA 72H, Figure 7-8 modified]



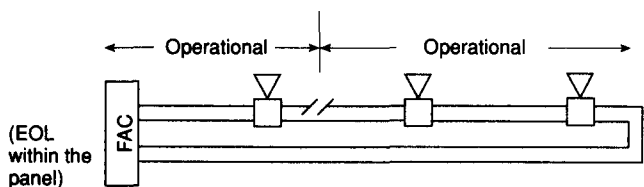
Testing of the circuit is similar to that described in A-7-2.2(c) with the addition of a power circuit.

Figure A-7-2.2(h)
[From NFPA 72H, Figure 7-9 modified]



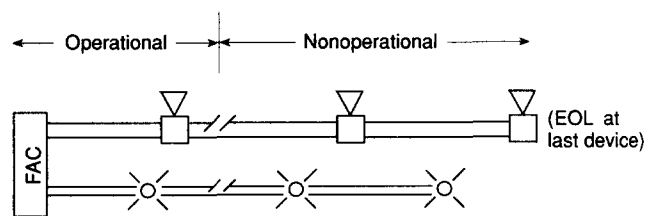
Testing of the indicating appliances connected to Style W and Style Y (Class B) is similar to that described in A-7-2.2(c).

Figure A-7-2.2(i)
[From NFPA 72H, Figure 7-13 modified]



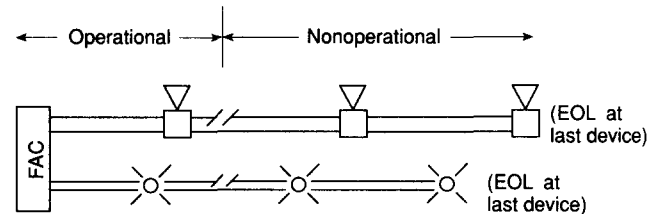
Testing of the indicating appliances connected to Style X and Style Z (Class B and Class A) is similar to that described in A-7-2.2(d).

Figure A-7-2.2(j)
[From NFPA 72H, Figure 7-10.2 modified]



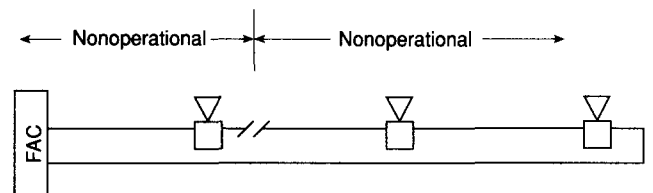
Testing of the indicating appliances connected to Style X and Style Z (Class B and Class A) is similar to that described in A-7-2.2(d).

Figure A-7-2.2(k)
[From NFPA 72H, Figure 7-11]



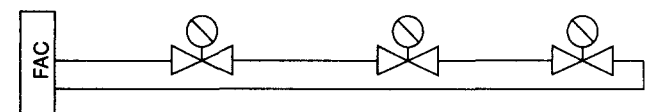
Testing of the indicating appliances connected to Style X and Style Z (Class B and Class A) is similar to that described in A-7-2.2(d).

Figure A-7-2.2(l)
[From NFPA 72H, Figure 7-12]



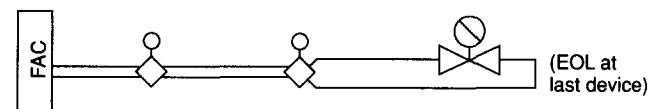
An open fault in the circuit wiring should cause a trouble condition.

Figure A-7-2.2(m)
[From NFPA 72H, Figure 7-13]



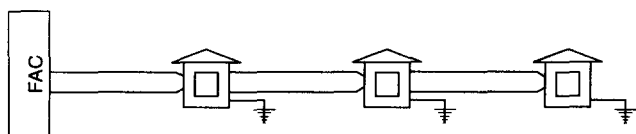
An open fault in the circuit wiring of operation of the valve switch (or any supervisory signal device) should cause a trouble condition.

Figure A-7-2.2(n)
[From NFPA 72H, Figure 7-14]



An open fault in the circuit wiring or operation of the valve switch should cause a trouble signal.

Figure A-7-2.2(o)
[From NFPA 72H, Figure 7-15]



Disconnect a leg of municipal circuit at master box. Verify alarm sent to public communication center. Disconnect leg of auxiliary circuit. Verify trouble condition on control unit. Restore circuits. Activate control unit and send alarm signal to communication center. Verify control unit in trouble condition until master box reset.

Figure A-7-2.2(p)

[From NFPA 72H, Figure 7-17]

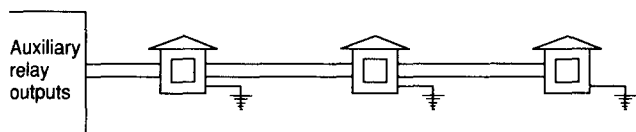


Figure A-7-2.2(q) Self-explanatory test.

Testing of supervised remote relays to be conducted in same manner as indicating appliances.

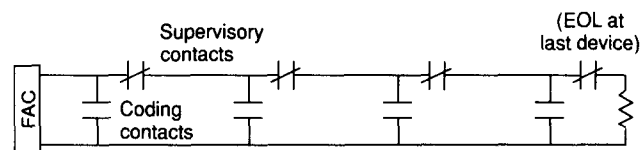
Circuit Styles.

NOTE: Some testing laboratories and authorities having jurisdiction permit systems to be classified as a Style 7 (Class A) by the application of two circuits of the same style operating in parallel. An example of this is to take two series circuits, either Style 0.5 or Style 1.0 (Class B), and operate them in parallel. The logic being that should a condition occur on one of the circuits, the remaining parallel circuit would be operative.

In order to understand the principles of the circuit, perform alarm receipt capability on a single circuit and indicate on the certificate of completion the style type based on the performance.

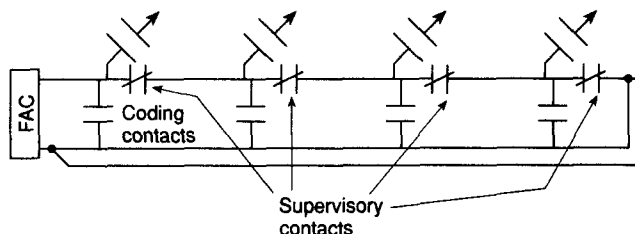
Style 0.5. This signaling circuit operates as a series circuit in performance. This is identical to the historical series audible signaling circuits. Any type of break or ground in one of the conductors or the internal of the multiple interface device, and the total circuit is rendered operative.

To test and verify this type of circuit, either lift a conductor or place an earth ground on a conductor or a terminal point where the signaling circuit attaches to the multiplex interface device.



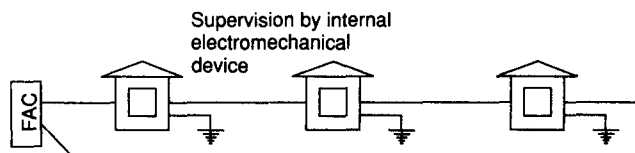
Style 0.5(a) functions so that when a box is operated, the supervisory contacts open, making the succeeding devices nonoperative while the operating box sends a coded signal. Any alarms occurring in any successive devices will not be received at the receiving station during this period.

Figure A-7-2.2(r) Style 0.5(a) (Class B) series.



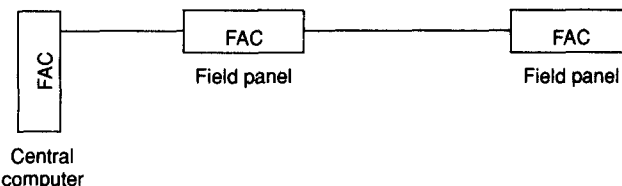
The contact closes when the device is operated and remains closed to shut out the remainder of the system until the code is complete.

Figure A-7-2.2(s) Style 0.5(b) (Class B) shunt.



An open or ground fault on the circuit should cause a trouble condition at the control unit.

Figure A-7-2.2(t) Style 0.5(c) (Class B) positive supervised successive.



This is a series circuit identical to diagram for Style 0.5, except that the fire alarm system hardware has enhanced performance. A single earth ground can be placed on a conductor or multiplex interface device, and the circuit and hardware still have alarm operability.

If a conductor break or an internal fault occurs in the pathway of the circuit conductors, the entire circuit becomes inoperative.

To verify alarm receipt capability and the resulting trouble signal, place an earth ground on one of the conductors or at the point where the signaling circuit attaches to the multiplex interface device. Then place one of the transmitters or an initiating devices into alarm.

Figure A-7-2.2(u) Style 1.0 (Class B).

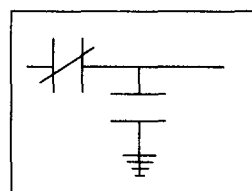
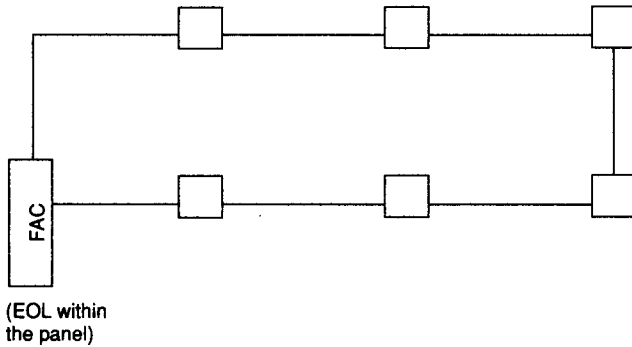


Figure A-7-2.2(v) Typical transmitter layout.



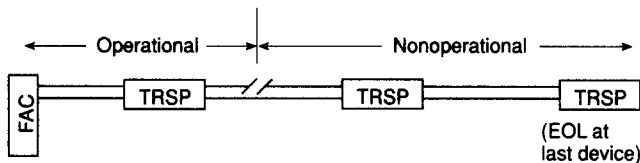
This is the central station McCulloh redundant type circuit and has alarm receipt capability on either side of a single break.

(a) To test, lift one of the conductors and operate a transmitter or initiating device on each side of the break. This activity should be repeated for each conductor.

(b) Place an earth ground on a conductor and operate a single transmitter or initiating device to verify alarm receipt capability and trouble condition for each conductor.

(c) Repeat the instructions of (a) and (b) at the same time and verify alarm receipt capability and that a trouble condition results.

Figure A-7-2.2(w) Typical McCulloh loop.

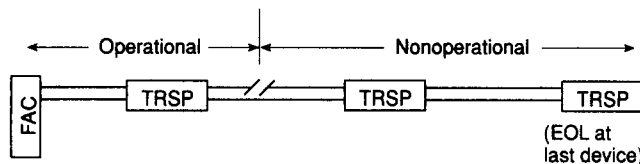


TRSP = Transponder

This is a parallel circuit whose multiplex interface devices transmit signal and operating power over the same conductors. The multiplex interface devices may be operable up to the point of a single break. Verify by lifting a conductor and causing an alarm condition on one of the units between the central alarm unit and the break. Either lift a conductor to verify the trouble condition or place an earth ground on the conductors. Test for all the valuations shown on the signaling table.

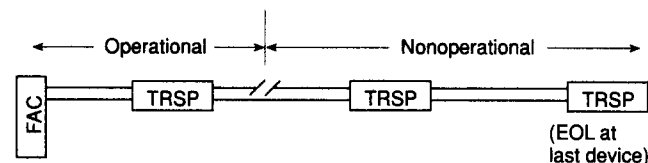
On ground fault testing verify alarm receipt capability by actuating a multiplex interface initiating device or a transmitter.

Figure A-7-2.2(x) Style 3.0 (Class B).



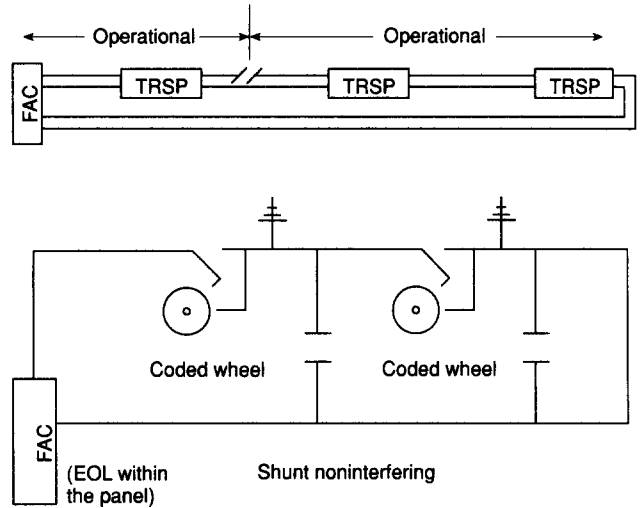
Repeat the instructions for Style 3.0 (Class B) and verify the trouble conditions by either lifting a conductor or placing a ground on the conductor.

Figure A-7-2.2(y) Style 3.5 (Class B).



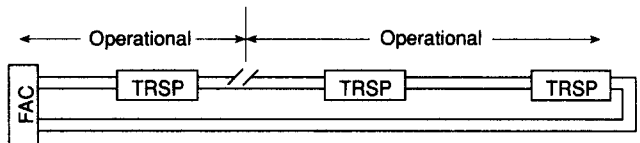
Repeat the instructions for Style 3.0 (Class B) and include a loss of carrier if the signal is being used.

Figure A-7-2.2(z) Style 4.0 (Class B).



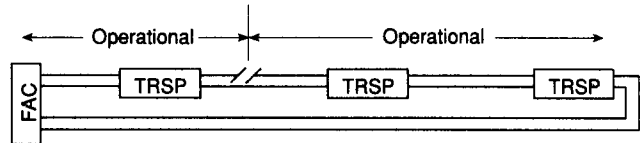
Repeat the instructions for Style 3.5 (Class B). Verify alarm receipt capability while lifting a conductor by actuating a multiple interface device or transmitter on each side of the break.

Figure A-7-2.2(aa) Style 4.5 (Class B).



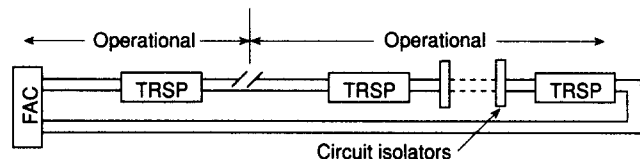
Verify the alarm receipt capability and trouble annunciation by lifting a conductor and actuating a multiplex interfacing device or a transmitter on each side of the break. For the earth ground verification, place an earth ground and certify alarm receipt capability and trouble annunciation by actuating a single multiplex interfacing device or a transmitter.

Figure A-7-2.2(bb) Style 5.0 (Class A).



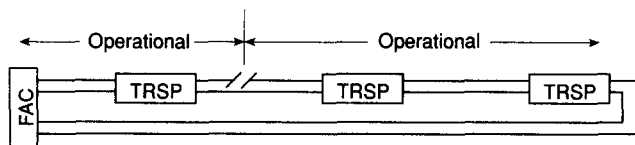
Repeat the instructions for Style 2.0 (Class A) [(a) through (c)]. Verify the remaining steps for trouble annunciation for the various combinations.

Figure A-7-2.2(cc) Style 6.0 (Class A).



For the portions of the circuits electrically located between the monitoring points of circuit isolators, follow the instructions for a Style 7.0 (Class A) circuit. It should be clearly noted that the alarm receipt capability for remaining portions of the circuit protection isolators is not the capability of the circuit, but permissible with enhanced system capabilities.

Figure A-7-2.2(dd) Style 6.0 (with circuit isolators) (Class A).



Repeat the instructions for testing of Style 6.0 (Class A) for alarm receipt capability and trouble annunciation.

NOTE 1: A portion of the circuit between the alarm processor or central supervising station and the first circuit isolator does not have alarm receipt capability in the presence of a wire-to-wire short. The same is true for the portion of the circuit from the last isolator to the alarm processor or the central supervising station.

NOTE 2: Some manufacturers of this type of equipment have isolators as part of the base assembly. Therefore in the field this component may not be readily observable without the assistance of the manufacturer's representative.

Figure A-7-2.2(ee) Style 7.0 (Class A).

A-7-3.2 Batteries. To maximize battery life, nickel-cadmium batteries should be charged as follows:

Float Voltage	1.42 Volts/Cell + .01 volts
High Rate Voltage	1.58 Volts/Cell + .07 – 0.00 volts

NOTE: High and low gravity voltages are (+) 0.07 volts and (–) 0.03 volts respectively.

[From NFPA 1221, 2-1.10.2.2, 3-1.5.3.2, and 4-1.6.2.3]

To maximize battery life, the battery voltage for lead-acid cells should be maintained within the limits shown in the following table:

Float Voltage	High Gravity Battery (Lead Calcium)	Low Gravity Battery (Lead Antimony)
Maximum	2.25 Volts/Cell	2.17 Volts/Cell
Minimum	2.20 Volts/Cell	2.13 Volts/Cell
High Rate Voltage		2.33 Volts/Cell

The following procedure is recommended for checking state of charge for nickel-cadmium batteries:

(a) Switch the battery charger from float to high-rate mode.

(b) The current, as indicated on the charger ammeter, will immediately rise to the maximum output of the charger, and the battery voltage, as shown on the charger voltmeter, will start to rise at the same time.

(c) The actual value of the voltage rise is unimportant since it depends on many variables; the length of time it takes for the voltage to rise is the important factor.

(d) If, for example, the voltage rises rapidly in a few minutes, then holds steady at the new value, the battery was fully charged. At the same time, the current will drop to slightly above its original value.

(e) In contrast, if the voltage rises slowly and the output current remains high, the high-rate charge should be continued until the voltage remains constant. Such a condition is an indication that the battery was not fully charged, and the float voltage should be increased slightly.

[From NFPA 1221, A-2-1.10.2.2(b)]

A-7-3.2.1 It is suggested that the annual test can be conducted in segments so that all devices are tested annually.

[New paragraph]

Appendix B Engineering Guide for Automatic Fire Detector Spacing

[From NFPA 72E-1990, Appendix C modified]

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

B-1 Introduction.

B-1.1 Scope. This appendix provides information intended to supplement Chapter 5 and includes a procedure for determining heat detector spacing based on the size and rate of growth of fire to be detected, various ceiling heights, and ambient temperature. The effects of ceiling height and the size and rate of growth of a flaming fire on smoke detector spacing are also treated. A procedure for analyzing the response of existing heat detection systems is also presented.

B-1.1.1 This appendix utilizes the results of fire research funded by the Fire Detection Institute to provide test data and analysis to the NFPA Technical Committee on Detection Devices. (See reference 10 in Appendix C.)

B-1.1.2 This appendix is based on full-scale fire tests in which all fires were geometrically growing flaming fires.

B-1.1.3 The tables and graphs in this appendix were produced using test data and data correlations for wood fuels having a total heat of combustion of about 20,900 kJ/kg and a convective heat release rate fraction equal to 75 percent of the total heat release rate. Users should refer to references 12 and 13 in Appendix C for fuels or burning conditions substantially different from these conditions.

[From NFPA 72E - 1990, Appendix C]

B-1.1.4 The guidance applicable to smoke detectors is limited to a theoretical analysis based on the flaming fire test data and is not intended to address the detection of smoldering fires.

B-1.2 Purpose. The purpose of this appendix is to assist fire alarm system engineers concerned with spacing and response of heat or smoke detectors.

B-1.2.1 Design. This appendix provides a method for modifying the listed spacing of both rate-of-rise and fixed-temperature heat detectors required to achieve detector response to a geometrically growing flaming fire at a specific fire size, taking into account the height of the ceiling on which the detectors are mounted and the fire safety objectives for the space. This procedure also permits modification of listed spacing of fixed temperature heat detectors to account for variation of ambient temperature (T_o) from standard test conditions.

[From NFPA 72E - 1990, Appendix C modified]

B-1.2.2 Analysis. This appendix may be used to estimate the fire size that can be detected by an existing array of listed heat detectors installed at a given spacing for a given ceiling height in known ambient conditions.

[From NFPA 72E - 1990, C-5-2]

B-1.2.3 This appendix is also intended to explain the effect of rate of fire growth and fire size of a flaming fire,

as well as the effect of ceiling height on the spacing and response of smoke detectors.

[From NFPA 72E - 1990, C-5-2.2 modified]

B-1.2.4 This methodology utilizes theories of fire development, fire plume dynamics, and detector performance, which are the major factors influencing detector response. However, it does not consider several lesser phenomena that, in general, are unlikely to have significant influence. A discussion of ceiling drag, heat loss to the ceiling, radiation to the detector from a fire, re-radiation of heat from a detector to its surroundings, and the heat of fusion of eutectic materials in fusible elements of heat detectors and their possible limitations on the design method are provided in references 4, 11, and 14 in Appendix C.

[From NFPA 72E - 1990, C-5-2.3]

B-1.3 Relationship to Listed Spacings. Listed spacings for heat detectors are based on relatively large fires (approximately 1200 Btu/sec), burning at a constant rate. [The listed spacing is based on the distance from a fire at which an ordinary degree heat detector actuates prior to operation of a 160°F (71°C) sprinkler installed at a 10-ft (3-m) spacing.] [See Figure A-5-2.7.1(a).]

Design spacing for this type of fire can be determined using the material in Chapter 5.

When smaller or larger fires and varying growth rates must be considered, the designer may use the material presented by this appendix.

[From NFPA 72E - 1990, Appendix C modified]

B-1.4 Required Data. The following data are required to use the methods in this appendix for either analysis or design.

B-1.4.1 Analysis.

T_o	Ambient temperature
H	Ceiling height or clearance above fuel
T_s	Detector operating temperature (heat detectors only)
$\Delta T_r/\text{min}$	Rate of temperature change set point for rate-of-rise heat detectors
RTI	Response time index for the detector (heat detectors only) or its listed spacing
α or t_g	Fuel fire intensity coefficient or t_g , the fire growth time
S	The actual installed spacing of the existing detectors

B-1.4.2 Design.

T_o	Ambient temperature
H	Ceiling height or clearance above fuel
T_s	Detector operating temperature (heat detectors only)
$\Delta T_r/\text{min}$	Rate of temperature change set point for rate-of-rise heat detectors
RTI	Response time index for the detector (heat detectors only) or its listed spacing
α or t_g	Fuel fire intensity coefficient or t_g , the fire growth time
Q_d or t_d	The threshold fire size at which response must occur or the time to detector response

B-1.4.3 The terms and data listed above are defined in more detail in the following sections.

[From NFPA 72E - 1990, Appendix C]

B-2 Fire Development and Ceiling Height Considerations.

B-2.1 General. The purpose of this section is to discuss the effects of ceiling height and the selection of a threshold fire size that may be used as the basis for determination of type and spacing of automatic fire detectors in a specific situation.

[From NFPA 72E - 1990, Appendix C modified]

B-2.1.1 A detector will ordinarily operate sooner in detecting the fire if it is nearer the fire.

[From NFPA 72E - 1990, B-1-1]

B-2.1.2 Generally, height is the most important single dimension where ceiling heights exceed 16 ft (4.9 m).

[From NFPA 72E - 1990, B-1-2]

B-2.1.3 As smoke and heat rise from a fire, they tend to spread in the general form of an inverted cone. Therefore, the concentration within the cone varies inversely as a variable exponential function of the distance from the source. This effect is very significant in the early stages of a fire, because the angle of the cone is wide. As a fire intensifies, the angle of the cone narrows and the significance of the effect of height is lessened.

[From NFPA 72E - 1990, B-1-3]

B-2.1.4 High Ceilings. As the ceiling height increases, a larger-size fire is required to actuate the same detector in the same time. In view of this, it is mandatory that the designer of a fire detection system calling for heat detectors consider the size of the fire and rate of heat release that may be permitted to develop before detection is ultimately obtained.

[From NFPA 72E - 1990, B-1-4]

B-2.1.5 The most sensitive detectors suitable for the maximum ambient temperature at heights above 30 ft (9.1 m) should be employed.

[From NFPA 72E - 1990, B-1-5]

B-2.1.6 Spacing recommended by testing laboratories for the location of detectors is an indication of their relative sensitivity. This applies with each detection principle; however, detectors operating on various physical principles have different inherent sensitivities to different types of fires and fuels.

[From NFPA 72E - 1990, B-1-6]

B-2.1.7 Reduction of listed spacing may be required for any of the following purposes:

- (a) Faster response of the device to a fire
- (b) Response of the device to a smaller fire
- (c) Accommodation to room geometry
- (d) Other special considerations, such as air movement, or ceiling or other obstructions.

[From NFPA 72E - 1990, B-1-7]

B-2.2 Fire Development.

B-2.2.1 Fire development will vary depending on the combustion characteristics of the fuels involved and the

physical configuration of the fuels. After ignition, most fires grow in an accelerating pattern.

B-2.2.2 Fire Size.

B-2.2.2.1 Fires can be characterized by their rate of heat release, measured in terms of the number of Btus per second (kW) generated. Typical maximum heat release rates, Q_m , for a number of different fuels and fuel configurations are provided in Tables B-2.2.2.1(a) and (b).

In Table B-2.2.2.1(a):

$$Q_m = q_A$$

Where:

Q_m = the maximum or peak heat release rate in Btu/sec

q = the heat release rate density per unit floor area in Btu/sec/ft²

A = the floor area of the fuel in ft².

[From NFPA 72E - 1990, Appendix C modified]

B-2.2.2.2 Example. A particular hazard analysis is to be based on a fire scenario involving a 10-ft by 10-ft stack of wood pallets 5 ft high. Approximately what peak heat release rate can be expected?

From Table B-2.2.2.1(a), the heat release rate density (q) for 5-ft high wood pallets is about 330 Btu/sec/ft².

The area is 10 ft by 10 ft = 100 ft².

$$Q_m = q_A = 330 \times 100 = 33,000 \text{ Btu/sec.}$$

The fire would have a medium to fast fire growth rate reaching 1000 Btu/sec in about 90 to 190 seconds.

[From NFPA 72E - 1990, Appendix C]

B-2.2.2.3 The National Institute of Standards and Technology (former National Bureau of Standards) has developed a large-scale calorimeter for measuring the heat release rates of burning furniture. Two reports issued by NIST (*see references 3 and 13 in Appendix C*) describe the apparatus and data collected during two test series.

Test data from 40 furniture calorimeter tests have been used to independently verify the power-law fire growth model, $Q = \alpha t^2$. (*See reference 14 in Appendix C.*) Here Q is the instantaneous heat release rate, α is the fire intensity coefficient, and t is time. The fire growth time, t_g , is arbitrarily defined as the time after established burning when the fire would reach a burning rate of 1000 Btu/sec. In terms of t_g :

$$\alpha = 1000/t_g^2 \text{ Btu/sec}^3$$

$$\alpha = 1055/t_g^2 \text{ kW/sec}^2$$

and

$$Q = (1000/t_g^2)t^2 \text{ Btu/sec}$$

$$Q = (1055/t_g^2)t^2 \text{ kW.}$$

Graphs of heat release data from the 40 furniture calorimeter tests can be found in reference 8. Best fit power-law fire growth curves have been superimposed on the graphs. Data from the best fit curves can be used with this appendix to design or analyze fire detection systems that must respond to similar items burning under a flat ceiling. Table B-2.2.2.3 is a summary of that data.

Table B-2.2.2.1(a) Maximum Heat Release Rates

Warehouse Materials		Growth Time (tg) (sec)	Heat Release Density (q)	Classification (s = slow, m = medium, f = fast)
1.	Wood pallets, stack, 1½ ft high (6-12% moisture)	150-310	110	f-m
2.	Wood pallets, stack, 5 ft high (6-12% moisture)	90-190	330	f-m
3.	Wood pallets, stack, 10 ft high (6-12% moisture)	80-110	600	f
4.	Wood pallets, stack, 16 ft high (6-12% moisture)	75-105	900	f
5.	Mail bags, filled, stored 5 ft high	190	35	m
6.	Cartons, compartmented, stacked 15 ft high	60	200	f
7.	Paper, vertical rolls, stacked 20 ft high	15-28	—	†
8.	Cotton (also PE, PE/Cot, Acrylic/Nylon/PE), garments in 12-ft high rack	20-42	—	†
9.	Cartons on pallets, rack storage, 15-30 ft high	40-280	—	f-m
10.	Paper products, densely packed in cartons, rack storage, 20 ft high	470	—	s
11.	PE letter trays, filled, stacked 5 ft high on cart	190	750	m
12.	PE trash barrels in cartons, stacked 15 ft high	55	250	f
13.	FRP shower stalls in cartons, stacked 15 ft high	85	110	f
14.	PE bottles, packed in Item 6	85	550	f
15.	PE bottles in cartons, stacked 15 ft high	75	170	f
16.	PE pallets, stacked 3 ft high	130	—	f
17.	PE pallets, stacked 6-8 ft high	30-55	—	f
18.	PU mattress, single, horizontal	110	—	f
19.	PE insulation board, rigid foam, stacked 15 ft high	8	170	†
20.	PS jars, packed in Item 6	55	1200	f
21.	PS tubs nested in cartons, stacked 14 ft high	105	450	f
22.	PS toy parts in cartons, stacked 15 ft high	110	180	f
23.	PS insulation board, rigid, stacked 14 ft high	7	290	†
24.	PVC bottles, packed in Item 6	9	300	†
25.	PP tubs, packed in Item 6	10	390	†
26.	PP and PE film in rolls, stacked 14 ft high	40	350	†
27.	Distilled spirits in barrels, stacked 20 ft high	23-40	—	†
28.	Methyl alcohol	—	65	—
29.	Gasoline	—	200	—
30.	Kerosene	—	200	—
31.	Diesel oil	—	180	—

For SI Units: 1 ft = 0.305 m.

NOTE: The heat release rates per unit floor area are for fully involved combustibles, assuming 100 percent combustion efficiency. The growth times shown are those required to exceed 1000 Btu/sec heat release rate for developing fires assuming 100 percent combustion efficiency.

(PE = polyethylene; PS = polystyrene; PVC = polyvinyl chloride; PP = polypropylene; PU = polyurethane; FRP = fiberglass-reinforced polyester.)

†Fire growth rate exceeds design data.

[From NFPA 72E - 1990, Appendix C modified]

Table B-2.2.2.1(b) Maximum Heat Release Rates from Fire Detection Institute Analysis

Materials	Approximate Values Btu/sec
Medium wastebasket with milk cartons	100
Large barrel with milk cartons	140
Upholstered chair with polyurethane foam	350
Latex foam mattress (heat at room door)	1200
Furnished living room (heat at open door)	4000-8000

For reference, the table contains the test numbers used in the original NIST reports. The virtual time of origin, t_v , is the time at which the fires began to obey the power-law fire growth model. Prior to t_v , the fuels may have smoldered but did not burn vigorously with an open flame. The model curves are then predicted by:

$$Q = \alpha(t - t_v)^2 \text{ Btu/sec or kW}$$

$$Q = (1000/t_g^2)(t - t_v)^2 \text{ Btu/sec}$$

$$Q = (1055/t_g^2)(t - t_v)^2 \text{ kW.}$$

Figure B-2.2.2.3 is an example of actual test data with a power-law curve superimposed. This shows how the model may be used to approximate the growth phase of the fire.

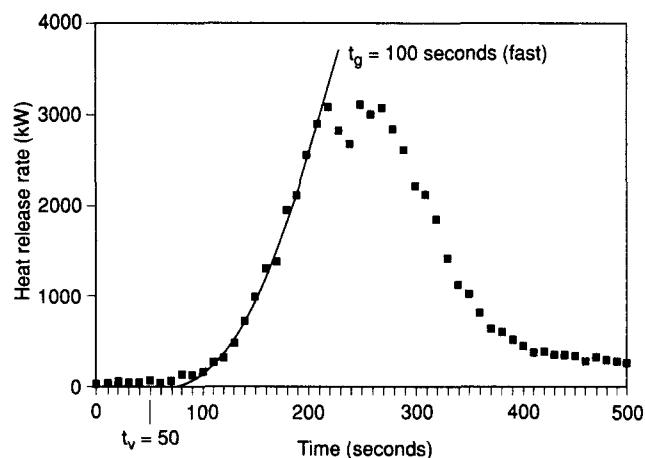


Figure B-2.2.2.3 Test 38, foam sofa.

[From NFPA 72E - 1990, Appendix C]

For tests 19, 21, 29, 42, and 67, different power-law curves were used to model the initial and the latter realms of burning. In examples such as these, engineers must choose the fire growth parameter that best describes the realm of burning that the detection system is being designed to respond to.

In addition to heat release rate data, the original NIST reports contain data on particulate conversion and radiation from the test specimens. These data can be used to determine the threshold fire size (heat release rate) at which tenability becomes endangered or when additional fuel packages might become involved in the fire.

[From NFPA 72E - 1990, C-5-2.2.2 modified]

B-2.2.2.4 A fire detection system can be designed to detect a fire at a certain size in terms of its heat release rate. This is called the threshold fire size (Q_d). The threshold size is the rate of heat release at which detection is desired.

[From NFPA 72E - 1990, C-2.2.3]

B-2.2.3 Fire Growth.

B-2.2.3.1 A second important consideration concerning fire development is the time (t_g) it takes for fire to reach a given heat release rate. Table B-2.2.2.1(a) and Table B-2.2.2.3 provide the times required to reach a heat release rate of 1000 Btu/sec (1055 kW) for a variety of materials in various configurations.

B-2.2.3.2 For purposes of this appendix, fires are classified as being either slow-, medium-, or fast-developing. (See Figure B-2.2.3.2.)

[From NFPA 72E - 1990, Appendix C modified]

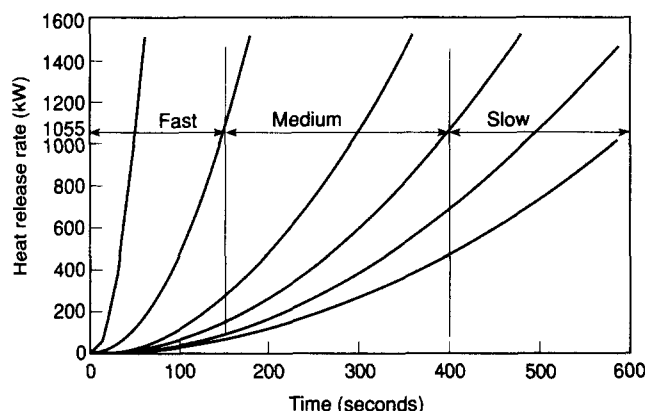


Figure B-2.2.3.2 Power-law heat release rates.

[From NFPA 72E - 1990, Appendix C]

B-2.2.3.2.1 The slow-developing fire is defined as one that would take 400 or more seconds (6 minutes, 40 seconds) from the time that established burning occurs until the fire reaches a heat release rate of 1000 Btu/sec (1055 kW). Using the relationships discussed in B-2.2.2.3, this corresponds to an α of 0.0062 Btu/sec³ or less (0.0066 kW/sec² or less).

[From NFPA 72E - 1990, Appendix C modified]

B-2.2.3.2.2 The medium-developing fire is one that would take 150 seconds (2 minutes, 30 seconds) or more and less than 400 seconds (6 minutes, 40 seconds) from the time that

established burning occurs until the fire reaches a heat release rate of 1000 Btu/sec (1055 kW). Using the relationships discussed in B-2.2.2.3, this corresponds to $0.0444 \leq \alpha < 0.0062$ Btu/sec³ ($0.0469 \leq \alpha < 0.0066$ kW/sec²).

B-2.2.3.2.3 The fast-developing fire is one that would take less than 150 seconds (2 minutes, 30 seconds) from the time that established burning occurs until the fire reaches a heat release rate of 1000 Btu/sec (1055 kW). Using the relationships discussed in B-2.2.2.3, this corresponds to an α greater than 0.0444 Btu/sec³ (0.0469 kW/sec²).

B-2.2.3.3 The design fires used in this guide grow according to the following equation: $Q = (1000/t_g^2)t^2$ [where Q is the heat release rate in Btu/sec; t_g is the fire growth time (149 sec = fast, 150–399 sec = medium, 400 sec = slow); and t is the time, in seconds, after established burning occurs].

B-2.2.4 Selection of Fire Size. The selection of threshold fire size, Q_d , should be based on an understanding of the characteristics of a specified space and fire safety objectives for that space.

For example, in a particular installation it may be desirable to detect a typical wastebasket fire. Table B-2.2.2.1(b) includes data for a fire involving a comparable array of combustibles, specifically milk cartons in a wastebasket. Such a fire is indicated to produce a peak heat release rate of 100 Btu/sec.

B-2.3 Ceiling Height.

B-2.3.1 The Fire Detection Institute data are based on the height of the ceiling above the fire. In this guide, it is recommended that the designer use the actual distance from floor to ceiling, since the ceiling height will thereby be more conservative and actual detector response will improve when the potential fuel in a room is above floor level.

B-2.3.2 Where the designer desires to consider the height of the potential fuel in the room, the distance between the fuel and the ceiling should be used in place of the ceiling height in the tables and graphs. This should be considered only where the minimum height of the potential fuel is always constant, and where the concept is acceptable to the authority having jurisdiction.

B-2.3.3 The procedures presented in this appendix are based on an analysis of test data for ceiling heights up to 30 ft (9.1 m). No data was analyzed for ceilings greater than 30 ft (9.1 m); therefore, in such installations, engineering judgment and manufacturer's recommendations should be used.

B-3 Heat Detector Spacing.

B-3.1 General.

B-3.1.1 This section discusses procedures for determination of installed spacing of listed heat detectors used to detect flaming fires.

B-3.1.2 The determination of the installed spacing of heat detectors using these procedures adjusts the listed spacing to reflect the effects of ceiling height, threshold fire size, rate of fire development, and, for fixed temperature detectors, the ambient temperature and the temperature rating of the detector.

B-3.1.3 Other factors that will affect detector response, such as beams and joists, are treated in Chapter 5.

Table B-2.2.2.3 Furniture Heat Release Rates

Test No.	Item/Mass/Description	Growth Time (t_g) (sec)	Classification		Virtual time (t_v) (sec)	Maximum Heat Release Rates (kW)
			(s = slow, m = medium, f = fast)	Alpha (α) (kW/sec ²)		
Test 15	Metal wardrobe, 41.4 kg (total)	50	f	0.4220	10	750
Test 18	Chair F33 (trial loveseat), 39.2 kg	400	s	0.0066	140	950
Test 19	Chair F21, 28.15 kg (initial)	175	m	0.0344	110	350
Test 19	Chair F21, 28.15 kg (later)	50	f	0.4220	190	2000
Test 21	Metal wardrobe, 40.8 kg (total) (initial)	250	m	0.0169	10	250
Test 21	Metal wardrobe, 40.8 kg (total) (average)	120	f	0.0733	60	250
Test 21	Metal wardrobe, 40.8 kg (total) (later)	100	f	0.1055	30	140
Test 22	Chair F24, 28.3 kg	350	m	0.0086	400	700
Test 23	Chair F23, 31.2 kg	400	s	0.0066	100	700
Test 24	Chair F22, 31.9 kg	2000	s	0.0003	150	300
Test 25	Chair F26, 19.2 kg	200	m	0.0264	90	800
Test 26	Chair F27, 29.0 kg	200	m	0.0264	360	900
Test 27	Chair F29, 14.0 kg	100	f	0.1055	70	1850
Test 28	Chair F28, 29.2 kg	425	s	0.0058	90	700
Test 29	Chair F25, 27.8 kg (later)	60	f	0.2931	175	700
Test 29	Chair F25, 27.8 kg (initial)	100	f	0.1055	100	2000
Test 30	Chair F30, 25.2 kg	60	f	0.2931	70	950
Test 31	Chair F31 (loveseat), 39.6 kg	60	F	0.2931	145	2600
Test 37	Chair F31 (loveseat), 40.4 kg	80	f	0.1648	100	2750
Test 38	Chair F32 (sofa), 51.5 kg	100	f	0.1055	50	3000
Test 39	1/2-in. plywood wardrobe with fabrics, 68.5 kg	35	†	0.8612	20	3250
Test 40	1/2-in. plywood wardrobe with fabrics, 68.32 kg	35	†	0.8612	40	3500
Test 41	1/8-in. plywood wardrobe with fabrics, 36.0 kg	40	†	0.6594	40	6000
Test 42	1/8-in. plywood wardrobe with fire-retardant int. fin. (initial growth)	70	f	0.2153	50	2000
Test 42	1/8-in. plywood wardrobe with fire-retardant int. fin. (later growth)	30	†	1.1722	100	5000
Test 43	Repeat of 1/2-in. plywood wardrobe, 67.62 kg	30	†	1.1722	50	3000
Test 44	1/8-in. plywood wardrobe with fire-retardant latex paint, 37.26 kg	90	f	0.1302	30	2900
Test 45	Chair F21, 28.34 kg	100	f	0.1055	120	2100
Test 46	Chair F21, 28.34 kg	45	†	0.5210	130	2600
Test 47	Chair, adj. back metal frame, foam cushions, 20.82 kg	170	m	0.0365	30	250
Test 48	Easy chair C07, 11.52 kg	175	m	0.0344	90	950
Test 49	Easy chair F-34, 15.68 kg	200	m	0.0264	50	200
Test 50	Chair, metal frame, minimum cushion, 16.52 kg	200	m	0.0264	120	3000
Test 51	Chair, molded fiberglass, no cushion, 5.28 kg	120	f	0.0733	20	35
Test 52	Molded plastic patient chair, 11.26 kg	275	m	0.0140	2090	700
Test 53	Chair, metal frame, padded seat and back, 15.54 kg	350	m	0.0086	50	280
Test 54	Loveseat, metal frame, foam cushions, 27.26 kg	500	s	0.0042	210	300
Test 56	Chair, wood frame, latex foam cushions, 11.2 kg	500	s	0.0042	50	85
Test 57	Loveseat, wood frame, foam cushions, 54.6 kg	350	m	0.0086	500	1000
Test 61	Wardrobe, 3/4-in. particleboard, 120.33 kg	150	m	0.0469	0	1200
Test 62	Bookcase, plywood with aluminum frame, 30.39 kg	65	f	0.2497	40	25
Test 64	Easy chair, molded flexible urethane frame, 15.98 kg	1000	s	0.0011	750	450
Test 66	Easy chair, 23.02 kg	76	f	0.1827	3700	600
Test 67	Mattress and boxspring, 62.36 kg (later)	350	m	0.0086	400	500
Test 67	Mattress and boxspring, 62.36 kg (initial)	1100	s	0.0009	90	400

For SI Units: 1 ft = 0.305 m; 1000 Btu/sec = 1055 kW; 1 lb = 0.456 kg.

† Fire growth exceeds design data.

[From NFPA 72E - 1990, Table C-5-2.2.2 modified]

B-3.1.4 The difference between the rated temperature of a fixed temperature detector (T_s) and the maximum ambient temperature (T_o) at the ceiling should be as small as possible. To reduce unwanted alarms, the difference between operating temperature and ambient temperature should be not less than 20°F (11°C).

B-3.1.5 Listed rate-of-rise heat detectors are designed to activate at a nominal rate of temperature rise of 15°F (8°C) per minute.

B-3.1.6 The listed spacing of a detector is an indicator of the detector's sensitivity. Given the same temperature rating, a detector listed for a 50-ft (15.2-m) spacing is more sensitive than one listed for a 20-ft (6.1-m) spacing.

B-3.1.7 Where using combination detectors incorporating both fixed temperature and rate-of-rise heat detection principles to detect a geometrically growing fire, the data herein for rate-of-rise detectors should be used in selecting an installed spacing because the rate-of-rise principle controls the response.

B-3.1.8 Rate-compensated detectors are not specifically covered by this guide. However, a conservative approach to predicting their performance is to use the fixed temperature heat detector guidance contained herein.

B-3.2 Fixed-Temperature Heat Detector Spacing.

B-3.2.1 Tables B-3.2.2 and B-3.2.4(a) through (y) are to be used to determine the installed spacing of fixed-temperature heat detectors. The analytical basis for the tables is presented in a later section of this appendix. This section describes how the tables are to be used.

B-3.2.1.1 Except for ceiling height, the nearest value shown in the tables will provide sufficient accuracy for these calculations. Interpolation is allowable but not necessary except for ceiling height.

B-3.2.2 Given the detector's listed spacing and the detector's rated temperature (T_s), use Table B-3.2.2 to find the detector time constant (τ_o). The time constant is a measure of the detector's sensitivity. (See B-3.3.)

[From NFPA 72E - 1990, Appendix C modified]

B-3.2.2.1 Response time index (RTI) can also be used to describe the sensitivity of a fixed temperature heat detector. (See Section B-4.)

B-3.2.3 Estimate the minimum ambient temperature (T_o) expected at the ceiling of the space to be protected. Calculate the temperature change (ΔT) of the detector required for detection ($\Delta T = T_s - T_o$).

B-3.2.3.1 Selection of the minimum ambient temperature requires engineering judgment. Use of the absolute minimum ambient temperature will result in the most conservative designs. This is true because it is then assumed that the detector must absorb enough energy to raise its temperature from the low ambient value up to its operating temperature. A review of historical data may show very low ambient temperatures that occur relatively infrequently, such as every one hundred years or so.

Depending on actual design considerations, it may be more prudent to use an average minimum ambient temperature. In any case, a sensitivity analysis should be per-

Table B-3.2.2 Time Constants (τ_o) for Any Listed Heat Detector*

Listed Spacing (ft)	ULI						FMRC All Temps.
	128°	135°	145°	160°	170°	196°	
10	400	330	262	195	160	97	196
15	250	190	156	110	89	45	110
20	165	135	105	70	52	17	70
25	124	100	78	48	32		48
30	95	80	61	36	22		36
40	71	57	41	18			
50	59	44	30				
70	36	24	9				

NOTE 1: These time constants are based on an analysis of the Underwriters Laboratories Inc. and Factory Mutual listing test procedures. Plunge test (see reference 8 in Appendix C) results performed on the detector to be used will give a more accurate time constant. See Section B-5 for a further discussion of detector time constants.

NOTE 2: These time constants can be converted to response time index (RTI) values by multiplying by $\sqrt{5}$ ft/sec. (See B-3-3.)

*At a reference velocity of 5 ft/sec.

[From NFPA 72E - 1990, C-5-2.2.1]

formed to determine the effect of changing the ambient temperature on the design results.

[From NFPA 72E - 1990, Appendix C]

B-3.2.4 Having determined the detector's sensitivity (time constant or RTI) (see B-3.2.2), the temperature change of the detector required for detection (see B-3.2.3), the threshold fire size (see B-3.2.2), the fire growth rate (see B-3.2.3), and the ceiling height, use Tables B-3.2.4(a) through (y) to determine the required installed spacing. Table B-3.2.4 is an index to the tables.

[From NFPA 72E - 1990, Appendix C modified]

Table B-3.2.4 Design Tables Index

	Threshold Fire Size (Btu/sec) Q_d	Fire Growth Period (sec) t_g	Alpha (Btu/sec ³) α
Table B-3.2.4(a)	250	50	0.400
Table B-3.2.4(b)	250	150	0.044
Table B-3.2.4(c)	250	300	0.011
Table B-3.2.4(d)	250	500	0.004
Table B-3.2.4(e)	250	600	0.003
Table B-3.2.4(f)	500	50	0.400
Table B-3.2.4(g)	500	150	0.044
Table B-3.2.4(h)	500	300	0.011
Table B-3.2.4(i)	500	500	0.004
Table B-3.2.4(j)	500	600	0.003
Table B-3.2.4(k)	750	50	0.400
Table B-3.2.4(l)	750	150	0.044
Table B-3.2.4(m)	750	300	0.011
Table B-3.2.4(n)	750	500	0.004
Table B-3.2.4(o)	750	600	0.003
Table B-3.2.4(p)	1000	50	0.400
Table B-3.2.4(q)	1000	150	0.044
Table B-3.2.4(r)	1000	300	0.011
Table B-3.2.4(s)	1000	500	0.004
Table B-3.2.4(t)	1000	600	0.003
Table B-3.2.4(u)	2000	50	0.400
Table B-3.2.4(v)	2000	150	0.044
Table B-3.2.4(w)	2000	300	0.011
Table B-3.2.4(x)	2000	500	0.004
Table B-3.2.4(y)	2000	600	0.003

[From NFPA 72E - 1990, Appendix C modified]

Table B-3.2.4(a)
 Q_d , Threshold Fire Size at Response: 250 Btu/sec
 t_g : 50 seconds to 1000 Btu/sec
 α : 0.400 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0
INSTALLED SPACING OF DETECTORS									
25	56	40	7	5	2	0	0	0	0
25	56	60	6	3	1	0	0	0	0
25	56	80	5	2	0	0	0	0	0
25	56	100	4	2	0	0	0	0	0
25	56	120	4	1	0	0	0	0	0
25	56	140	3	1	0	0	0	0	0
50	112	40	5	3	1	0	0	0	0
50	112	60	4	2	0	0	0	0	0
50	112	80	3	1	0	0	0	0	0
50	112	100	3	0	0	0	0	0	0
50	112	120	2	0	0	0	0	0	0
50	112	140	2	0	0	0	0	0	0
75	168	40	4	2	0	0	0	0	0
75	168	60	3	1	0	0	0	0	0
75	168	80	2	0	0	0	0	0	0
75	168	100	2	0	0	0	0	0	0
75	168	120	2	0	0	0	0	0	0
75	168	140	1	0	0	0	0	0	0
100	224	40	3	1	0	0	0	0	0
100	224	60	2	0	0	0	0	0	0
100	224	80	2	0	0	0	0	0	0
100	224	100	1	0	0	0	0	0	0
100	224	120	1	0	0	0	0	0	0
100	224	140	1	0	0	0	0	0	0
125	280	40	3	0	0	0	0	0	0
125	280	60	2	0	0	0	0	0	0
125	280	80	1	0	0	0	0	0	0
125	280	100	1	0	0	0	0	0	0
125	280	120	0	0	0	0	0	0	0
125	280	140	0	0	0	0	0	0	0
150	335	40	2	0	0	0	0	0	0
150	335	60	2	0	0	0	0	0	0
150	335	80	1	0	0	0	0	0	0
150	335	100	0	0	0	0	0	0	0
150	335	120	0	0	0	0	0	0	0
150	335	140	0	0	0	0	0	0	0
175	391	40	2	0	0	0	0	0	0
175	391	60	1	0	0	0	0	0	0
175	391	80	1	0	0	0	0	0	0
175	391	100	0	0	0	0	0	0	0
175	391	120	0	0	0	0	0	0	0
175	391	140	0	0	0	0	0	0	0
200	447	40	2	0	0	0	0	0	0
200	447	60	1	0	0	0	0	0	0
200	447	80	0	0	0	0	0	0	0
200	447	100	0	0	0	0	0	0	0
200	447	120	0	0	0	0	0	0	0
200	447	140	0	0	0	0	0	0	0

τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0
INSTALLED SPACING OF DETECTORS									
225	503	40	2	0	0	0	0	0	0
225	503	60	1	0	0	0	0	0	0
225	503	80	0	0	0	0	0	0	0
225	503	100	0	0	0	0	0	0	0
225	503	120	0	0	0	0	0	0	0
225	503	140	0	0	0	0	0	0	0
250	559	40	2	0	0	0	0	0	0
250	559	60	0	0	0	0	0	0	0
250	559	80	0	0	0	0	0	0	0
250	559	100	0	0	0	0	0	0	0
250	559	120	0	0	0	0	0	0	0
250	559	140	0	0	0	0	0	0	0
275	615	40	1	0	0	0	0	0	0
275	615	60	0	0	0	0	0	0	0
275	615	80	0	0	0	0	0	0	0
275	615	100	0	0	0	0	0	0	0
275	615	120	0	0	0	0	0	0	0
275	615	140	0	0	0	0	0	0	0
300	671	40	1	0	0	0	0	0	0
300	671	60	0	0	0	0	0	0	0
300	671	80	0	0	0	0	0	0	0
300	671	100	0	0	0	0	0	0	0
300	671	120	0	0	0	0	0	0	0
300	671	140	0	0	0	0	0	0	0
325	727	40	1	0	0	0	0	0	0
325	727	60	0	0	0	0	0	0	0
325	727	80	0	0	0	0	0	0	0
325	727	100	0	0	0	0	0	0	0
325	727	120	0	0	0	0	0	0	0
325	727	140	0	0	0	0	0	0	0
350	783	40	1	0	0	0	0	0	0
350	783	60	0	0	0	0	0	0	0
350	783	80	0	0	0	0	0	0	0
350	783	100	0	0	0	0	0	0	0
350	783	120	0	0	0	0	0	0	0
350	783	140	0	0	0	0	0	0	0
375	839	40	0	0	0	0	0	0	0
375	839	60	0	0	0	0	0	0	0
375	839	80	0	0	0	0	0	0	0
375	839	100	0	0	0	0	0	0	0
375	839	120	0	0	0	0	0	0	0
375	839	140	0	0	0	0	0	0	0
400	894	40	0	0	0	0	0	0	0
400	894	60	0	0	0	0	0	0	0
400	894	80	0	0	0	0	0	0	0
400	894	100	0	0	0	0	0	0	0
400	894	120	0	0	0	0	0	0	0
400	894	140	0	0	0	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(b)
 Q_d : Threshold Fire Size at Response: 250 Btu/sec
 t_g : 150 Seconds to 1000 Btu/sec
 α : 0.044 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET																
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0										
			INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS																
25	56	40	15	12	9	6	3	0	0	225	503	40	5	3	1	0	0	0	0	225	503	40	5	3	1	0	0	0	0
25	56	60	12	9	6	3	0	0	0	225	503	60	4	2	0	0	0	0	0	225	503	60	4	2	0	0	0	0	0
25	56	80	10	7	4	1	0	0	0	225	503	80	3	1	0	0	0	0	0	225	503	80	3	1	0	0	0	0	0
25	56	100	9	6	2	0	0	0	0	225	503	100	2	0	0	0	0	0	0	225	503	100	2	0	0	0	0	0	0
25	56	120	8	4	1	0	0	0	0	225	503	120	2	0	0	0	0	0	0	225	503	120	2	0	0	0	0	0	0
25	56	140	7	4	1	0	0	0	0	225	503	140	2	0	0	0	0	0	0	225	503	140	2	0	0	0	0	0	0
50	112	40	11	9	6	3	1	0	0	250	559	40	5	2	0	0	0	0	0	250	559	40	5	2	0	0	0	0	0
50	112	60	9	6	3	1	0	0	0	250	559	60	3	1	0	0	0	0	0	250	559	60	3	1	0	0	0	0	0
50	112	80	7	5	2	0	0	0	0	250	559	80	3	0	0	0	0	0	0	250	559	80	3	0	0	0	0	0	0
50	112	100	6	4	1	0	0	0	0	250	559	100	2	0	0	0	0	0	0	250	559	100	2	0	0	0	0	0	0
50	112	120	6	3	1	0	0	0	0	250	559	120	2	0	0	0	0	0	0	250	559	120	2	0	0	0	0	0	0
50	112	140	5	2	0	0	0	0	0	250	559	140	1	0	0	0	0	0	0	250	559	140	1	0	0	0	0	0	0
75	168	40	9	7	4	2	0	0	0	275	615	40	4	2	0	0	0	0	0	275	615	40	4	2	0	0	0	0	0
75	168	60	7	5	2	0	0	0	0	275	615	60	3	1	0	0	0	0	0	275	615	60	3	1	0	0	0	0	0
75	168	80	6	3	1	0	0	0	0	275	615	80	2	0	0	0	0	0	0	275	615	80	2	0	0	0	0	0	0
75	168	100	5	3	0	0	0	0	0	275	615	100	2	0	0	0	0	0	0	275	615	100	2	0	0	0	0	0	0
75	168	120	4	2	0	0	0	0	0	275	615	120	2	0	0	0	0	0	0	275	615	120	2	0	0	0	0	0	0
75	168	140	4	1	0	0	0	0	0	275	615	140	1	0	0	0	0	0	0	275	615	140	1	0	0	0	0	0	0
100	224	40	8	6	3	1	0	0	0	300	671	40	4	2	0	0	0	0	0	300	671	40	4	2	0	0	0	0	0
100	224	60	6	4	2	0	0	0	0	300	671	60	3	1	0	0	0	0	0	300	671	60	3	1	0	0	0	0	0
100	224	80	5	3	1	0	0	0	0	300	671	80	2	0	0	0	0	0	0	300	671	80	2	0	0	0	0	0	0
100	224	100	4	2	0	0	0	0	0	300	671	100	2	0	0	0	0	0	0	300	671	100	2	0	0	0	0	0	0
100	224	120	4	1	0	0	0	0	0	300	671	120	1	0	0	0	0	0	0	300	671	120	1	0	0	0	0	0	0
100	224	140	3	1	0	0	0	0	0	300	671	140	1	0	0	0	0	0	0	300	671	140	1	0	0	0	0	0	0
125	280	40	7	5	2	1	0	0	0	325	727	40	4	2	0	0	0	0	0	325	727	40	4	2	0	0	0	0	0
125	280	60	5	3	1	0	0	0	0	325	727	60	3	1	0	0	0	0	0	325	727	60	3	1	0	0	0	0	0
125	280	80	4	2	0	0	0	0	0	325	727	80	2	0	0	0	0	0	0	325	727	80	2	0	0	0	0	0	0
125	280	100	4	1	0	0	0	0	0	325	727	100	2	0	0	0	0	0	0	325	727	100	2	0	0	0	0	0	0
125	280	120	3	1	0	0	0	0	0	325	727	120	1	0	0	0	0	0	0	325	727	120	1	0	0	0	0	0	0
125	280	140	3	0	0	0	0	0	0	325	727	140	1	0	0	0	0	0	0	325	727	140	1	0	0	0	0	0	0
150	335	40	6	4	2	0	0	0	0	350	783	40	4	2	0	0	0	0	0	350	783	40	4	2	0	0	0	0	0
150	335	60	5	2	1	0	0	0	0	350	783	60	3	0	0	0	0	0	0	350	783	60	3	0	0	0	0	0	0
150	335	80	4	2	0	0	0	0	0	350	783	80	2	0	0	0	0	0	0	350	783	80	2	0	0	0	0	0	0
150	335	100	3	1	0	0	0	0	0	350	783	100	2	0	0	0	0	0	0	350	783	100	2	0	0	0	0	0	0
150	335	120	3	0	0	0	0	0	0	350	783	120	1	0	0	0	0	0	0	350	783	120	1	0	0	0	0	0	0
150	335	140	2	0	0	0	0	0	0	350	783	140	1	0	0	0	0	0	0	350	783	140	1	0	0	0	0	0	0
175	391	40	6	3	1	0	0	0	0	375	839	40	3	1	0	0	0	0	0	375	839	40	3	1	0	0	0	0	0
175	391	60	4	2	0	0	0	0	0	375	839	60	2	0	0	0	0	0	0	375	839	60	2	0	0	0	0	0	0
175	391	80	3	1	0	0	0	0	0	375	839	80	2	0	0	0	0	0	0	375	839	80	2	0	0	0	0	0	0
175	391	100	3	1	0	0	0	0	0	375	839	100	1	0	0	0	0	0	0	375	839	100	1	0	0	0	0	0	0
175	391	120	2	0	0	0	0	0	0	375	839	120	1	0	0	0	0	0	0	375	839	120	1	0	0	0	0	0	0
175	391	140	2	0	0	0	0	0	0	375	839	140	0	0	0	0	0	0	0	375	839	140	0	0	0	0	0	0	0
200	447	40	5	3	1	0	0	0	0	400	894	40	3	1	0	0	0	0	0	400	894	40	3	1	0	0	0	0	0
200	447	60	4	2	0	0	0	0	0	400	894	60	2	0	0	0	0	0	0	400	894	60	2	0	0	0	0	0	0
200	447	80	3	1	0	0	0	0	0	400	894	80	2	0	0	0	0	0	0	400	894	80	2	0	0	0	0	0	0
200	447	100	3	0	0	0	0	0	0	400	894	100	1	0	0	0	0	0	0	400	894	100	1	0	0	0	0	0	0
200	447	120	2	0	0	0	0	0	0	400	894	120	1	0	0	0	0	0	0	400	894	120	1	0	0	0	0	0	0
200	447	140	2	0	0	0	0	0	0	400	894	140	0	0	0	0	0	0	0	400	894	140	0	0	0	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(c)
 Q_d , Threshold Fire Size at Response: 250 Btu/sec
 t_g : 300 Seconds to 1000 Btu/sec
 α : 0.011 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET																
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0										
			INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS																
25	56	40	21	18	14	10	6	3	0	225	503	40	8	6	3	2	0	0	0	225	503	60	6	4	2	0	0	0	0
25	56	60	17	13	9	5	2	0	0	225	503	60	6	4	2	0	0	0	0	225	503	80	5	3	1	0	0	0	0
25	56	80	14	10	6	3	0	0	0	225	503	80	5	3	1	0	0	0	0	225	503	100	4	2	0	0	0	0	0
25	56	100	12	8	4	1	0	0	0	225	503	100	4	2	0	0	0	0	0	225	503	120	4	1	0	0	0	0	0
25	56	120	11	7	3	0	0	0	0	225	503	120	4	1	0	0	0	0	0	225	503	140	3	1	0	0	0	0	0
25	56	140	10	6	2	0	0	0	0	225	503	140	3	1	0	0	0	0	0	225	503								
50	112	40	17	4	11	7	4	2	0	250	559	40	8	5	3	1	0	0	0	250	559	60	6	3	1	0	0	0	0
50	112	60	13	0	7	4	1	0	0	250	559	60	6	3	1	0	0	0	0	250	559	80	5	2	0	0	0	0	0
50	112	80	11	8	5	2	0	0	0	250	559	80	5	2	0	0	0	0	0	250	559	100	4	2	0	0	0	0	0
50	112	100	10	6	3	0	0	0	0	250	559	100	4	2	0	0	0	0	0	250	559	120	3	1	0	0	0	0	0
50	112	120	8	5	2	0	0	0	0	250	559	120	3	1	0	0	0	0	0	250	559	140	3	1	0	0	0	0	0
50	112	140	8	4	1	0	0	0	0	250	559	140	3	1	0	0	0	0	0	250	559								
75	168	40	14	1	8	6	3	1	0	275	615	40	7	5	3	1	0	0	0	275	615	60	6	3	1	0	0	0	0
75	168	60	11	8	5	3	1	0	0	275	615	60	6	3	1	0	0	0	0	275	615	80	4	2	0	0	0	0	0
75	168	80	9	6	3	1	0	0	0	275	615	80	4	2	0	0	0	0	0	275	615	100	4	1	0	0	0	0	0
75	168	100	8	5	2	0	0	0	0	275	615	100	4	1	0	0	0	0	0	275	615	120	3	1	0	0	0	0	0
75	168	120	7	4	1	0	0	0	0	275	615	120	3	1	0	0	0	0	0	275	615	140	3	0	0	0	0	0	0
75	168	140	6	3	1	0	0	0	0	275	615	140	3	0	0	0	0	0	0	275	615								
100	224	40	12	10	7	4	2	0	0	300	671	40	7	5	2	1	0	0	0	300	671	60	5	3	1	0	0	0	0
100	224	60	10	7	4	2	0	0	0	300	671	60	5	3	1	0	0	0	0	300	671	80	4	2	0	0	0	0	0
100	224	80	8	5	3	1	0	0	0	300	671	80	4	2	0	0	0	0	0	300	671	100	3	1	0	0	0	0	0
100	224	100	7	4	2	0	0	0	0	300	671	100	3	1	0	0	0	0	0	300	671	120	3	1	0	0	0	0	0
100	224	120	6	3	1	0	0	0	0	300	671	120	3	1	0	0	0	0	0	300	671	140	3	0	0	0	0	0	0
100	224	140	5	3	0	0	0	0	0	300	671	140	3	0	0	0	0	0	0	300	671								
125	280	40	11	9	6	3	1	0	0	325	727	40	7	4	2	0	0	0	0	325	727	60	5	3	1	0	0	0	0
125	280	60	9	6	3	1	0	0	0	325	727	60	5	3	1	0	0	0	0	325	727	80	4	2	0	0	0	0	0
125	280	80	7	4	2	0	0	0	0	325	727	80	4	2	0	0	0	0	0	325	727	100	3	1	0	0	0	0	0
125	280	100	6	3	1	0	0	0	0	325	727	100	3	1	0	0	0	0	0	325	727	120	3	1	0	0	0	0	0
125	280	120	5	3	1	0	0	0	0	325	727	120	3	1	0	0	0	0	0	325	727	140	2	0	0	0	0	0	0
125	280	140	5	2	0	0	0	0	0	325	727	140	2	0	0	0	0	0	0	325	727								
150	335	40	10	8	5	3	1	0	0	350	783	40	6	4	2	0	0	0	0	350	783	60	5	2	1	0	0	0	0
150	335	60	8	5	3	1	0	0	0	350	783	60	5	2	1	0	0	0	0	350	783	80	4	2	0	0	0	0	0
150	335	80	6	4	2	0	0	0	0	350	783	80	4	2	0	0	0	0	0	350	783	100	3	1	0	0	0	0	0
150	335	100	6	3	1	0	0	0	0	350	783	100	3	1	0	0	0	0	0	350	783	120	3	0	0	0	0	0	0
150	335	120	5	2	0	0	0	0	0	350	783	120	3	0	0	0	0	0	0	350	783	140	2	0	0	0	0	0	0
150	335	140	4	2	0	0	0	0	0	350	783	140	2	0	0	0	0	0	0	350	783								
175	391	40	9	7	4	2	1	0	0	375	839	40	6	4	2	0	0	0	0	375	839	60	4	2	0	0	0	0	0
175	391	60	7	5	2	1	0	0	0	375	839	60	4	2	0	0	0	0	0	375	839	80	4	1	0	0	0	0	0
175	391	80	6	3	1	0	0	0	0	375	839	80	4	1	0	0	0	0	0	375	839	100	3	1	0	0	0	0	0
175	391	100	5	3	1	0	0	0	0	375	839	100	3	1	0	0	0	0	0	375	839	120	2	0	0	0	0	0	0
175	391	120	4	2	0	0	0	0	0	375	839	120	2	0	0	0	0	0	0	375	839	140	2	0	0	0	0	0	0
175	391	140	4	1	0	0	0	0	0	375	839	140	2	0	0	0	0	0	0	375	839								
200	447	40	9	6	4	2	0	0	0	400	894	40	6	3	2	0	0	0	0	400	894	60	4	2	0	0	0	0	0
200	447	60	7	4	2	0	0	0	0	400	894	60	4	2	0	0	0	0	0	400	894	80	3	1	0	0	0	0	0
200	447	80	5	3	1	0	0	0	0	400	894	80	3	1	0	0	0	0	0	400	894	100	3	1	0	0	0	0	0
200	447	100	5	2	0	0	0	0	0	400	894	100	3	1	0	0	0	0	0	400	894	120	2	0	0	0	0	0	0
200	447	120	4	2	0	0	0	0	0	400	894	120	2	0	0	0	0	0	0	400	894	140	2	0	0	0	0	0	0
200	447	140	3	1	0	0	0	0	0	400	894	140	2	0	0	0	0	0	0	400	894								

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(d)
 Q_d : Threshold Fire Size at Response: 250 Btu/sec
 t_p : 500 Seconds to 1000 Btu/sec
 α : 0.004 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET							
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0	
INSTALLED SPACING OF DETECTORS									INSTALLED SPACING OF DETECTORS											
25	56	40	26	22	17	13	9	5	1	225	503	40	11	9	6	4	2	0	0	0
25	56	60	20	16	11	7	3	0	0	225	503	60	9	6	4	1	0	0	0	0
25	56	80	17	12	8	4	0	0	0	225	503	80	7	5	2	0	0	0	0	0
25	56	100	15	10	5	1	0	0	0	225	503	100	6	3	1	0	0	0	0	0
25	56	120	13	8	4	0	0	0	0	225	503	120	5	3	1	0	0	0	0	0
25	56	140	11	7	2	0	0	0	0	225	503	140	5	2	0	0	0	0	0	0
50	112	40	21	18	14	11	7	4	1	250	559	40	11	8	6	3	1	0	0	0
50	112	60	17	13	9	6	2	0	0	250	559	60	8	6	3	1	0	0	0	0
50	112	80	14	10	6	3	0	0	0	250	559	80	7	4	2	0	0	0	0	0
50	112	100	12	8	4	1	0	0	0	250	559	100	6	3	1	0	0	0	0	0
50	112	120	11	7	3	0	0	0	0	250	559	120	5	2	0	0	0	0	0	0
50	112	140	9	6	2	0	0	0	0	250	559	140	4	2	0	0	0	0	0	0
75	168	40	18	15	12	9	6	3	0	275	615	40	10	8	5	3	1	0	0	0
75	168	60	14	11	8	5	2	0	0	275	615	60	8	5	3	1	0	0	0	0
75	168	80	12	9	5	2	0	0	0	275	615	80	6	4	2	0	0	0	0	0
75	168	100	10	7	4	1	0	0	0	275	615	100	5	3	1	0	0	0	0	0
75	168	120	9	6	2	0	0	0	0	275	615	120	5	2	0	0	0	0	0	0
75	168	140	8	5	1	0	0	0	0	275	615	140	4	2	0	0	0	0	0	0
100	224	40	16	14	10	7	4	0	0	300	671	40	10	1	0	0	7	5	3	3
100	224	60	13	10	7	4	1	0	0	300	671	60	7	0	0	0	5	3	1	1
100	224	80	11	8	4	2	0	0	0	300	671	80	6	0	0	0	4	1	0	0
100	224	100	9	6	3	0	0	0	0	300	671	100	5	0	0	0	3	1	0	0
100	224	120	8	5	2	0	0	0	0	300	671	120	4	0	0	0	2	0	0	0
100	224	140	7	4	1	0	0	0	0	300	671	140	4	0	0	0	2	0	0	0
125	280	40	15	12	9	6	4	1	0	325	727	40	9	1	0	0	7	4	2	2
125	280	60	12	9	6	3	1	0	0	325	727	60	7	0	0	0	5	2	1	0
125	280	80	10	7	4	1	0	0	0	325	727	80	6	0	0	0	3	1	0	0
125	280	100	8	5	2	0	0	0	0	325	727	100	5	0	0	0	2	0	0	0
125	280	120	7	4	1	0	0	0	0	325	727	120	4	0	0	0	2	0	0	0
125	280	140	6	3	1	0	0	0	0	325	727	140	4	0	0	0	1	0	0	0
150	335	40	14	11	8	5	3	1	0	350	783	40	9	1	0	0	6	4	2	2
150	335	60	11	8	5	3	1	0	0	350	783	60	7	0	0	0	4	2	0	0
150	335	80	9	6	3	1	0	0	0	350	783	80	6	0	0	0	3	1	0	0
150	335	100	8	5	2	0	0	0	0	350	783	100	5	0	0	0	2	0	0	0
150	335	120	7	4	1	0	0	0	0	350	783	120	4	0	0	0	2	0	0	0
150	335	140	6	3	1	0	0	0	0	350	783	140	3	0	0	0	1	0	0	0
175	391	40	13	10	7	5	2	1	0	375	839	40	9	0	0	0	6	4	2	2
175	391	60	10	7	4	2	0	0	0	375	839	60	6	0	0	0	4	2	0	0
175	391	80	8	5	3	1	0	0	0	375	839	80	5	0	0	0	3	1	0	0
175	391	100	7	4	2	0	0	0	0	375	839	100	4	0	0	0	2	0	0	0
175	391	120	6	3	1	0	0	0	0	375	839	120	4	0	0	0	2	0	0	0
175	391	140	5	3	0	0	0	0	0	375	839	140	3	0	0	0	1	0	0	0
200	447	40	12	9	7	4	2	1	0	400	894	40	8	0	0	0	6	4	2	2
200	447	60	9	7	4	2	0	0	0	400	894	60	6	0	0	0	4	2	0	0
200	447	80	8	5	2	1	0	0	0	400	894	80	5	0	0	0	3	1	0	0
200	447	100	6	4	1	0	0	0	0	400	894	100	4	0	0	0	2	0	0	0
200	447	120	6	3	1	0	0	0	0	400	894	120	4	0	0	0	1	0	0	0
200	447	140	5	2	0	0	0	0	0	400	894	140	3	0	0	0	1	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(e)
 Q_d : Threshold Fire Size at Response: 250 Btu/sec
 t_g : 600 Seconds to 1000 Btu/sec
 α : 0.003 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS									
25	56	40	28	23	18	14	9	5	2	225	503	40	12	10	7	5	2	1	0
25	56	60	22	17	12	8	4	0	0	225	503	60	10	7	4	2	0	0	0
25	56	80	18	13	8	4	0	0	0	225	503	80	8	5	3	1	0	0	0
25	56	100	15	10	6	2	0	0	0	225	503	100	7	4	2	0	0	0	0
25	56	120	13	8	4	0	0	0	0	225	503	120	6	3	1	0	0	0	0
25	56	140	12	7	3	0	0	0	0	225	503	140	5	3	0	0	0	0	0
50	112	40	23	19	15	12	8	4	1	250	559	40	12	9	7	4	2	1	0
50	112	60	18	14	10	6	3	0	0	250	559	60	9	7	4	2	0	0	0
50	112	80	15	11	7	3	0	0	0	250	559	80	8	5	2	1	0	0	0
50	112	100	13	9	5	1	0	0	0	250	559	100	6	4	1	0	0	0	0
50	112	120	11	7	3	0	0	0	0	250	559	120	6	3	1	0	0	0	0
50	112	140	10	6	2	0	0	0	0	250	559	140	5	2	0	0	0	0	0
75	168	40	20	17	13	10	7	3	1	275	615	40	11	9	6	4	2	0	0
75	168	60	16	12	9	5	2	0	0	275	615	60	9	6	4	1	0	0	0
75	168	80	13	10	6	3	0	0	0	275	615	80	7	5	2	0	0	0	0
75	168	100	11	8	4	1	0	0	0	275	615	100	6	3	1	0	0	0	0
75	168	120	10	6	3	0	0	0	0	275	615	120	5	3	1	0	0	0	0
75	168	140	9	5	2	0	0	0	0	275	615	140	5	2	0	0	0	0	0
100	224	40	18	15	12	9	5	3	0	300	671	40	11	8	6	3	1	0	0
100	224	60	14	11	8	4	2	0	0	300	671	60	8	6	3	1	0	0	0
100	224	80	12	8	5	2	0	0	0	300	671	80	7	4	2	0	0	0	0
100	224	100	10	7	4	1	0	0	0	300	671	100	6	3	1	0	0	0	0
100	224	120	9	5	2	0	0	0	0	300	671	120	5	2	0	0	0	0	0
100	224	140	8	5	1	0	0	0	0	300	671	140	4	2	0	0	0	0	0
125	280	40	16	14	10	7	5	2	0	325	727	40	10	8	5	3	1	0	0
125	280	60	13	10	7	4	1	0	0	325	727	60	8	5	3	1	0	0	0
125	280	80	11	8	4	2	0	0	0	325	727	80	6	4	2	0	0	0	0
125	280	100	9	6	3	0	0	0	0	325	727	100	6	3	1	0	0	0	0
125	280	120	8	5	2	0	0	0	0	325	727	120	5	2	0	0	0	0	0
125	280	140	7	4	1	0	0	0	0	325	727	140	4	2	0	0	0	0	0
150	335	40	15	12	9	7	4	2	0	350	783	40	10	7	5	3	1	0	0
150	335	60	12	9	6	3	1	0	0	350	783	60	8	5	3	1	0	0	0
150	335	80	10	7	4	1	0	0	0	350	783	80	6	4	2	0	0	0	0
150	335	100	8	5	3	0	0	0	0	350	783	100	5	3	1	0	0	0	0
150	335	120	7	4	2	0	0	0	0	350	783	120	5	2	0	0	0	0	0
150	335	140	7	4	1	0	0	0	0	350	783	140	4	2	0	0	0	0	0
175	391	40	14	11	9	6	3	1	0	375	839	40	10	7	5	3	1	0	0
175	391	60	11	8	5	3	1	0	0	375	839	60	7	5	3	1	0	0	0
175	391	80	9	6	3	1	0	0	0	375	839	80	6	3	1	0	0	0	0
175	391	100	8	5	2	0	0	0	0	375	839	100	5	3	1	0	0	0	0
175	391	120	7	4	1	0	0	0	0	375	839	120	4	2	0	0	0	0	0
175	391	140	6	3	1	0	0	0	0	375	839	140	4	1	0	0	0	0	0
200	447	40	13	11	8	5	3	1	0	400	894	40	9	7	4	2	1	0	0
200	447	60	10	8	5	2	1	0	0	400	894	60	7	5	2	1	0	0	0
200	447	80	8	6	3	1	0	0	0	400	894	80	6	3	1	0	0	0	0
200	447	100	7	4	2	0	0	0	0	400	894	100	5	2	0	0	0	0	0
200	447	120	6	4	1	0	0	0	0	400	894	120	4	2	0	0	0	0	0
200	447	140	6	3	1	0	0	0	0	400	894	140	4	1	0	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(f)
 Q_d : Threshold Fire Size at Response: 500 Btu/sec
 t_d : 50 Seconds to 1000 Btu/sec
 α : 0.400 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS									
25	56	40	13	11	8	5	2	1	0	225	503	40	4	2	0	0	0	0	0
25	56	60	11	8	5	3	1	0	0	225	503	60	3	1	0	0	0	0	0
25	56	80	9	6	4	1	0	0	0	225	503	80	2	0	0	0	0	0	0
25	56	100	8	5	3	1	0	0	0	225	503	100	2	0	0	0	0	0	0
25	56	120	7	4	2	0	0	0	0	225	503	120	2	0	0	0	0	0	0
25	56	140	7	4	1	0	0	0	0	225	503	140	1	0	0	0	0	0	0
50	112	40	10	7	5	2	1	0	0	250	559	40	4	2	0	0	0	0	0
50	112	60	8	5	3	1	0	0	0	250	559	60	3	1	0	0	0	0	0
50	112	80	7	4	2	0	0	0	0	250	559	80	2	0	0	0	0	0	0
50	112	100	6	3	1	0	0	0	0	250	559	100	2	0	0	0	0	0	0
50	112	120	5	3	0	0	0	0	0	250	559	120	1	0	0	0	0	0	0
50	112	140	5	2	0	0	0	0	0	250	559	140	1	0	0	0	0	0	0
75	168	40	8	6	3	1	0	0	0	275	615	40	4	2	0	0	0	0	0
75	168	60	6	4	2	0	0	0	0	275	615	60	3	0	0	0	0	0	0
75	168	80	5	3	1	0	0	0	0	275	615	80	2	0	0	0	0	0	0
75	168	100	4	2	0	0	0	0	0	275	615	100	2	0	0	0	0	0	0
75	168	120	4	2	0	0	0	0	0	275	615	120	1	0	0	0	0	0	0
75	168	140	3	1	0	0	0	0	0	275	615	140	1	0	0	0	0	0	0
100	224	40	7	4	2	0	0	0	0	300	671	40	3	1	0	0	0	0	0
100	224	60	5	3	1	0	0	0	0	300	671	60	2	0	0	0	0	0	0
100	224	80	4	2	0	0	0	0	0	300	671	80	2	0	0	0	0	0	0
100	224	100	4	1	0	0	0	0	0	300	671	100	1	0	0	0	0	0	0
100	224	120	3	1	0	0	0	0	0	300	671	120	1	0	0	0	0	0	0
100	224	140	3	0	0	0	0	0	0	300	671	140	0	0	0	0	0	0	0
125	280	40	6	4	2	0	0	0	0	325	727	40	3	1	0	0	0	0	0
125	280	60	5	2	0	0	0	0	0	325	727	60	2	0	0	0	0	0	0
125	280	80	4	2	0	0	0	0	0	325	727	80	2	0	0	0	0	0	0
125	280	100	3	1	0	0	0	0	0	325	727	100	1	0	0	0	0	0	0
125	280	120	3	0	0	0	0	0	0	325	727	120	1	0	0	0	0	0	0
125	280	140	2	0	0	0	0	0	0	325	727	140	0	0	0	0	0	0	0
150	335	40	5	3	1	0	0	0	0	350	783	40	3	1	0	0	0	0	0
150	335	60	4	2	0	0	0	0	0	350	783	60	2	0	0	0	0	0	0
150	335	80	3	1	0	0	0	0	0	350	783	80	2	0	0	0	0	0	0
150	335	100	3	0	0	0	0	0	0	350	783	100	1	0	0	0	0	0	0
150	335	120	2	0	0	0	0	0	0	350	783	120	0	0	0	0	0	0	0
150	335	140	2	0	0	0	0	0	0	350	783	140	0	0	0	0	0	0	0
175	391	40	5	3	1	0	0	0	0	375	839	40	3	1	0	0	0	0	0
175	391	60	4	2	0	0	0	0	0	375	839	60	2	0	0	0	0	0	0
175	391	80	3	1	0	0	0	0	0	375	839	80	1	0	0	0	0	0	0
175	391	100	2	0	0	0	0	0	0	375	839	100	1	0	0	0	0	0	0
175	391	120	2	0	0	0	0	0	0	375	839	120	0	0	0	0	0	0	0
175	391	140	2	0	0	0	0	0	0	375	839	140	0	0	0	0	0	0	0
200	447	40	5	2	0	0	0	0	0	400	894	40	3	0	0	0	0	0	0
200	447	60	3	1	0	0	0	0	0	400	894	60	2	0	0	0	0	0	0
200	447	80	3	0	0	0	0	0	0	400	894	80	1	0	0	0	0	0	0
200	447	100	2	0	0	0	0	0	0	400	894	100	1	0	0	0	0	0	0
200	447	120	2	0	0	0	0	0	0	400	894	120	0	0	0	0	0	0	0
200	447	140	1	0	0	0	0	0	0	400	894	140	0	0	0	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

B-3.2.4(g)
 Q_d , Threshold Fire Size at Response: 500 Btu/sec
 t_g : 150 Seconds to 1000 Btu/sec
 α : 0.044 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
			INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS						
25	56	40	24	22	18	15	11	8	5	225	503	40	9	7	5	3	1	0	0
25	56	60	20	17	13	10	6	3	0	225	503	60	7	5	3	1	0	0	0
25	56	80	17	14	10	6	3	0	0	225	503	80	6	4	2	0	0	0	0
25	56	100	15	11	8	4	1	0	0	225	503	100	5	3	1	0	0	0	0
25	56	120	13	10	6	3	0	0	0	225	503	120	5	2	0	0	0	0	0
25	56	140	12	8	5	1	0	0	0	225	503	140	4	2	0	0	0	0	0
50	112	40	19	16	14	11	8	5	2	250	559	40	9	7	4	2	1	0	0
50	112	60	15	13	10	7	4	1	0	250	559	60	7	5	2	1	0	0	0
50	112	80	13	10	7	4	2	0	0	250	559	80	6	3	1	0	0	0	0
50	112	100	11	9	5	3	0	0	0	250	559	100	5	3	1	0	0	0	0
50	112	120	10	7	4	1	0	0	0	250	559	120	4	2	1	0	0	0	0
50	112	140	9	6	3	1	0	0	0	250	559	140	4	2	0	0	0	0	0
75	168	40	16	14	11	8	5	3	1	275	615	40	8	6	4	2	0	0	0
75	168	60	13	10	8	5	2	1	0	275	615	60	7	4	2	0	0	0	0
75	168	80	11	8	5	3	1	0	0	275	615	80	5	3	1	0	0	0	0
75	168	100	10	7	4	2	0	0	0	275	615	100	5	2	0	0	0	0	0
75	168	120	8	6	3	1	0	0	0	275	615	120	4	2	0	0	0	0	0
75	168	140	8	5	2	0	0	0	0	275	615	140	3	1	0	0	0	0	0
100	224	40	14	12	9	6	4	2	1	300	671	40	8	6	3	2	0	0	0
100	224	60	11	9	6	4	2	0	0	300	671	60	6	4	2	0	0	0	0
100	224	80	10	7	4	2	0	0	0	300	671	80	5	3	1	0	0	0	0
100	224	100	8	6	3	1	0	0	0	300	671	100	4	2	0	0	0	0	0
100	224	120	7	5	2	0	0	0	0	300	671	120	4	2	0	0	0	0	0
100	224	140	7	4	2	0	0	0	0	300	671	140	3	1	0	0	0	0	0
125	280	40	13	10	8	5	3	1	0	325	727	40	8	5	3	1	0	0	0
125	280	60	10	8	5	3	1	0	0	325	727	60	6	4	2	0	0	0	0
125	280	80	8	6	3	1	0	0	0	325	727	80	5	3	1	0	0	0	0
125	280	100	7	5	2	1	0	0	0	325	727	100	4	2	0	0	0	0	0
125	280	120	6	4	2	0	0	0	0	325	727	120	3	1	0	0	0	0	0
125	280	140	6	3	1	0	0	0	0	325	727	140	3	1	0	0	0	0	0
150	335	40	12	9	7	4	2	1	0	350	783	40	7	5	3	1	0	0	0
150	335	60	9	7	4	2	1	0	0	350	783	60	6	3	1	0	0	0	0
150	335	80	8	5	3	1	0	0	0	350	783	80	5	2	0	0	0	0	0
150	335	100	7	4	2	0	0	0	0	350	783	100	4	2	0	0	0	0	0
150	335	120	6	3	1	0	0	0	0	350	783	120	3	1	0	0	0	0	0
150	335	140	5	3	1	0	0	0	0	350	783	140	3	1	0	0	0	0	0
175	391	40	11	8	6	4	2	0	0	375	839	40	7	5	3	1	0	0	0
175	391	60	8	6	4	2	0	0	0	375	839	60	5	3	1	0	0	0	0
175	391	80	7	5	2	1	0	0	0	375	839	80	4	2	0	0	0	0	0
175	391	100	6	4	2	0	0	0	0	375	839	100	4	2	0	0	0	0	0
175	391	120	5	3	1	0	0	0	0	375	839	120	3	1	0	0	0	0	0
175	391	140	5	2	0	0	0	0	0	375	839	140	3	0	0	0	0	0	0
200	447	40	10	8	5	3	1	0	0	400	894	40	7	4	2	1	0	0	0
200	447	60	8	5	3	1	0	0	0	400	894	60	5	3	1	0	0	0	0
200	447	80	7	4	2	0	0	0	0	400	894	80	4	2	0	0	0	0	0
200	447	100	6	3	1	0	0	0	0	400	894	100	3	1	0	0	0	0	0
200	447	120	5	2	1	0	0	0	0	400	894	120	3	1	0	0	0	0	0
200	447	140	4	2	0	0	0	0	0	400	894	140	3	0	0	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(h)
 Q_d , Threshold Fire Size at Response: 500 Btu/sec
 t_g : 300 Seconds to 1000 Btu/sec
 α : 0.011 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
INSTALLED SPACING OF DETECTORS																			
25	56	40	34	30	25	21	17	13	9	225	503	40	14	12	10	7	5	3	1
25	56	60	27	23	18	14	10	6	2	225	503	60	11	9	6	4	2	0	0
25	56	80	23	18	14	9	5	2	0	225	503	80	10	7	4	2	1	0	0
25	56	100	20	15	11	7	3	0	0	225	503	100	8	6	3	1	0	0	0
25	56	120	18	13	8	4	1	0	0	225	503	120	7	5	2	1	0	0	0
25	56	140	16	11	7	3	0	0	0	225	503	140	6	4	2	0	0	0	0
50	112	40	27	24	21	17	14	10	7	250	559	40	14	11	9	6	4	2	1
50	112	60	22	18	15	11	8	4	1	250	559	60	11	8	6	3	2	0	0
50	112	80	18	15	11	8	4	1	0	250	559	80	9	6	4	2	0	0	0
50	112	100	16	12	9	5	2	0	0	250	559	100	8	5	3	1	0	0	0
50	112	120	14	11	7	3	0	0	0	250	559	120	7	4	2	0	0	0	0
50	112	140	13	9	5	2	0	0	0	250	559	140	6	4	1	0	0	0	0
75	168	40	23	21	18	14	11	8	5	275	615	40	13	11	8	6	4	2	1
75	168	60	19	16	13	9	6	3	1	275	615	60	10	8	5	3	1	0	0
75	168	80	16	13	9	6	3	1	0	275	615	80	9	6	4	2	0	0	0
75	168	100	14	11	7	4	1	0	0	275	615	100	7	5	3	1	0	0	0
75	168	120	12	9	6	3	0	0	0	275	615	120	6	4	2	0	0	0	0
75	168	140	11	8	4	1	0	0	0	275	615	140	6	3	1	0	0	0	0
100	224	40	21	18	15	12	9	6	4	300	671	40	12	10	8	5	3	2	0
100	224	60	17	14	11	8	5	2	0	300	671	60	10	7	5	3	1	0	0
100	224	80	14	11	8	5	2	0	0	300	671	80	8	6	3	1	0	0	0
100	224	100	12	9	6	3	1	0	0	300	671	100	7	5	2	1	0	0	0
100	224	120	11	8	5	2	0	0	0	300	671	120	6	4	2	0	0	0	0
100	224	140	10	7	4	1	0	0	0	300	671	140	6	3	1	0	0	0	0
125	280	40	19	16	14	11	8	5	3	325	727	40	12	10	7	5	3	1	0
125	280	60	15	12	10	7	4	2	0	325	727	60	9	7	5	2	1	0	0
125	280	80	13	10	7	4	2	0	0	325	727	80	8	5	3	1	0	0	0
125	280	100	11	8	5	3	1	0	0	325	727	100	7	4	2	0	0	0	0
125	280	120	10	7	4	2	0	0	0	325	727	120	6	3	1	0	0	0	0
125	280	140	9	6	3	1	0	0	0	325	727	140	5	3	1	0	0	0	0
150	335	40	17	15	12	10	7	4	2	350	783	40	12	9	7	4	3	1	0
150	335	60	14	11	8	6	3	1	0	350	783	60	9	7	4	2	1	0	0
150	335	80	12	9	6	4	1	0	0	350	783	80	7	5	3	1	0	0	0
150	335	100	10	7	5	2	0	0	0	350	783	100	6	4	2	0	0	0	0
150	335	120	9	6	3	1	0	0	0	350	783	120	6	3	1	0	0	0	0
150	335	140	8	5	3	1	0	0	0	350	783	140	5	3	1	0	0	0	0
175	391	40	16	14	11	9	6	4	2	375	839	40	11	9	6	4	2	1	0
175	391	60	13	10	8	5	3	1	0	375	839	60	9	6	4	2	0	0	0
175	391	80	11	8	5	3	1	0	0	375	839	80	7	5	3	1	0	0	0
175	391	100	9	7	4	2	0	0	0	375	839	100	6	4	2	0	0	0	0
175	391	120	8	6	3	1	0	0	0	375	839	120	5	3	1	0	0	0	0
175	391	140	7	5	2	0	0	0	0	375	839	140	5	2	0	0	0	0	0
200	447	40	15	13	10	8	5	3	1	400	894	40	11	8	6	4	2	1	0
200	447	60	12	10	7	4	2	1	0	400	894	60	8	6	4	2	0	0	0
200	447	80	10	8	5	3	1	0	0	400	894	80	7	4	2	1	0	0	0
200	447	100	9	6	4	1	0	0	0	400	894	100	6	3	1	0	0	0	0
200	447	120	8	5	3	1	0	0	0	400	894	120	5	3	1	0	0	0	0
200	447	140	7	4	2	0	0	0	0	400	894	140	5	2	0	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(i)
Q_a, Threshold Fire Size at Response: 500 Btu/sec
t_g: 500 Seconds to 1000 Btu/sec
α: 0.004 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET								
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0		
INSTALLED SPACING OF DETECTORS											INSTALLED SPACING OF DETECTORS										
25	56	40	41	35	30	25	20	16	11		225	503	40	19	17	14	11	8	6	3	
25	56	60	32	26	21	16	12	7	3		225	503	60	15	13	10	7	4	2	0	
25	56	80	27	21	16	11	7	3	0		225	503	80	13	10	7	4	2	0	0	
25	56	100	23	17	12	8	4	0	0		225	503	100	11	8	5	3	1	0	0	
25	56	120	20	15	10	5	1	0	0		225	503	120	10	7	4	2	0	0	0	
25	56	140	18	13	8	3	0	0	0		225	503	140	9	6	3	1	0	0	0	
50	112	40	34	30	26	22	18	14	10		250	559	40	18	16	13	10	8	5	3	
50	112	60	27	23	18	14	10	6	3		250	559	60	14	12	9	6	4	2	0	
50	112	80	23	18	14	10	6	2	0		250	559	80	12	9	7	4	2	0	0	
50	112	100	20	15	11	7	3	0	0		250	559	100	10	8	5	2	1	0	0	
50	112	120	17	13	9	5	1	0	0		250	559	120	9	6	4	1	0	0	0	
50	112	140	16	11	7	3	0	0	0		250	559	140	8	6	3	1	0	0	0	
75	168	40	30	26	23	19	15	12	8		275	615	40	17	15	12	10	7	5	2	
75	168	60	24	20	16	13	9	5	2		275	615	60	14	11	8	6	3	1	0	
75	168	80	20	16	12	9	5	2	0		275	615	80	12	9	6	3	1	0	0	
75	168	100	17	14	10	6	2	0	0		275	615	100	10	7	5	2	0	0	0	
75	168	120	15	11	8	4	1	0	0		275	615	120	9	6	3	1	0	0	0	
75	168	140	14	10	6	2	0	0	0		275	615	140	8	5	3	1	0	0	0	
100	224	40	27	24	20	17	14	10	7		300	671	40	17	14	12	9	6	4	2	
100	224	60	21	18	15	11	8	4	2		300	671	60	13	11	8	5	3	1	0	
100	224	80	18	15	11	8	4	1	0		300	671	80	11	8	6	3	1	0	0	
100	224	100	16	12	9	5	2	0	0		300	671	100	10	7	4	2	0	0	0	
100	224	120	14	10	7	5	3	0	0		300	671	120	8	6	3	1	0	0	0	
100	224	140	13	9	5	2	0	0	0		300	671	140	8	5	2	0	0	0	0	
125	280	40	25	22	19	15	12	9	6		325	727	40	16	14	11	9	6	4	2	
125	280	60	20	17	13	10	7	4	1		325	727	60	13	10	8	5	3	1	0	
125	280	80	16	13	10	7	4	1	0		325	727	80	11	8	5	3	1	0	0	
125	280	100	14	11	8	5	2	0	0		325	727	100	9	7	4	2	0	0	0	
125	280	120	13	9	6	3	0	0	0		325	727	120	8	5	3	1	0	0	0	
125	280	140	11	8	5	2	0	0	0		325	727	140	7	5	2	0	0	0	0	
150	335	40	23	20	17	14	11	8	5		350	783	40	16	13	11	8	6	3	2	
150	335	60	18	15	12	9	6	3	1		350	783	60	12	10	7	5	2	1	0	
150	335	80	15	12	9	6	3	1	0		350	783	80	10	8	5	3	1	0	0	
150	335	100	13	10	7	4	1	0	0		350	783	100	9	6	4	2	0	0	0	
150	335	120	12	9	5	3	0	0	0		350	783	120	8	5	3	1	0	0	0	
150	335	140	11	7	4	1	0	0	0		350	783	140	7	4	2	0	0	0	0	
175	391	40	21	19	16	13	10	7	4		375	839	40	15	13	10	8	5	3	1	
175	391	60	17	14	11	8	5	3	1		375	839	60	12	9	7	4	2	1	0	
175	391	80	14	11	8	5	3	1	0		375	839	80	10	7	5	2	1	0	0	
175	391	100	12	9	6	3	1	0	0		375	839	100	8	6	3	1	0	0	0	
175	391	120	11	8	5	2	0	0	0		375	839	120	7	5	2	1	0	0	0	
175	391	140	10	7	4	1	0	0	0		375	839	140	7	4	2	0	0	0	0	
200	447	40	20	18	15	12	9	6	4		400	894	40	14	12	10	7	5	3	1	
200	447	60	16	13	10	7	5	2	1		400	894	60	11	9	6	4	2	1	0	
200	447	80	13	11	8	5	2	0	0		400	894	80	9	7	4	2	1	0	0	
200	447	100	12	9	6	3	1	0	0		400	894	100	8	6	3	1	0	0	0	
200	447	120	10	7	4	2	0	0	0		400	894	120	7	5	2	1	0	0	0	
200	447	140	9	6	3	1	0	0	0		400	894	140	6	4	2	0	0	0	0	

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(j)
 Q_d , Threshold Fire Size at Response: 500 Btu/sec
 t_g : 600 Seconds to 1000 Btu/sec
 α : 0.003 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS									
25	56	40	43	37	31	26	21	17	12	225	503	40	21	18	16	13	10	7	4
25	56	60	34	27	22	17	12	8	4	225	503	60	17	14	11	8	5	3	1
25	56	80	28	22	16	12	7	3	0	225	503	80	14	11	8	5	3	1	0
25	56	100	24	18	13	8	4	0	0	225	503	100	12	9	6	3	1	0	0
25	56	120	21	15	10	6	1	0	0	225	503	120	11	8	5	2	0	0	0
25	56	140	19	13	8	4	0	0	0	225	503	140	10	7	4	1	0	0	0
50	112	40	36	32	27	23	19	15	11	250	559	40	20	18	15	12	9	6	4
50	112	60	29	24	20	15	11	7	3	250	559	60	16	13	10	7	5	2	1
50	112	80	24	19	15	10	6	2	0	250	559	80	13	11	8	5	2	0	0
50	112	100	21	16	11	7	3	0	0	250	559	100	12	9	6	3	1	0	0
50	112	120	18	14	9	5	1	0	0	250	559	120	10	7	4	2	0	0	0
50	112	140	17	12	7	3	0	0	0	250	559	140	9	6	3	1	0	0	0
75	168	40	32	29	25	21	17	13	9	275	615	40	19	17	14	11	8	6	3
75	168	60	26	22	18	14	10	6	3	275	615	60	15	13	10	7	4	2	0
75	168	80	21	17	13	9	6	2	0	275	615	80	13	10	7	4	2	0	0
75	168	100	19	14	10	6	3	0	0	275	615	100	11	8	5	3	1	0	0
75	168	120	17	12	8	4	1	0	0	275	615	120	10	7	4	2	0	0	0
75	168	140	15	11	7	3	0	0	0	275	615	140	9	6	3	1	0	0	0
100	224	40	29	26	22	19	15	12	8	300	671	40	18	16	13	11	8	5	3
100	224	60	23	20	16	12	9	5	2	300	671	60	15	12	9	6	4	2	0
100	224	80	19	16	12	8	5	2	0	300	671	80	12	10	7	4	2	0	0
100	224	100	17	13	9	6	2	0	0	300	671	100	11	8	5	2	1	0	0
100	224	120	15	11	7	4	1	0	0	300	671	120	9	7	4	1	0	0	0
100	224	140	14	10	6	2	0	0	0	300	671	140	8	6	3	1	0	0	0
125	280	40	27	24	20	17	14	10	7	325	727	40	18	15	13	10	7	5	3
125	280	60	21	18	15	11	8	5	2	325	727	60	14	11	9	6	4	2	0
125	280	80	18	15	11	8	4	1	0	325	727	80	12	9	6	4	2	0	0
125	280	100	16	12	9	5	2	0	0	325	727	100	10	7	5	2	1	0	0
125	280	120	14	10	7	3	1	0	0	325	727	120	9	6	4	1	0	0	0
125	280	140	12	9	5	2	0	0	0	325	727	140	8	5	3	1	0	0	0
150	335	40	25	22	19	16	13	9	6	350	783	40	17	15	12	9	7	4	2
150	335	60	20	17	14	10	7	4	1	350	783	60	13	11	8	6	3	1	0
150	335	80	17	14	10	7	4	1	0	350	783	80	11	9	6	3	1	0	0
150	335	100	15	11	8	5	2	0	0	350	783	100	10	7	4	2	0	0	0
150	335	120	13	10	6	3	0	0	0	350	783	120	9	6	3	1	0	0	0
150	335	140	12	8	5	2	0	0	0	350	783	140	8	5	2	1	0	0	0
175	391	40	23	21	18	15	12	8	6	375	839	40	17	14	12	9	6	4	2
175	391	60	19	16	13	9	6	3	1	375	839	60	13	11	8	5	3	1	0
175	391	80	16	13	9	6	3	1	0	375	839	80	11	8	6	3	1	0	0
175	391	100	14	10	7	4	1	0	0	375	839	100	9	7	4	2	0	0	0
175	391	120	12	9	6	3	0	0	0	375	839	120	8	6	3	1	0	0	0
175	391	140	11	8	4	2	0	0	0	375	839	140	7	5	2	0	0	0	0
200	447	40	22	19	17	14	11	8	5	400	894	40	16	14	11	9	6	4	2
200	447	60	18	15	12	9	6	3	1	400	894	60	13	10	7	5	3	1	0
200	447	80	15	12	9	6	3	1	0	400	894	80	11	8	5	3	1	0	0
200	447	100	13	10	7	4	1	0	0	400	894	100	9	6	4	2	0	0	0
200	447	120	11	8	5	2	0	0	0	400	894	120	8	5	3	1	0	0	0
200	447	140	10	7	4	1	0	0	0	400	894	140	7	5	2	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(k)
 Q_d , Threshold Fire Size at Response: 750 Btu/sec
 t_g : 50 Seconds to 1000 Btu/sec
 α : 0.400 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET																
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0										
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS																			
25	56	40	18	15	13	10	7	4	2	225	503	40	6	4	2	0	0	0	0	225	503	60	5	3	1	0	0	0	0
25	56	60	15	12	9	6	4	1	0	225	503	80	4	2	0	0	0	0	0	225	503	100	3	1	0	0	0	0	0
25	56	80	13	10	7	4	2	0	0	225	503	120	3	1	0	0	0	0	0	225	503	140	2	0	0	0	0	0	0
25	56	100	11	9	6	3	1	0	0	225	503	160	2	0	0	0	0	0	0	225	503	180	1	0	0	0	0	0	0
25	56	120	10	7	4	2	0	0	0	225	503	200	1	0	0	0	0	0	0	225	503	220	1	0	0	0	0	0	0
25	56	140	9	6	4	1	0	0	0	225	503	240	1	0	0	0	0	0	0	225	503	260	1	0	0	0	0	0	0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS																			
50	112	40	14	11	9	6	3	2	0	250	559	40	6	4	2	0	0	0	0	250	559	60	4	2	0	0	0	0	0
50	112	60	11	9	6	3	1	0	0	250	559	80	4	2	0	0	0	0	0	250	559	100	3	1	0	0	0	0	0
50	112	80	9	7	4	2	0	0	0	250	559	120	3	1	0	0	0	0	0	250	559	140	2	0	0	0	0	0	0
50	112	100	8	6	3	1	0	0	0	250	559	160	2	0	0	0	0	0	0	250	559	180	1	0	0	0	0	0	0
50	112	120	7	5	2	0	0	0	0	250	559	200	1	0	0	0	0	0	0	250	559	220	1	0	0	0	0	0	0
50	112	140	7	4	2	0	0	0	0	250	559	240	1	0	0	0	0	0	0	250	559	260	1	0	0	0	0	0	0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS																			
75	168	40	11	9	6	4	2	0	0	275	615	40	6	3	1	0	0	0	0	275	615	60	4	2	0	0	0	0	0
75	168	60	9	7	4	2	0	0	0	275	615	80	4	2	0	0	0	0	0	275	615	100	3	1	0	0	0	0	0
75	168	80	8	5	3	1	0	0	0	275	615	120	3	1	0	0	0	0	0	275	615	140	2	0	0	0	0	0	0
75	168	100	7	4	2	0	0	0	0	275	615	160	2	0	0	0	0	0	0	275	615	180	1	0	0	0	0	0	0
75	168	120	6	3	1	0	0	0	0	275	615	200	1	0	0	0	0	0	0	275	615	220	1	0	0	0	0	0	0
75	168	140	5	3	1	0	0	0	0	275	615	240	1	0	0	0	0	0	0	275	615	260	1	0	0	0	0	0	0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS																			
100	224	40	10	7	5	3	1	0	0	300	671	40	5	3	1	0	0	0	0	300	671	60	4	2	0	0	0	0	0
100	224	60	8	5	3	1	0	0	0	300	671	80	4	2	0	0	0	0	0	300	671	100	3	1	0	0	0	0	0
100	224	80	7	4	2	0	0	0	0	300	671	120	3	1	0	0	0	0	0	300	671	140	2	0	0	0	0	0	0
100	224	100	6	3	1	0	0	0	0	300	671	160	2	0	0	0	0	0	0	300	671	180	1	0	0	0	0	0	0
100	224	120	5	3	1	0	0	0	0	300	671	200	1	0	0	0	0	0	0	300	671	220	1	0	0	0	0	0	0
100	224	140	4	2	0	0	0	0	0	300	671	240	1	0	0	0	0	0	0	300	671	260	1	0	0	0	0	0	0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS																			
125	280	40	9	6	4	2	0	0	0	325	727	40	5	3	1	0	0	0	0	325	727	60	4	2	0	0	0	0	0
125	280	60	7	5	2	1	0	0	0	325	727	80	4	2	0	0	0	0	0	325	727	100	3	1	0	0	0	0	0
125	280	80	6	3	1	0	0	0	0	325	727	120	3	1	0	0	0	0	0	325	727	140	2	0	0	0	0	0	0
125	280	100	5	3	1	0	0	0	0	325	727	160	2	0	0	0	0	0	0	325	727	180	1	0	0	0	0	0	0
125	280	120	4	2	0	0	0	0	0	325	727	200	1	0	0	0	0	0	0	325	727	220	1	0	0	0	0	0	0
125	280	140	4	2	0	0	0	0	0	325	727	240	1	0	0	0	0	0	0	325	727	260	1	0	0	0	0	0	0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS																			
150	335	40	8	6	3	1	0	0	0	350	783	40	5	3	1	0	0	0	0	350	783	60	4	2	0	0	0	0	0
150	335	60	6	4	2	0	0	0	0	350	783	80	4	2	0	0	0	0	0	350	783	100	3	1	0	0	0	0	0
150	335	80	5	3	1	0	0	0	0	350	783	120	3	1	0	0	0	0	0	350	783	140	2	0	0	0	0	0	0
150	335	100	4	2	0	0	0	0	0	350	783	160	2	0	0	0	0	0	0	350	783	180	1	0	0	0	0	0	0
150	335	120	4	2	0	0	0	0	0	350	783	200	1	0	0	0	0	0	0	350	783	220	1	0	0	0	0	0	0
150	335	140	3	1	0	0	0	0	0	350	783	240	1	0	0	0	0	0	0	350	783	260	1	0	0	0	0	0	0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS																			
175	391	40	7	5	3	1	0	0	0	375	839	40	5	2	0	0	0	0	0	375	839	60	4	2	0	0	0	0	0
175	391	60	6	3	1	0	0	0	0	375	839	80	4	2	0	0	0	0	0	375	839	100	3	1	0	0	0	0	0
175	391	80	5	2	0	0	0	0	0	375	839	120	3	1	0	0	0	0	0	375	839	140	2	0	0	0	0	0	0
175	391	100	4	2	0	0	0	0	0	375	839	160	2	0	0	0	0	0	0	375	839	180	1	0	0	0	0	0	0
175	391	120	3	1	0	0	0	0	0	375	839	200	1	0	0	0	0	0	0	375	839	220	1	0	0	0	0	0	0
175	391	140	3	1	0	0	0	0	0	375	839	240	1	0	0	0	0	0	0	375	839	260	1	0	0	0	0	0	0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS																			
200	447	40	7	4	2	1	0	0	0	400	894	40	4	2	0	0	0	0	0	400	894	60	3	1	0	0	0	0	0
200	447	60	5	3	1	0	0	0	0	400	894	80	3	1	0	0	0	0	0	400	894	100	2	0	0	0	0	0	0
200	447	80	4	2	0	0	0	0	0	400	894	120	2	0	0	0	0	0	0	400	894	140	1	0	0	0	0	0	0
200	447	100	4	1	0	0	0	0	0	400	894	160	1	0	0	0	0	0	0	400	894	180	1	0	0	0	0	0	0
200	447	120	3	1	0	0	0	0	0	400	894	200	1	0	0	0	0	0	0	400	894	220	1	0	0	0	0	0	0
200	447	140	3	0	0	0	0	0	0	400	894	240	1	0	0	0	0	0	0	400	894	260	1	0	0	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(l)
 Q_d , Threshold Fire Size at Response: 750 Btu/sec
 t_g : 150 Seconds to 1000 Btu/sec
 α : 0.044 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
INSTALLED SPACING OF DETECTORS																			
25	56	40	32	29	26	22	18	15	11	225	503	40	13	11	8	6	4	2	1
25	56	60	26	23	19	15	12	8	4	225	503	60	10	8	6	3	2	0	0
25	56	80	23	19	15	11	8	4	1	225	503	80	9	6	4	2	0	0	0
25	56	100	20	16	12	8	5	1	0	225	503	100	8	5	3	1	0	0	0
25	56	120	18	14	10	6	3	0	0	225	503	120	7	4	2	0	0	0	0
25	56	140	16	12	8	5	1	0	0	225	503	140	6	4	1	0	0	0	0
50	112	40	25	23	20	17	14	11	8	250	559	40	12	10	8	5	3	2	0
50	112	60	21	18	15	12	8	5	3	250	559	60	10	7	5	3	1	0	0
50	112	80	18	15	12	8	5	2	0	250	559	80	8	6	4	2	0	0	0
50	112	100	16	13	9	6	3	1	0	250	559	100	7	5	2	1	0	0	0
50	112	120	14	11	8	4	2	0	0	250	559	120	6	4	2	0	0	0	0
50	112	140	13	10	6	3	1	0	0	250	559	140	6	3	1	0	0	0	0
75	168	40	22	19	17	14	11	8	5	275	615	40	12	10	7	5	3	1	0
75	168	60	18	15	12	9	6	4	1	275	615	60	9	7	5	3	1	0	0
75	168	80	15	12	9	6	4	1	0	275	615	80	8	5	3	1	0	0	0
75	168	100	13	10	7	5	2	0	0	275	615	100	7	4	2	1	0	0	0
75	168	120	12	9	6	3	1	0	0	275	615	120	6	4	2	0	0	0	0
75	168	140	11	8	5	2	0	0	0	275	615	140	5	3	1	0	0	0	0
100	224	40	19	17	14	12	9	6	4	300	671	40	11	9	7	4	3	1	0
100	224	60	16	13	10	8	5	3	1	300	671	60	9	7	4	2	1	0	0
100	224	80	13	11	8	5	3	1	0	300	671	80	7	5	3	1	0	0	0
100	224	100	12	9	6	3	1	0	0	300	671	100	6	4	2	0	0	0	0
100	224	120	10	8	5	2	1	0	0	300	671	120	6	3	1	0	0	0	0
100	224	140	9	7	4	1	0	0	0	300	671	140	5	3	1	0	0	0	0
125	280	40	17	15	13	10	7	5	3	325	727	40	11	9	6	4	2	1	0
125	280	60	14	12	9	6	4	2	1	325	727	60	9	6	4	2	1	0	0
125	280	80	12	9	7	4	2	0	0	325	727	80	7	5	3	1	0	0	0
125	280	100	10	8	5	3	1	0	0	325	727	100	6	4	2	0	0	0	0
125	280	120	9	7	4	2	0	0	0	325	727	120	5	3	1	0	0	0	0
125	280	140	8	6	3	1	0	0	0	325	727	140	5	2	1	0	0	0	0
150	335	40	16	14	11	9	6	4	2	350	783	40	10	8	6	4	2	1	0
150	335	60	13	10	8	5	3	1	0	350	783	60	8	6	4	2	0	0	0
150	335	80	11	8	6	3	1	0	0	350	783	80	7	4	2	1	0	0	0
150	335	100	9	7	4	2	1	0	0	350	783	100	6	3	2	0	0	0	0
150	335	120	8	6	3	1	0	0	0	350	783	120	5	3	1	0	0	0	0
150	335	140	8	5	3	1	0	0	0	350	783	140	5	2	0	0	0	0	0
175	391	40	15	13	10	8	5	3	2	375	839	40	10	8	5	3	2	0	0
175	391	60	12	9	7	5	2	1	0	375	839	60	8	6	3	2	0	0	0
175	391	80	10	8	5	3	1	0	0	375	839	80	6	4	2	0	0	0	0
175	391	100	9	6	4	2	0	0	0	375	839	100	6	3	1	0	0	0	0
175	391	120	8	5	3	1	0	0	0	375	839	120	5	3	1	0	0	0	0
175	391	140	7	4	2	0	0	0	0	375	839	140	4	2	0	0	0	0	0
200	447	40	14	12	9	7	4	3	1	400	894	40	10	7	5	3	2	0	0
200	447	60	11	9	6	4	2	1	0	400	894	60	8	5	3	1	0	0	0
200	447	80	9	7	4	2	1	0	0	400	894	80	6	4	2	0	0	0	0
200	447	100	8	6	3	1	0	0	0	400	894	100	5	3	1	0	0	0	0
200	447	120	7	5	2	1	0	0	0	400	894	120	5	2	1	0	0	0	0
200	447	140	6	4	2	0	0	0	0	400	894	140	4	2	0	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(m)
 Q_d , Threshold Fire Size at Response: 750 Btu/sec
 t_g : 300 Seconds to 1000 Btu/sec
 α : 0.011 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS									
25	56	40	43	39	34	30	25	21	17	225	503	40	20	17	15	12	9	7	5
25	56	60	35	30	25	21	16	12	8	225	503	60	16	13	11	8	5	3	1
25	56	80	30	24	20	15	11	6	3	225	503	80	13	11	8	5	3	1	0
25	56	100	26	21	16	11	7	3	0	225	503	100	12	9	6	4	2	0	0
25	56	120	23	18	13	9	4	1	0	225	503	120	10	8	5	2	1	0	0
25	56	140	21	15	11	6	2	0	0	225	503	140	9	7	4	2	0	0	0
50	112	40	36	32	29	25	21	17	14	250	559	40	19	16	14	11	9	6	4
50	112	60	29	25	21	17	14	10	6	250	559	60	15	12	10	7	5	3	1
50	112	80	24	21	17	13	9	5	2	250	559	80	13	10	7	5	3	1	0
50	112	100	21	17	13	10	6	2	0	250	559	100	11	8	6	3	1	0	0
50	112	120	19	15	11	7	3	0	0	250	559	120	10	7	4	2	1	0	0
50	112	140	17	13	9	5	2	0	0	250	559	140	9	6	4	1	0	0	0
75	168	40	31	28	25	22	18	15	11	275	615	40	18	16	13	10	8	6	3
75	168	60	25	22	18	15	12	8	5	275	615	60	14	12	9	7	4	2	1
75	168	80	21	18	14	11	7	4	1	275	615	80	12	9	7	4	2	1	0
75	168	100	19	15	12	8	5	2	0	275	615	100	10	8	5	3	1	0	0
75	168	120	17	13	10	6	3	0	0	275	615	120	9	7	4	2	0	0	0
75	168	140	15	12	8	4	1	0	0	275	615	140	8	6	3	1	0	0	0
100	224	40	28	25	22	19	16	13	10	300	671	40	17	15	12	10	7	5	3
100	224	60	22	19	16	13	10	7	4	300	671	60	14	11	9	6	4	2	1
100	224	80	19	16	13	10	6	3	1	300	671	80	11	9	6	4	2	1	0
100	224	100	17	14	10	7	4	1	0	300	671	100	10	7	5	3	1	0	0
100	224	120	15	12	8	5	2	0	0	300	671	120	9	6	4	2	0	0	0
100	224	140	14	10	7	4	1	0	0	300	671	140	8	5	3	1	0	0	0
125	280	40	25	23	20	17	14	11	8	325	727	40	16	14	12	9	7	5	3
125	280	60	20	18	15	12	9	6	3	325	727	60	13	11	8	6	3	2	0
125	280	80	17	14	11	8	5	3	1	325	727	80	11	9	6	4	2	0	0
125	280	100	15	12	9	6	3	1	0	325	727	100	10	7	5	2	1	0	0
125	280	120	14	11	7	4	2	0	0	325	727	120	8	6	3	1	0	0	0
125	280	140	12	9	6	3	1	0	0	325	727	140	8	5	3	1	0	0	0
150	335	40	23	21	18	15	13	10	7	350	783	40	16	14	11	9	6	4	2
150	335	60	19	16	13	10	8	5	2	350	783	60	13	10	8	5	3	1	0
150	335	80	16	13	10	7	5	2	0	350	783	80	11	8	6	3	1	0	0
150	335	100	14	11	8	5	3	1	0	350	783	100	9	7	4	2	1	0	0
150	335	120	13	10	7	4	1	0	0	350	783	120	8	6	3	1	0	0	0
150	335	140	11	8	5	3	0	0	0	350	783	140	7	5	2	1	0	0	0
175	391	40	22	20	17	14	11	9	6	375	839	40	15	13	11	8	6	4	2
175	391	60	18	15	12	9	7	4	2	375	839	60	12	10	7	5	3	1	0
175	391	80	15	12	9	7	4	2	0	375	839	80	10	8	5	3	1	0	0
175	391	100	13	10	7	5	2	0	0	375	839	100	9	6	4	2	0	0	0
175	391	120	12	9	6	3	1	0	0	375	839	120	8	5	3	1	0	0	0
175	391	140	11	8	5	2	0	0	0	375	839	140	7	5	2	1	0	0	0
200	447	40	21	18	16	13	10	8	5	400	894	40	15	13	10	8	5	3	2
200	447	60	17	14	11	9	6	4	2	400	894	60	12	9	7	5	3	1	0
200	447	80	14	11	9	6	3	1	0	400	894	80	10	7	5	3	1	0	0
200	447	100	12	10	7	4	2	0	0	400	894	100	8	6	4	2	0	0	0
200	447	120	11	8	5	3	1	0	0	400	894	120	7	5	3	1	0	0	0
200	447	140	10	7	4	2	0	0	0	400	894	140	7	4	2	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(n)
 Q_d , Threshold Fire Size at Response: 750 Btu/sec
 t_g : 500 Seconds to 1000 Btu/sec
 α : 0.004 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS									
25	56	40	52	45	39	34	29	24	20	225	503	40	26	23	20	17	14	12	9
25	56	60	41	34	28	23	18	14	9	225	503	60	20	18	15	12	9	6	3
25	56	80	34	28	22	17	12	8	4	225	503	80	17	14	11	8	6	3	1
25	56	100	29	23	18	13	8	4	0	225	503	100	15	12	9	6	3	1	0
25	56	120	26	20	14	10	5	1	0	225	503	120	13	11	7	4	2	0	0
25	56	140	23	17	12	7	3	0	0	225	503	140	12	9	6	3	1	0	0
50	112	40	44	40	35	30	26	22	18	250	559	40	24	22	19	16	14	11	8
50	112	60	35	30	26	21	17	12	8	250	559	60	19	17	14	11	8	5	3
50	112	80	30	25	20	15	11	7	3	250	559	80	16	14	11	8	5	3	1
50	112	100	26	21	16	12	7	3	0	250	559	100	14	12	9	6	3	1	0
50	112	120	23	18	13	9	5	1	0	250	559	120	13	10	7	4	2	0	0
50	112	140	21	16	11	7	3	0	0	250	559	140	12	9	6	3	1	0	0
75	168	40	39	35	31	27	24	20	16	275	615	40	23	21	18	16	13	10	7
75	168	60	31	27	23	19	15	11	7	275	615	60	19	16	13	10	8	5	3
75	168	80	26	22	18	14	10	6	3	275	615	80	16	13	10	7	5	2	1
75	168	100	23	19	15	10	7	3	0	275	615	100	14	11	8	5	3	1	0
75	168	120	20	16	12	8	4	1	0	275	615	120	12	9	7	4	1	0	0
75	168	140	18	14	10	6	2	0	0	275	615	140	11	8	5	3	1	0	0
100	224	40	35	32	29	25	21	18	14	300	671	40	22	20	18	15	12	9	7
100	224	60	28	25	21	17	14	10	6	300	671	60	18	15	13	10	7	5	2
100	224	80	24	20	16	13	9	5	2	300	671	80	15	13	10	7	4	2	0
100	224	100	21	17	13	10	6	2	0	300	671	100	13	11	8	5	2	1	0
100	224	120	19	15	11	7	4	0	0	300	671	120	12	9	6	3	1	0	0
100	224	140	17	13	9	5	2	0	0	300	671	140	11	8	5	2	0	0	0
125	280	40	32	30	26	23	20	16	13	325	727	40	22	19	17	14	11	9	6
125	280	60	26	23	19	16	12	9	6	325	727	60	17	15	12	9	7	4	2
125	280	80	22	19	15	12	8	5	2	325	727	80	15	12	9	6	4	2	0
125	280	100	19	16	12	9	5	2	0	325	727	100	13	10	7	5	2	1	0
125	280	120	17	14	10	7	3	0	0	325	727	120	11	9	6	3	1	0	0
125	280	140	16	12	8	5	2	0	0	325	727	140	10	7	5	2	0	0	0
150	335	40	30	28	25	21	18	15	12	350	783	40	21	19	16	13	11	8	6
150	335	60	24	21	18	15	11	8	5	350	783	60	17	14	12	9	6	4	2
150	335	80	21	17	14	11	7	4	1	350	783	80	14	12	9	6	4	2	0
150	335	100	18	15	11	8	5	2	0	350	783	100	12	10	7	4	2	0	0
150	335	120	16	13	9	6	3	0	0	350	783	120	11	8	5	3	1	0	0
150	335	140	15	11	8	4	1	0	0	350	783	140	10	7	4	2	0	0	0
175	391	40	28	26	23	20	17	14	10	375	839	40	20	18	16	13	10	8	5
175	391	60	23	20	17	14	10	7	4	375	839	60	16	14	11	8	6	3	2
175	391	80	19	16	13	10	7	4	1	375	839	80	14	11	8	6	3	1	0
175	391	100	17	14	11	7	4	1	0	375	839	100	12	9	7	4	2	0	0
175	391	120	15	12	9	5	2	0	0	375	839	120	11	8	5	3	1	0	0
175	391	140	14	10	7	4	1	0	0	375	839	140	10	7	4	2	0	0	0
200	447	40	27	24	22	18	16	12	10	400	894	40	20	17	15	12	10	7	5
200	447	60	22	19	16	13	10	7	4	400	894	60	16	13	11	8	5	3	1
200	447	80	18	15	12	9	6	3	1	400	894	80	13	11	8	5	3	1	0
200	447	100	16	13	10	7	4	1	0	400	894	100	11	9	6	4	2	0	0
200	447	120	14	11	8	5	2	0	0	400	894	120	10	8	5	3	1	0	0
200	447	140	13	10	7	4	1	0	0	400	894	140	9	7	4	2	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(o)
 Q_d , Threshold Fire Size at Response: 750 Btu/sec
 t_d : 600 Seconds to 1000 Btu/sec
 α : 0.003 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
			INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS						
25	56	40	55	47	41	35	30	25	21	225	503	40	28	26	23	19	16	13	10
25	56	60	43	36	29	24	19	14	10	225	503	60	22	20	17	13	10	7	4
25	56	80	36	28	23	18	13	8	4	225	503	80	19	16	13	10	7	4	1
25	56	100	31	24	18	13	9	4	0	225	503	100	16	13	10	7	4	1	0
25	56	120	27	20	15	10	6	1	0	225	503	120	15	12	8	5	2	0	0
25	56	140	24	18	12	8	3	0	0	225	503	140	13	10	7	4	1	0	0
50	112	40	47	42	37	32	28	23	19	250	559	40	27	24	21	18	15	12	10
50	112	60	37	32	27	22	18	13	9	250	559	60	21	19	16	13	10	7	4
50	112	80	31	26	21	16	12	8	4	250	559	80	18	15	12	9	6	3	1
50	112	100	27	22	17	12	8	4	0	250	559	100	16	13	10	7	4	1	0
50	112	120	24	19	14	9	5	1	0	250	559	120	14	11	8	5	2	0	0
50	112	140	22	16	11	7	3	0	0	250	559	140	13	10	7	4	1	0	0
75	168	40	42	38	34	29	25	21	17	275	615	40	26	23	20	18	15	12	9
75	168	60	33	29	25	20	16	12	8	275	615	60	21	18	15	12	9	6	4
75	168	80	28	24	19	15	11	7	3	275	615	80	17	15	12	9	6	3	1
75	168	100	24	20	15	11	7	3	0	275	615	100	15	12	9	6	3	1	0
75	168	120	22	17	13	9	5	1	0	275	615	120	13	11	7	5	2	0	0
75	168	140	20	15	11	6	3	0	0	275	615	140	12	9	6	3	1	0	0
100	224	40	38	35	31	27	23	19	16	300	671	40	25	22	20	17	14	11	8
100	224	60	30	27	23	19	15	11	7	300	671	60	20	17	14	11	8	6	3
100	224	80	26	22	18	14	10	6	3	300	671	80	17	14	11	8	5	3	1
100	224	100	22	18	14	10	7	3	0	300	671	100	15	12	9	6	3	1	0
100	224	120	20	16	12	8	4	1	0	300	671	120	13	10	7	4	2	0	0
100	224	140	18	14	10	6	2	0	0	300	671	140	12	9	6	3	1	0	0
125	280	40	35	32	29	25	22	18	14	325	727	40	24	22	19	16	13	10	8
125	280	60	28	25	21	17	14	10	7	325	727	60	19	16	14	11	8	5	3
125	280	80	24	20	16	13	9	6	2	325	727	80	16	13	10	8	5	2	1
125	280	100	21	17	13	10	6	3	0	325	727	100	14	11	8	5	3	1	0
125	280	120	19	15	11	7	4	1	0	325	727	120	12	10	7	4	2	0	0
125	280	140	17	13	9	5	2	0	0	325	727	140	11	8	5	3	1	0	0
150	335	40	33	30	27	23	20	17	13	350	783	40	23	21	18	15	13	10	7
150	335	60	26	23	20	16	13	9	6	350	783	60	18	16	13	10	7	5	3
150	335	80	22	19	15	12	8	5	2	350	783	80	15	13	10	7	5	2	1
150	335	100	19	16	12	9	5	2	0	350	783	100	13	11	8	5	3	1	0
150	335	120	17	14	10	7	3	0	0	350	783	120	12	9	6	4	1	0	0
150	335	140	16	12	8	5	2	0	0	350	783	140	11	8	5	3	1	0	0
175	391	40	31	28	25	22	19	15	12	375	839	40	22	20	17	15	12	9	7
175	391	60	25	22	18	15	12	9	5	375	839	60	18	15	13	10	7	5	2
175	391	80	21	18	14	11	8	4	2	375	839	80	15	12	10	7	4	2	0
175	391	100	18	15	12	8	5	2	0	375	839	100	13	10	8	5	0	1	0
175	391	120	16	13	10	6	3	0	0	375	839	120	12	9	6	3	1	0	0
175	391	140	15	11	8	5	1	0	0	375	839	140	11	8	5	2	0	0	0
200	447	40	29	27	24	21	17	14	11	400	894	40	22	19	17	14	11	9	6
200	447	60	23	21	17	14	11	8	5	400	894	60	17	15	12	9	7	4	2
200	447	80	20	17	14	10	7	4	1	400	894	80	15	12	9	6	4	2	0
200	447	100	17	14	11	8	4	2	0	400	894	100	13	10	7	5	2	1	0
200	447	120	15	12	9	6	3	0	0	400	894	120	11	9	6	3	1	0	0
200	447	140	14	11	7	4	1	0	0	400	894	140	10	7	5	2	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(p)
 Q_d , Threshold Fire Size at Response: 1000 Btu/sec
 t_g : 50 Seconds to 1000 Btu/sec
 α : 0.400 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET																
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0										
			INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS																
25	56	40	22	20	17	14	11	8	5	225	503	40	8	6	4	2	0	0	0	250	559	40	8	5	3	1	0	0	0
25	56	60	18	16	13	10	7	4	2	225	503	60	6	4	2	0	0	0	0	250	559	60	6	4	2	0	0	0	0
25	56	80	16	13	10	7	4	2	0	225	503	80	5	3	1	0	0	0	0	250	559	80	5	3	1	0	0	0	0
25	56	100	14	11	8	5	3	0	0	225	503	100	5	2	0	0	0	0	0	250	559	100	4	2	0	0	0	0	0
25	56	120	13	10	7	4	1	0	0	225	503	120	4	2	0	0	0	0	0	250	559	120	4	2	0	0	0	0	0
25	56	140	12	9	6	3	1	0	0	225	503	140	3	1	0	0	0	0	0	250	559	140	3	1	0	0	0	0	0
50	112	40	17	15	12	9	7	4	2	250	559	40	8	5	3	1	0	0	0	250	559	60	6	4	2	0	0	0	0
50	112	60	14	11	9	6	4	2	0	250	559	60	6	4	2	0	0	0	0	250	559	80	5	3	1	0	0	0	0
50	112	80	12	9	7	4	2	0	0	250	559	80	5	3	1	0	0	0	0	250	559	100	4	2	0	0	0	0	0
50	112	100	11	8	5	3	1	0	0	250	559	100	4	2	0	0	0	0	0	250	559	120	4	2	0	0	0	0	0
50	112	120	10	7	4	2	0	0	0	250	559	120	4	2	0	0	0	0	0	250	559	140	3	1	0	0	0	0	0
50	112	140	9	6	3	1	0	0	0	250	559	140	3	1	0	0	0	0	0	250	559	140	3	1	0	0	0	0	0
75	168	40	14	12	9	7	4	2	1	275	615	40	7	5	3	1	0	0	0	275	615	60	6	3	1	0	0	0	0
75	168	60	12	9	7	4	2	1	0	275	615	60	6	3	1	0	0	0	0	275	615	80	5	2	0	0	0	0	0
75	168	80	10	7	5	3	1	0	0	275	615	80	5	2	0	0	0	0	0	275	615	100	4	2	0	0	0	0	0
75	168	100	9	6	4	2	0	0	0	275	615	100	4	2	0	0	0	0	0	275	615	120	3	1	0	0	0	0	0
75	168	120	8	5	3	1	0	0	0	275	615	120	3	1	0	0	0	0	0	275	615	140	3	1	0	0	0	0	0
75	168	140	7	4	2	0	0	0	0	275	615	140	3	1	0	0	0	0	0	275	615	140	3	1	0	0	0	0	0
100	224	40	12	10	8	5	3	1	0	300	671	40	7	5	3	1	0	0	0	300	671	60	5	3	1	0	0	0	0
100	224	60	10	8	5	3	1	0	0	300	671	60	5	3	1	0	0	0	0	300	671	80	4	2	0	0	0	0	0
100	224	80	8	6	4	2	0	0	0	300	671	80	4	2	0	0	0	0	0	300	671	100	4	2	0	0	0	0	0
100	224	100	7	5	3	1	0	0	0	300	671	100	4	2	0	0	0	0	0	300	671	120	3	1	0	0	0	0	0
100	224	120	7	4	2	0	0	0	0	300	671	120	3	1	0	0	0	0	0	300	671	140	3	1	0	0	0	0	0
100	224	140	6	4	1	0	0	0	0	300	671	140	3	1	0	0	0	0	0	300	671	140	3	1	0	0	0	0	0
125	280	40	11	9	6	4	2	1	0	325	727	40	7	4	2	1	0	0	0	325	727	60	5	3	1	0	0	0	0
125	280	60	9	7	4	2	1	0	0	325	727	60	5	3	1	0	0	0	0	325	727	80	4	2	0	0	0	0	0
125	280	80	8	5	3	1	0	0	0	325	727	80	4	2	0	0	0	0	0	325	727	100	3	1	0	0	0	0	0
125	280	100	7	4	2	0	0	0	0	325	727	100	3	1	0	0	0	0	0	325	727	120	3	1	0	0	0	0	0
125	280	120	6	3	1	0	0	0	0	325	727	120	3	1	0	0	0	0	0	325	727	140	3	0	0	0	0	0	0
125	280	140	5	3	1	0	0	0	0	325	727	140	3	0	0	0	0	0	0	325	727	140	3	0	0	0	0	0	0
150	335	40	0	8	5	3	2	0	0	350	783	40	6	4	2	0	0	0	0	350	783	60	5	3	1	0	0	0	0
150	335	60	8	6	3	2	0	0	0	350	783	60	5	3	1	0	0	0	0	350	783	80	4	2	0	0	0	0	0
150	335	80	7	4	2	0	0	0	0	350	783	80	4	2	0	0	0	0	0	350	783	100	3	1	0	0	0	0	0
150	335	100	6	3	2	0	0	0	0	350	783	100	3	1	0	0	0	0	0	350	783	120	3	1	0	0	0	0	0
150	335	120	5	3	1	0	0	0	0	350	783	120	3	1	0	0	0	0	0	350	783	140	2	0	0	0	0	0	0
150	335	140	5	2	0	0	0	0	0	350	783	140	2	0	0	0	0	0	0	350	783	140	2	0	0	0	0	0	0
175	391	40	9	7	5	3	1	0	0	375	839	40	6	4	2	0	0	0	0	375	839	60	5	2	0	0	0	0	0
175	391	60	7	5	3	1	0	0	0	375	839	60	5	2	0	0	0	0	0	375	839	80	4	2	0	0	0	0	0
175	391	80	6	4	2	0	0	0	0	375	839	80	4	2	0	0	0	0	0	375	839	100	3	1	0	0	0	0	0
175	391	100	5	3	1	0	0	0	0	375	839	100	3	1	0	0	0	0	0	375	839	120	3	0	0	0	0	0	0
175	391	120	5	2	0	0	0	0	0	375	839	120	3	0	0	0	0	0	0	375	839	140	2	0	0	0	0	0	0
175	391	140	4	2	0	0	0	0	0	375	839	140	2	0	0	0	0	0	0	375	839	140	2	0	0	0	0	0	0
200	447	40	9	6	4	2	1	0	0	400	894	40	6	4	2	0	0	0	0	400	894	60	4	2	0	0	0	0	0
200	447	60	7	5	2	1	0	0	0	400	894	60	4	2	0	0	0	0	0	400	894	80	3	1	0	0	0	0	0
200	447	80	6	3	1	0	0	0	0	400	894	80	3	1	0	0	0	0	0	400	894	100	3	1	0	0	0	0	0
200	447	100	5	3	1	0	0	0	0	400	894	100	3	1	0	0	0	0	0	400	894	120	2	0	0	0	0	0	0
200	447	120	4	2	0	0	0	0	0	400	894	120	2	0	0	0	0	0	0	400	894	140	2	0	0	0	0	0	0
200	447	140	4	2	0	0	0	0	0	400	894	140	2	0	0	0	0	0	0	400	894	140	2	0	0	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(q)
 Q_d , Threshold Fire Size at Response: 1000 Btu/sec
 t_d : 150 Seconds to 1000 Btu/sec
 α : 0.044 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET																
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0										
			INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS																
25	56	40	39	36	32	28	25	21	17	225	503	40	16	14	12	9	7	5	3	225	503	60	13	11	8	6	4	2	1
25	56	60	32	28	24	21	17	13	9	225	503	80	11	9	6	4	2	1	0	225	503	100	10	7	5	3	1	0	0
25	56	80	27	24	20	16	12	8	4	225	503	120	9	6	4	2	0	0	0	225	503	140	8	5	3	1	0	0	0
25	56	100	24	20	16	12	8	4	1	225	503	140	8	5	3	1	0	0	0	225	503	140	8	5	3	1	0	0	0
25	56	120	22	18	14	10	6	2	0	225	503	140	8	5	3	1	0	0	0	225	503	140	8	5	3	1	0	0	0
25	56	140	20	16	12	8	4	0	0	225	503	140	8	5	3	1	0	0	0	225	503	140	8	5	3	1	0	0	0
50	112	40	31	29	26	22	19	16	13	250	559	40	16	13	11	9	6	4	2	250	559	60	12	10	8	5	3	2	0
50	112	60	25	23	19	16	13	9	6	250	559	80	11	8	6	3	2	0	0	250	559	100	9	7	4	2	1	0	0
50	112	80	22	19	15	12	9	6	3	250	559	120	9	7	4	2	1	0	0	250	559	140	8	6	3	1	0	0	0
50	112	100	19	16	13	9	6	3	0	250	559	140	8	6	3	1	0	0	0	250	559	140	8	6	3	1	0	0	0
50	112	120	17	14	11	7	4	1	0	250	559	140	8	6	3	1	0	0	0	250	559	140	8	6	3	1	0	0	0
50	112	140	16	13	9	6	2	0	0	250	559	140	7	5	3	1	0	0	0	250	559	140	7	5	3	1	0	0	0
75	168	40	27	24	22	19	16	13	10	275	615	40	15	13	10	8	6	4	2	275	615	60	12	10	7	5	3	1	0
75	168	60	22	19	16	13	10	7	4	275	615	80	10	8	5	3	1	0	0	275	615	100	9	6	4	2	0	0	0
75	168	80	19	16	13	10	7	4	2	275	615	120	9	6	4	2	0	0	0	275	615	140	8	5	3	1	0	0	0
75	168	100	16	14	11	7	4	2	0	275	615	140	8	5	3	1	0	0	0	275	615	140	7	5	2	1	0	0	0
75	168	120	15	12	9	6	3	1	0	275	615	140	7	5	2	1	0	0	0	275	615	140	7	5	2	1	0	0	0
75	168	140	13	10	7	4	2	0	0	275	615	140	7	5	2	1	0	0	0	275	615	140	7	5	2	1	0	0	0
100	224	40	24	22	19	16	13	10	8	300	671	40	14	12	10	7	5	3	2	300	671	60	11	9	7	4	2	1	0
100	224	60	19	17	14	11	8	6	3	300	671	80	10	7	5	3	1	0	0	300	671	100	8	6	4	2	0	0	0
100	224	80	16	14	11	8	5	3	1	300	671	120	7	5	3	1	0	0	0	300	671	140	7	4	2	0	0	0	0
100	224	100	14	12	9	6	3	1	0	300	671	140	7	4	2	0	0	0	0	300	671	140	7	4	2	0	0	0	0
100	224	120	13	10	7	5	2	0	0	300	671	140	7	4	2	0	0	0	0	300	671	140	7	4	2	0	0	0	0
100	224	140	12	9	6	3	1	0	0	300	671	140	7	4	2	0	0	0	0	300	671	140	7	4	2	0	0	0	0
125	280	40	21	19	17	14	11	9	6	325	727	40	14	12	9	7	5	3	1	325	727	60	11	9	6	4	2	1	0
125	280	60	17	15	12	10	7	4	2	325	727	80	9	7	4	2	1	0	0	325	727	100	8	6	3	1	0	0	0
125	280	80	15	12	10	7	4	2	1	325	727	120	7	5	2	1	0	0	0	325	727	140	6	4	2	0	0	0	0
125	280	100	13	10	8	5	3	1	0	325	727	140	6	4	2	0	0	0	0	325	727	140	6	4	2	0	0	0	0
125	280	120	12	9	6	4	1	0	0	325	727	140	6	4	2	0	0	0	0	325	727	140	6	4	2	0	0	0	0
125	280	140	11	8	5	3	1	0	0	325	727	140	6	4	2	0	0	0	0	325	727	140	6	4	2	0	0	0	0
150	335	40	20	18	15	13	10	7	5	350	783	40	13	11	9	6	4	2	1	350	783	60	10	8	6	4	2	1	0
150	335	60	16	14	11	8	6	4	2	350	783	80	9	6	4	2	1	0	0	350	783	100	8	5	3	1	0	0	0
150	335	80	14	11	9	6	3	2	0	350	783	120	7	4	2	1	0	0	0	350	783	140	6	4	2	0	0	0	0
150	335	100	12	9	7	4	2	1	0	350	783	140	6	4	2	0	0	0	0	350	783	140	6	4	2	0	0	0	0
150	335	120	11	8	5	3	1	0	0	350	783	140	6	4	2	0	0	0	0	350	783	140	6	4	2	0	0	0	0
150	335	140	10	7	4	2	1	0	0	350	783	140	6	4	2	0	0	0	0	350	783	140	6	4	2	0	0	0	0
175	391	40	18	16	14	11	9	6	4	375	839	40	13	11	8	6	4	2	1	375	839	60	10	8	5	3	2	0	0
175	391	60	15	13	10	7	5	3	1	375	839	80	8	6	4	2	0	0	0	375	839	100	7	5	3	1	0	0	0
175	391	80	13	10	8	5	3	1	0	375	839	120	6	4	2	0	0	0	0	375	839	140	6	3	1	0	0	0	0
175	391	100	11	9	6	4	2	0	0	375	839	140	6	3	1	0	0	0	0	375	839	140	6	3	1	0	0	0	0
175	391	120	10	7	5	2	1	0	0	375	839	140	6	3	1	0	0	0	0	375	839	140	6	3	1	0	0	0	0
175	391	140	9	6	4	2	0	0	0	375	839	140	6	3	1	0	0	0	0	375	839	140	6	3	1	0	0	0	0
200	447	40	17	15	13	10	8	5	3	400	894	40	12	10	8	5	3	2	1	400	894	60	10	7	5	3	1	0	0
200	447	60	14	12	9	7	4	2	1	400	894	80	8	6	4	2	0	0	0	400	894	100	7	5	3	1	0	0	0
200	447	80	12	9	7	4	2	1	0	400	894	120	6	4	2	0	0	0	0	400	894	140	6	3	1	0	0	0	0
200	447	100	10	8	5	3	1	0	0	400	894	140	6	3	1	0	0	0	0	400	894	140	6	3	1	0	0	0	0
200	447	120	9	7	4	2	1	0	0	400	894	140	6	3	1	0	0	0	0	400	894	140	6	3	1	0	0	0	0
200	447	140	8	6	3	1	0	0	0	400	894	140	6	3	1	0	0	0	0	400	894	140	6	3	1	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(r)
 Q_d , Threshold Fire Size at Response: 1000 Btu/sec
 t_g : 300 Seconds to 1000 Btu/sec
 α : 0.011 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS									
25	56	40	52	47	42	37	32	28	23	225	503	40	24	22	19	17	14	11	9
25	56	60	42	36	31	26	22	17	13	225	503	60	19	17	14	11	9	6	4
25	56	80	35	30	25	20	15	11	7	225	503	80	16	14	11	8	6	3	1
25	56	100	31	25	20	15	11	7	3	225	503	100	14	12	9	6	4	2	0
25	56	120	28	22	17	12	8	4	0	225	503	120	13	10	7	5	2	1	0
25	56	140	25	19	14	10	5	1	0	225	503	140	12	9	6	3	1	0	0
50	112	40	43	40	36	32	28	24	20	250	559	40	23	21	18	16	13	10	8
50	112	60	35	31	27	23	19	15	11	250	559	60	18	16	13	11	8	5	3
50	112	80	30	25	21	17	13	9	5	250	559	80	16	13	10	8	5	3	1
50	112	100	26	22	18	13	9	6	2	250	559	100	14	11	8	6	3	1	0
50	112	120	23	19	15	11	7	3	0	250	559	120	12	10	7	4	2	0	0
50	112	140	21	17	12	8	4	1	0	250	559	140	11	8	6	3	1	0	0
75	168	40	37	35	31	28	24	21	17	275	615	40	22	20	17	15	12	9	7
75	168	60	30	27	24	20	16	13	9	275	615	60	18	15	13	10	7	5	3
75	168	80	26	22	19	15	11	8	4	275	615	80	15	12	10	7	5	2	1
75	168	100	23	19	15	12	8	5	1	275	615	100	13	11	8	5	3	1	0
75	168	120	20	17	13	9	6	2	0	275	615	120	12	9	6	4	2	0	0
75	168	140	19	15	11	7	4	1	0	275	615	140	11	8	5	3	1	0	0
100	224	40	34	31	28	25	22	18	15	300	671	40	21	19	16	14	11	9	6
100	224	60	27	24	21	18	14	11	8	300	671	60	17	15	12	9	7	4	2
100	224	80	23	20	17	13	10	7	4	300	671	80	14	12	9	7	4	2	1
100	224	100	20	17	14	10	7	4	1	300	671	100	13	10	7	5	3	1	0
100	224	120	18	15	12	8	5	2	0	300	671	120	11	9	6	3	1	0	0
100	224	140	17	13	10	6	3	0	0	300	671	140	10	8	5	3	1	0	0
125	280	40	31	29	26	23	19	16	13	325	727	40	20	18	16	13	11	8	6
125	280	60	25	22	19	16	13	10	7	325	727	60	16	14	11	9	6	4	2
125	280	80	21	18	15	12	9	6	3	325	727	80	14	11	9	6	4	2	1
125	280	100	19	16	13	9	6	3	1	325	727	100	12	10	7	4	2	1	0
125	280	120	17	14	10	7	4	1	0	325	727	120	11	8	6	3	1	0	0
125	280	140	15	12	9	6	3	0	0	325	727	140	10	7	5	2	1	0	0
150	335	40	29	27	24	21	18	15	12	350	783	40	20	18	15	13	10	8	5
150	335	60	23	21	18	15	12	9	6	350	783	60	16	13	11	8	6	4	2
150	335	80	20	17	14	11	8	5	2	350	783	80	13	11	8	6	3	2	0
150	335	100	17	14	11	8	5	3	1	350	783	100	12	9	7	4	2	1	0
150	335	120	16	13	10	6	4	1	0	350	783	120	10	8	5	3	1	0	0
150	335	140	14	11	8	5	2	0	0	350	783	140	9	7	4	2	1	0	0
175	391	40	27	25	22	19	16	13	11	375	839	40	19	17	14	12	9	7	5
175	391	60	22	19	16	13	10	8	5	375	839	60	15	13	10	8	5	3	2
175	391	80	18	16	13	10	7	4	2	375	839	80	13	10	8	5	3	1	0
175	391	100	16	13	10	8	5	2	0	375	839	100	11	9	6	4	2	0	0
175	391	120	15	12	9	6	3	1	0	375	839	120	10	7	5	3	1	0	0
175	391	140	13	10	7	4	2	0	0	375	839	140	9	6	4	2	0	0	0
200	447	40	25	23	21	18	15	12	9	400	894	40	18	16	14	11	9	7	4
200	447	60	20	18	15	12	10	7	4	400	894	60	15	12	10	7	5	3	1
200	447	80	17	15	12	9	6	4	2	400	894	80	12	10	7	5	3	1	0
200	447	100	15	13	10	7	4	2	0	400	894	100	11	8	6	3	2	0	0
200	447	120	14	11	8	5	3	1	0	400	894	120	10	7	5	2	1	0	0
200	447	140	12	10	7	4	2	0	0	400	894	140	9	6	4	2	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(s)
 Q_d , Threshold Fire Size at Response: 1000 Btu/sec
 t_d : 500 Seconds to 1000 Btu/sec
 α : 0.004 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET							
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0	
INSTALLED SPACING OF DETECTORS																				
25	56	40	62	54	48	42	37	31	27	225	503	40	31	29	26	23	20	17	14	
25	56	60	49	41	35	29	24	19	15	225	503	60	25	22	19	16	13	10	7	
25	56	80	41	33	27	22	17	12	8	225	503	80	21	18	15	12	9	6	3	
25	56	100	35	28	22	17	12	8	4	225	503	100	19	16	13	9	6	3	1	
25	56	120	31	24	18	13	9	4	0	225	503	120	17	14	10	7	4	2	0	
25	56	140	28	21	16	11	6	2	0	225	503	140	15	12	9	6	3	0	0	
INSTALLED SPACING OF DETECTORS																				
50	112	40	53	48	43	38	33	29	24	250	559	40	30	28	25	22	19	16	13	
50	112	60	42	37	32	27	22	18	14	250	559	60	24	21	18	15	12	9	7	
50	112	80	35	30	25	20	16	11	7	250	559	80	20	18	15	11	8	6	3	
50	112	100	31	25	20	16	11	7	3	250	559	100	18	15	12	9	6	3	1	
50	112	120	27	22	17	12	8	4	0	250	559	120	16	13	10	7	4	1	0	
50	112	140	25	19	14	10	6	2	0	250	559	140	14	11	8	5	2	0	0	
INSTALLED SPACING OF DETECTORS																				
75	168	40	47	43	39	35	31	26	22	275	615	40	29	27	24	21	18	15	12	
75	168	60	38	33	29	25	20	16	12	275	615	60	23	20	18	15	12	9	6	
75	168	80	32	27	23	19	14	10	6	275	615	80	20	17	14	11	8	5	3	
75	168	100	28	23	19	14	10	6	3	275	615	100	17	14	11	8	5	3	1	
75	168	120	25	20	16	11	7	3	0	275	615	120	15	12	9	6	4	1	0	
75	168	140	22	18	13	9	5	1	0	275	615	140	14	11	8	5	2	0	0	
INSTALLED SPACING OF DETECTORS																				
100	224	40	43	40	36	32	28	24	20	300	671	40	28	25	23	20	17	14	11	
100	224	60	34	31	27	23	19	15	11	300	671	60	22	20	17	14	11	8	5	
100	224	80	29	25	21	17	13	9	6	300	671	80	19	16	13	10	7	5	2	
100	224	100	25	21	17	13	9	6	2	300	671	100	16	14	11	8	5	2	1	
100	224	120	23	19	15	11	7	3	0	300	671	120	15	12	9	6	3	1	0	
100	224	140	21	16	12	8	5	1	0	300	671	140	13	10	7	5	2	0	0	
INSTALLED SPACING OF DETECTORS																				
125	280	40	39	37	33	30	26	22	19	325	727	40	27	25	22	19	16	13	11	
125	280	60	32	28	25	21	17	14	10	325	727	60	21	19	16	13	10	8	5	
125	280	80	27	23	20	16	12	9	5	325	727	80	18	16	13	10	7	4	2	
125	280	100	24	20	16	12	9	5	2	325	727	100	16	13	10	7	5	2	0	
125	280	120	21	17	14	10	6	3	0	325	727	120	14	11	8	6	3	1	0	
125	280	140	19	15	11	8	4	1	0	325	727	140	13	10	7	4	2	0	0	
INSTALLED SPACING OF DETECTORS																				
150	335	40	37	34	31	28	24	21	17	350	783	40	26	24	21	18	15	13	10	
150	335	60	30	27	23	20	16	13	9	350	783	60	21	18	15	13	10	7	5	
150	335	80	25	22	18	15	11	8	5	350	783	80	18	15	12	9	7	4	2	
150	335	100	22	19	15	12	8	5	2	350	783	100	15	13	10	7	4	2	0	
150	335	120	20	16	13	9	6	2	0	350	783	120	14	11	8	5	3	1	0	
150	335	140	18	14	11	7	4	1	0	350	783	140	12	10	7	4	2	0	0	
INSTALLED SPACING OF DETECTORS																				
175	391	40	35	32	29	26	23	19	16	375	839	40	25	23	20	18	15	12	9	
175	391	60	28	25	22	18	15	12	8	375	839	60	20	18	15	12	9	7	4	
175	391	80	24	20	17	14	10	7	4	375	839	80	17	14	12	9	6	4	2	
175	391	100	21	18	14	11	7	4	1	375	839	100	15	12	9	7	4	2	0	
175	391	120	19	15	12	8	5	2	0	375	839	120	13	11	8	5	3	1	0	
175	391	140	17	13	10	7	3	1	0	375	839	140	12	9	6	4	1	0	0	
INSTALLED SPACING OF DETECTORS																				
200	447	40	33	30	28	24	21	18	15	400	894	40	24	22	20	17	14	11	9	
200	447	60	26	24	20	17	14	11	8	400	894	60	19	17	14	12	9	6	4	
200	447	80	22	19	16	13	10	7	4	400	894	80	16	14	11	8	6	3	1	
200	447	100	20	17	13	10	7	4	1	400	894	100	14	12	9	6	4	2	0	
200	447	120	18	14	11	8	5	2	0	400	894	120	13	10	7	5	2	1	0	
200	447	140	16	13	9	6	3	1	0	400	894	140	12	9	6	4	1	0	0	

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(t)
Q_d: Threshold Fire Size at Response: 1000 Btu/sec
t_g: 600 Seconds to 1000 Btu/sec
α: 0.003 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
			INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS						
25	56	40	65	56	50	43	38	33	28	225	503	40	34	32	29	26	22	19	16
25	56	60	51	43	36	30	25	20	15	225	503	60	27	25	21	18	15	12	8
25	56	80	42	34	28	23	18	13	8	225	503	80	23	20	17	14	10	7	4
25	56	100	36	29	23	17	13	8	4	225	503	100	20	17	14	11	7	4	1
25	56	120	32	25	19	14	9	5	1	225	503	120	18	15	12	8	5	2	0
25	56	140	29	21	16	11	6	2	0	225	503	140	17	13	10	6	3	1	0
50	112	40	56	51	45	40	35	30	26	250	559	40	33	30	27	24	21	18	15
50	112	60	45	39	33	28	23	19	14	250	559	60	26	23	20	17	14	11	8
50	112	80	37	31	26	21	16	12	8	250	559	80	22	19	16	13	10	7	4
50	112	100	33	26	21	16	12	7	3	250	559	100	19	16	13	10	7	4	1
50	112	120	29	23	18	13	8	4	0	250	559	120	17	14	11	8	5	2	0
50	112	140	26	20	15	10	6	2	0	250	559	140	16	13	9	6	3	1	0
75	168	40	50	46	42	37	32	28	24	275	615	40	31	29	26	23	20	17	14
75	168	60	40	35	31	26	22	17	13	275	615	60	25	23	19	16	13	10	7
75	168	80	34	29	24	20	15	11	7	275	615	80	21	18	15	12	9	6	3
75	168	100	30	25	20	15	11	7	3	275	615	100	19	16	13	9	6	3	1
75	168	120	26	21	17	12	8	4	0	275	615	120	17	14	11	7	4	2	0
75	168	140	24	19	14	10	5	2	0	275	615	140	15	12	9	6	3	0	0
100	224	40	46	43	38	34	30	26	22	300	671	40	30	28	25	22	19	16	13
100	224	60	37	33	28	24	20	16	12	300	671	60	24	22	19	16	13	10	7
100	224	80	31	27	23	18	14	10	6	300	671	80	21	18	15	12	9	6	3
100	224	100	27	23	18	14	10	6	3	300	671	100	18	15	12	9	6	3	1
100	224	120	24	20	15	11	7	3	0	300	671	120	16	13	10	7	4	1	0
100	224	140	22	17	13	9	5	1	0	300	671	140	15	12	8	5	3	0	0
125	280	40	43	40	36	32	28	24	21	325	727	40	29	27	24	21	18	15	13
125	280	60	34	31	27	23	19	15	11	325	727	60	23	21	18	15	12	9	6
125	280	80	29	25	21	17	13	10	6	325	727	80	20	17	14	11	8	5	3
125	280	100	25	21	17	13	10	6	2	325	727	100	17	15	12	8	6	3	1
125	280	120	23	19	15	11	7	3	0	325	727	120	16	13	10	7	4	1	0
125	280	140	21	16	12	8	5	1	0	325	727	140	14	11	8	5	2	0	0
150	335	40	40	37	34	30	26	23	19	350	783	40	28	26	23	21	18	15	12
150	335	60	32	29	25	21	18	14	11	350	783	60	23	20	17	14	11	9	6
150	335	80	27	24	20	16	12	9	5	350	783	80	19	17	14	11	8	5	3
150	335	100	24	20	16	13	9	5	2	350	783	100	17	14	11	8	5	3	1
150	335	120	21	17	14	10	6	3	0	350	783	120	15	12	9	6	3	1	0
150	335	140	19	15	12	8	4	1	0	350	783	140	14	11	8	5	2	0	0
175	391	40	38	35	32	28	25	21	18	375	839	40	28	25	23	20	17	14	11
175	391	60	30	27	24	20	17	13	10	375	839	60	22	19	17	14	11	8	5
175	391	80	26	22	19	15	12	8	5	375	839	80	19	16	13	10	7	5	2
175	391	100	22	19	15	12	8	5	2	375	839	100	16	14	11	8	5	2	1
175	391	120	20	17	13	9	6	3	0	375	839	120	15	12	9	6	3	1	0
175	391	140	18	15	11	7	4	1	0	375	839	140	13	10	7	5	2	0	0
200	447	40	36	33	30	27	24	20	17	400	894	40	27	25	22	19	16	13	11
200	447	60	29	26	22	19	16	12	9	400	894	60	21	19	16	13	10	8	5
200	447	80	24	21	18	14	11	8	4	400	894	80	18	15	13	10	7	4	2
200	447	100	21	18	15	11	8	4	2	400	894	100	16	13	10	7	5	2	1
200	447	120	19	16	12	9	5	2	0	400	894	120	14	11	8	6	3	1	0
200	447	140	17	14	10	7	4	1	0	400	894	140	13	10	7	4	2	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(u)
Q_d, Threshold Fire Size at Response: 2000 Btu/sec
t_g: 50 Seconds to 1000 Btu/sec
α: 0.400 Btu/sec¹

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS									
25	56	40	35	33	31	28	25	21	18	225	503	40	15	12	10	8	5	3	2
25	56	60	30	27	24	21	18	15	11	225	503	60	12	9	7	5	3	1	0
25	56	80	26	23	20	17	14	10	7	225	503	80	10	8	5	3	2	0	0
25	56	100	23	21	17	14	11	7	4	225	503	100	9	6	4	2	1	0	0
25	56	120	21	18	15	12	8	5	2	225	503	120	8	5	3	1	0	0	0
25	56	140	20	17	13	10	7	3	1	225	503	140	7	5	3	1	0	0	0
50	112	40	28	26	23	21	18	15	12	250	559	40	14	12	9	7	5	3	2
50	112	60	23	21	18	15	13	10	7	250	559	60	11	9	6	4	2	1	0
50	112	80	20	18	15	12	9	6	4	250	559	80	9	7	5	3	1	0	0
50	112	100	18	15	13	10	7	4	2	250	559	100	8	6	4	2	0	0	0
50	112	120	16	14	11	8	5	3	1	250	559	120	7	5	3	1	0	0	0
50	112	140	15	12	10	7	4	2	0	250	559	140	7	4	2	1	0	0	0
75	168	40	24	22	19	17	14	11	9	275	615	40	13	11	9	6	4	2	1
75	168	60	20	17	15	12	9	7	4	275	615	60	10	8	6	4	2	1	0
75	168	80	17	15	12	9	7	4	2	275	615	80	9	7	4	2	1	0	0
75	168	100	15	13	10	7	5	3	1	275	615	100	8	5	3	2	0	0	0
75	168	120	14	11	8	6	3	1	0	275	615	120	7	5	2	1	0	0	0
75	168	140	13	10	7	5	2	1	0	275	615	140	6	4	2	0	0	0	0
100	224	40	21	19	17	14	11	9	6	300	671	40	13	10	8	6	4	2	1
100	224	60	17	15	13	10	7	5	3	300	671	60	10	8	5	3	2	0	0
100	224	80	15	13	10	7	5	3	1	300	671	80	8	6	4	2	1	0	0
100	224	100	13	11	8	6	3	2	0	300	671	100	7	5	3	1	0	0	0
100	224	120	12	10	7	4	2	1	0	300	671	120	7	4	2	1	0	0	0
100	224	140	11	8	6	3	2	0	0	300	671	140	6	4	2	0	0	0	0
125	280	40	19	17	15	12	10	7	5	325	727	40	12	10	8	5	3	2	1
125	280	60	16	13	11	8	6	4	2	325	727	60	10	7	5	3	1	0	0
125	280	80	13	11	9	6	4	2	1	325	727	80	8	6	4	2	0	0	0
125	280	100	12	10	7	5	2	1	0	325	727	100	7	5	3	1	0	0	0
125	280	120	11	8	6	3	2	0	0	325	727	120	6	4	2	0	0	0	0
125	280	140	10	7	5	3	1	0	0	325	727	140	6	3	1	0	0	0	0
150	335	40	18	16	13	11	8	6	4	350	783	40	12	9	7	5	3	2	0
150	335	60	14	12	10	7	5	3	1	350	783	60	9	7	5	3	1	0	0
150	335	80	12	10	7	5	3	1	0	350	783	80	8	5	3	2	0	0	0
150	335	100	11	8	6	4	2	0	0	350	783	100	7	4	2	1	0	0	0
150	335	120	10	7	5	3	1	0	0	350	783	120	6	4	2	0	0	0	0
150	335	140	9	6	4	2	0	0	0	350	783	140	5	3	1	0	0	0	0
175	391	40	16	14	12	9	7	5	3	375	839	40	11	9	7	4	3	1	0
175	391	60	13	11	9	6	4	2	1	375	839	60	9	7	4	2	1	0	0
175	391	80	11	9	7	4	2	1	0	375	839	80	7	5	3	1	0	0	0
175	391	100	10	8	5	3	1	0	0	375	839	100	6	4	2	0	0	0	0
175	391	120	9	7	4	2	1	0	0	375	839	120	6	3	2	0	0	0	0
175	391	140	8	6	3	2	0	0	0	375	839	140	5	3	1	0	0	0	0
200	447	40	15	13	11	8	6	4	2	400	894	40	11	9	6	4	2	1	0
200	447	60	12	10	8	5	3	2	0	400	894	60	9	6	4	2	1	0	0
200	447	80	11	8	6	4	2	1	0	400	894	80	7	5	3	1	0	0	0
200	447	100	9	7	5	3	1	0	0	400	894	100	6	4	2	0	0	0	0
200	447	120	8	6	4	2	0	0	0	400	894	120	5	3	1	0	0	0	0
200	447	140	8	5	3	1	0	0	0	400	894	140	5	3	1	0	0	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(v)
Q_d, Threshold Fire Size at Response: 2000 Btu/sec
t_g: 150 Seconds to 1000 Btu/sec
α: 0.044 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
INSTALLED SPACING OF DETECTORS																			
25	56	40	60	57	53	49	44	40	36	225	503	40	27	26	23	21	18	15	13
25	56	60	50	46	41	37	32	28	23	225	503	60	22	20	18	15	12	10	7
25	56	80	43	38	34	29	25	20	16	225	503	80	19	17	14	11	9	6	4
25	56	100	38	33	28	24	19	15	11	225	503	100	17	14	12	9	7	4	2
25	56	120	34	29	25	20	15	11	7	225	503	120	15	13	10	7	5	3	1
25	56	140	31	26	21	17	13	8	4	225	503	140	14	11	9	6	4	2	0
INSTALLED SPACING OF DETECTORS																			
50	112	40	49	47	44	40	37	33	30	250	559	40	26	24	22	19	17	14	12
50	112	60	40	38	34	31	27	23	19	250	559	60	21	19	16	14	11	9	6
50	112	80	35	32	28	24	21	17	13	250	559	80	18	16	13	11	8	6	4
50	112	100	31	28	24	20	16	12	9	250	559	100	16	14	11	8	6	4	2
50	112	120	28	24	21	17	13	9	6	250	559	120	14	12	9	7	4	2	1
50	112	140	26	22	18	14	10	7	3	250	559	140	13	11	8	5	3	1	0
INSTALLED SPACING OF DETECTORS																			
75	168	40	43	41	38	35	32	28	25	275	615	40	25	23	21	18	16	13	11
75	168	60	35	33	30	26	23	20	16	275	615	60	20	18	16	13	11	8	6
75	168	80	30	28	24	21	18	14	11	275	615	80	17	15	13	10	7	5	3
75	168	100	27	24	21	17	14	10	7	275	615	100	15	13	10	8	5	3	2
75	168	120	24	21	18	14	11	8	4	275	615	120	14	11	9	6	4	2	1
75	168	140	22	19	16	12	9	5	2	275	615	140	12	10	7	5	3	1	0
INSTALLED SPACING OF DETECTORS																			
100	224	40	38	36	34	31	28	25	22	300	671	40	24	22	20	17	15	12	10
100	224	60	31	29	26	23	20	17	14	300	671	60	19	17	15	12	10	7	5
100	224	80	27	25	22	18	15	12	9	300	671	80	17	14	12	9	7	5	3
100	224	100	24	21	18	15	12	9	6	300	671	100	15	12	10	7	5	3	1
100	224	120	22	19	16	13	9	6	3	300	671	120	13	11	8	6	3	2	0
100	224	140	20	17	14	11	7	4	2	300	671	140	12	10	7	5	2	1	0
INSTALLED SPACING OF DETECTORS																			
125	280	40	35	33	31	28	25	22	19	325	727	40	23	21	19	16	14	11	9
125	280	60	29	27	24	21	18	15	12	325	727	60	19	17	14	12	9	7	5
125	280	80	25	22	19	16	13	11	8	325	727	80	16	14	11	9	6	4	2
125	280	100	22	19	16	13	10	7	5	325	727	100	14	12	9	7	4	2	1
125	280	120	20	17	14	11	8	5	3	325	727	120	13	10	8	5	3	1	0
125	280	140	18	15	12	9	6	4	1	325	727	140	11	9	7	4	2	1	0
INSTALLED SPACING OF DETECTORS																			
150	335	40	32	31	28	26	23	20	17	350	783	40	22	20	18	16	13	11	8
150	335	60	27	24	22	19	16	13	10	350	783	60	18	16	13	11	9	6	4
150	335	80	23	20	18	15	12	9	6	350	783	80	15	13	11	8	6	4	2
150	335	100	20	18	15	12	9	6	4	350	783	100	13	11	9	6	4	2	1
150	335	120	18	16	13	10	7	4	2	350	783	120	12	10	7	5	3	1	0
150	335	140	17	14	11	8	5	3	1	350	783	140	11	9	6	4	2	1	0
INSTALLED SPACING OF DETECTORS																			
175	391	40	30	29	26	24	21	18	15	375	839	40	22	20	17	15	12	10	8
175	391	60	25	23	20	17	15	12	9	375	839	60	17	15	13	10	8	6	4
175	391	80	21	19	16	14	11	8	6	375	839	80	15	13	10	8	5	3	2
175	391	100	19	16	14	11	8	6	3	375	839	100	13	11	8	6	4	2	1
175	391	120	17	15	12	9	6	4	2	375	839	120	12	9	7	5	3	1	0
175	391	140	16	13	10	7	5	2	1	375	839	140	11	8	6	3	2	0	0
INSTALLED SPACING OF DETECTORS																			
200	447	40	29	27	25	22	19	17	14	400	894	40	21	19	17	14	12	9	7
200	447	60	23	21	19	16	13	11	8	400	894	60	17	15	12	10	8	5	3
200	447	80	20	18	15	12	10	7	5	400	894	80	14	12	10	7	5	3	2
200	447	100	18	15	13	10	7	5	3	400	894	100	13	10	8	5	3	2	1
200	447	120	16	14	11	8	5	3	1	400	894	120	11	9	6	4	2	1	0
200	447	140	15	12	9	7	4	2	1	400	894	140	10	8	5	3	2	0	0

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(w)
 Q_d , Threshold Fire Size at Response: 2000 Btu/sec
 t_g : 300 Seconds to 1000 Btu/sec
 α : 0.011 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET							
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0	
INSTALLED SPACING OF DETECTORS																				
25	56	40	79	73	66	60	55	49	44	225	503	40	39	37	35	32	29	26	23	
25	56	60	64	56	50	44	39	33	29	225	503	60	32	30	27	24	21	18	15	
25	56	80	54	46	40	34	29	24	20	225	503	80	27	25	22	19	16	13	10	
25	56	100	47	40	33	28	23	18	14	225	503	100	24	21	18	15	12	9	6	
25	56	120	42	35	29	23	18	14	9	225	503	120	22	19	16	13	10	7	4	
25	56	140	38	31	25	20	15	10	6	225	503	140	20	17	14	11	8	5	2	
INSTALLED SPACING OF DETECTORS																				
50	112	40	67	63	58	54	49	44	40	250	559	40	37	36	33	30	28	25	22	
50	112	60	54	49	45	40	35	30	26	250	559	60	30	28	25	23	19	17	14	
50	112	80	46	41	36	31	27	22	18	250	559	80	26	24	21	18	15	12	9	
50	112	100	41	35	30	26	21	17	12	250	559	100	23	20	17	14	11	8	6	
50	112	120	36	31	26	21	17	13	8	250	559	120	21	18	15	12	9	6	3	
50	112	140	33	28	23	18	14	9	5	250	559	140	19	16	13	10	7	4	2	
INSTALLED SPACING OF DETECTORS																				
75	168	40	59	56	52	48	44	40	36	275	615	40	36	34	32	29	26	23	20	
75	168	60	48	44	40	36	32	28	24	275	615	60	29	27	24	21	18	16	13	
75	168	80	41	37	33	29	24	20	16	275	615	80	25	23	20	17	14	11	8	
75	168	100	36	32	28	23	19	15	11	275	615	100	22	19	17	14	11	8	5	
75	168	120	33	28	24	20	15	11	7	275	615	120	20	17	14	11	8	6	3	
75	168	140	30	25	21	17	12	9	5	275	615	140	18	15	12	9	7	4	2	
INSTALLED SPACING OF DETECTORS																				
100	224	40	53	51	48	44	41	37	33	300	671	40	35	33	30	28	25	22	19	
100	224	60	43	40	37	33	29	25	22	300	671	60	28	26	23	20	18	15	13	
100	224	80	37	34	30	26	22	19	15	300	671	80	24	22	19	16	13	10	8	
100	224	100	33	29	25	22	18	14	10	300	671	100	21	19	16	13	10	7	5	
100	224	120	30	26	22	18	14	10	7	300	671	120	19	16	14	11	8	5	3	
100	224	140	27	23	19	15	11	8	4	300	671	140	17	15	12	9	6	4	1	
INSTALLED SPACING OF DETECTORS																				
125	280	40	49	47	44	41	37	34	31	325	727	40	33	32	29	27	24	21	18	
125	280	60	40	37	34	31	27	23	20	325	727	60	27	25	22	20	17	14	11	
125	280	80	34	31	28	24	21	17	14	325	727	80	23	21	18	15	12	10	7	
125	280	100	30	27	23	20	16	13	9	325	727	100	20	18	15	12	10	7	4	
125	280	120	27	24	20	17	13	9	6	325	727	120	18	16	13	10	7	5	2	
125	280	140	25	22	18	14	11	7	4	325	727	140	17	14	11	8	6	3	1	
INSTALLED SPACING OF DETECTORS																				
150	335	40	46	44	41	38	35	32	28	350	783	40	32	31	28	26	23	20	17	
150	335	60	37	35	32	28	25	22	18	350	783	60	26	24	21	19	16	13	11	
150	335	80	32	29	26	23	19	16	12	350	783	80	22	20	17	15	12	9	7	
150	335	100	28	25	22	19	15	12	8	350	783	100	20	17	15	12	9	6	4	
150	335	120	26	22	19	15	12	9	5	350	783	120	18	15	12	10	7	4	2	
150	335	140	23	20	17	13	10	6	3	350	783	140	16	14	11	8	5	3	1	
INSTALLED SPACING OF DETECTORS																				
175	391	40	43	41	39	36	33	29	26	375	839	40	31	30	27	25	22	19	16	
175	391	60	35	33	30	27	23	20	17	375	839	60	25	23	21	18	15	13	10	
175	391	80	30	28	24	21	18	15	11	375	839	80	22	19	17	14	11	9	6	
175	391	100	27	24	21	17	14	11	8	375	839	100	19	17	14	11	9	6	4	
175	391	120	24	21	18	14	11	8	5	375	839	120	17	15	12	9	6	4	2	
175	391	140	22	19	16	12	9	6	3	375	839	140	16	13	10	8	5	3	1	
INSTALLED SPACING OF DETECTORS																				
200	447	40	41	39	37	34	31	28	25	400	894	40	30	29	26	24	21	18	16	
200	447	60	33	31	28	25	22	19	16	400	894	60	25	23	20	17	15	12	9	
200	447	80	29	26	23	20	17	14	10	400	894	80	21	19	16	13	11	8	5	
200	447	100	25	22	19	16	13	10	7	400	894	100	19	16	13	11	8	6	3	
200	447	120	23	20	17	14	10	7	4	400	894	120	17	14	11	9	6	4	2	
200	447	140	21	18	15	11	8	5	2	400	894	140	15	13	10	7	5	2	1	

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(x)
 Q_d , Threshold Fire Size at Response: 2000 Btu/sec
 t_g : 500 Seconds to 1000 Btu/sec
 α : 0.004 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET							
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0	
INSTALLED SPACING OF DETECTORS																				
25	56	40	92	82	74	67	60	54	49	225	503	40	50	48	45	42	38	35	31	
25	56	60	72	62	55	48	42	36	31	225	503	60	40	38	34	31	27	24	20	
25	56	80	61	51	43	37	32	26	22	225	503	80	35	31	28	24	21	17	14	
25	56	100	52	43	36	30	25	20	15	225	503	100	30	27	24	20	16	13	9	
25	56	120	46	37	31	25	20	15	10	225	503	120	27	24	20	17	13	10	6	
25	56	140	42	33	27	21	16	11	7	225	503	140	25	21	18	14	11	7	4	
INSTALLED SPACING OF DETECTORS																				
50	112	40	81	74	68	62	56	51	46	250	559	40	48	46	43	40	37	33	30	
50	112	60	64	57	51	45	40	35	30	250	559	60	39	36	33	30	26	23	19	
50	112	80	54	47	41	35	30	25	20	250	559	80	33	30	27	23	20	17	13	
50	112	100	47	40	34	29	23	19	14	250	559	100	29	26	23	19	16	12	9	
50	112	120	42	35	29	24	19	14	10	250	559	120	26	23	20	16	13	9	6	
50	112	140	38	31	25	20	15	11	6	250	559	140	24	21	17	14	10	7	4	
INSTALLED SPACING OF DETECTORS																				
75	168	40	73	68	63	58	53	48	43	275	615	40	46	44	41	38	35	32	29	
75	168	60	58	53	47	42	37	33	28	275	615	60	37	35	32	28	25	22	19	
75	168	80	49	44	38	33	28	24	19	275	615	80	32	29	26	22	19	16	13	
75	168	100	43	37	32	27	22	18	13	275	615	100	28	25	22	18	15	12	8	
75	168	120	39	33	27	22	18	13	9	275	615	120	25	22	19	15	12	9	5	
75	168	140	35	29	24	19	14	10	6	275	615	140	23	20	16	13	10	6	3	
INSTALLED SPACING OF DETECTORS																				
100	224	40	67	63	58	54	50	45	41	300	671	40	45	43	40	37	34	31	27	
100	224	60	54	49	45	40	35	31	27	300	671	60	36	34	31	27	24	21	18	
100	224	80	46	41	36	31	27	23	18	300	671	80	31	28	25	22	18	15	12	
100	224	100	40	35	30	26	21	17	13	300	671	100	27	24	21	18	14	11	8	
100	224	120	36	31	26	21	17	13	9	300	671	120	24	21	18	15	11	8	5	
100	224	140	33	27	23	18	14	10	6	300	671	140	22	19	16	13	9	6	3	
INSTALLED SPACING OF DETECTORS																				
125	280	40	62	59	55	51	47	43	38	325	727	40	43	41	39	36	33	30	26	
125	280	60	50	46	42	38	33	29	25	325	727	60	35	32	30	26	23	20	17	
125	280	80	43	38	34	30	25	21	17	325	727	80	30	27	24	21	18	14	11	
125	280	100	37	33	29	24	20	16	12	325	727	100	26	23	20	17	14	11	8	
125	280	120	34	29	25	20	16	12	8	325	727	120	24	21	17	14	11	8	5	
125	280	140	31	26	22	17	13	9	5	325	727	140	22	19	15	12	9	6	3	
INSTALLED SPACING OF DETECTORS																				
150	335	40	58	55	52	48	44	40	36	350	783	40	42	40	37	35	31	28	25	
150	335	60	47	44	40	36	32	28	24	350	783	60	34	31	29	26	22	19	16	
150	335	80	40	36	32	28	24	20	16	350	783	80	29	26	23	20	17	14	11	
150	335	100	35	31	27	23	19	15	11	350	783	100	25	23	19	16	13	10	7	
150	335	120	32	27	23	19	15	11	8	350	783	120	23	20	17	14	11	7	5	
150	335	140	29	25	20	16	12	9	5	350	783	140	21	18	15	12	8	5	3	
INSTALLED SPACING OF DETECTORS																				
175	391	40	55	53	49	46	42	38	35	375	839	40	41	39	36	33	30	27	24	
175	391	60	44	41	38	34	30	26	23	375	839	60	33	31	28	25	22	19	16	
175	391	80	38	34	31	27	23	19	15	375	839	80	28	25	22	19	16	13	10	
175	391	100	33	30	26	22	18	14	11	375	839	100	25	22	19	16	13	10	7	
175	391	120	30	26	22	18	15	11	7	375	839	120	22	19	16	13	10	7	4	
175	391	140	27	23	20	16	12	8	4	375	839	140	20	17	14	11	8	5	2	
INSTALLED SPACING OF DETECTORS																				
200	447	40	52	50	47	44	40	36	33	400	894	40	40	38	35	32	29	27	24	
200	447	60	42	39	36	32	29	25	21	400	894	60	32	30	27	24	21	18	15	
200	447	80	36	33	29	26	22	18	15	400	894	80	27	25	22	19	16	13	10	
200	447	100	32	28	25	21	17	14	10	400	894	100	24	21	18	15	12	9	6	
200	447	120	29	25	21	18	14	10	7	400	894	120	22	19	16	13	10	7	4	
200	447	140	26	22	19	15	11	8	4	400	894	140	20	17	14	11	8	5	2	

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-3.2.4(y)
 Q_d , Threshold Fire Size at Response: 2000 Btu/sec
 t_g : 600 Seconds to 1000 Btu/sec
 α : 0.003 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET							
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0	
			INSTALLED SPACING OF DETECTORS										INSTALLED SPACING OF DETECTORS							
25	56	40	96	85	78	68	62	56	50	225	503	40	54	52	49	45	42	38	34	
25	56	60	75	64	56	49	43	37	32	225	503	60	44	41	37	34	30	26	22	
25	56	80	63	52	44	38	32	27	22	225	503	80	37	34	30	26	23	19	15	
25	56	100	54	44	37	31	25	20	15	225	503	100	33	29	25	22	18	14	11	
25	56	120	48	38	31	25	20	15	11	225	503	120	30	26	22	18	14	11	7	
25	56	140	43	34	27	21	16	12	7	225	503	140	27	23	19	15	12	8	4	
50	112	40	86	78	71	64	58	53	48	250	559	40	52	50	47	43	40	36	33	
50	112	60	68	60	53	47	41	36	31	250	559	60	42	39	36	32	29	25	21	
50	112	80	57	49	42	36	31	26	21	250	559	80	36	33	29	25	22	18	15	
50	112	100	49	41	35	29	24	19	15	250	559	100	32	28	24	21	17	14	10	
50	112	120	44	36	30	24	19	15	10	250	559	120	28	25	21	17	14	10	7	
50	112	140	40	32	26	21	16	11	7	250	559	140	26	22	19	15	11	8	4	
75	168	40	78	72	66	61	55	50	45	275	615	40	50	48	45	42	39	35	32	
75	168	60	62	56	50	44	39	34	29	275	615	60	41	38	35	31	28	24	21	
75	168	80	52	46	40	34	30	25	20	275	615	80	35	32	28	25	21	18	14	
75	168	100	46	39	33	28	23	19	14	275	615	100	30	27	24	20	17	13	10	
75	168	120	41	34	28	23	19	14	10	275	615	120	27	24	20	17	13	10	6	
75	168	140	37	30	25	20	15	11	6	275	615	140	25	22	18	14	11	7	4	
100	224	40	72	67	62	57	52	48	43	300	671	40	49	47	44	40	37	34	30	
100	224	60	57	52	47	42	37	32	28	300	671	60	39	37	33	30	27	23	20	
100	224	80	49	43	38	33	28	24	19	300	671	80	33	31	27	24	20	17	13	
100	224	100	43	37	32	27	22	18	13	300	671	100	29	26	23	19	16	12	9	
100	224	120	38	32	27	22	18	13	9	300	671	120	26	23	20	16	13	9	6	
100	224	140	35	29	24	19	14	10	6	300	671	140	24	21	17	14	10	7	4	
125	280	40	67	63	59	54	50	45	41	325	727	40	47	45	42	39	36	33	29	
125	280	60	54	49	45	40	35	31	27	325	727	60	38	35	32	29	26	22	19	
125	280	80	46	41	36	31	27	23	18	325	727	80	32	30	26	23	20	16	13	
125	280	100	40	35	30	26	21	17	13	325	727	100	29	25	22	19	15	12	9	
125	280	120	36	31	26	21	17	13	9	325	727	120	26	22	19	16	12	9	6	
125	280	140	33	27	23	18	14	10	6	325	727	140	23	20	17	13	10	7	3	
150	335	40	63	60	56	52	47	43	39	350	783	40	46	44	41	38	35	32	28	
150	335	60	51	47	42	38	34	30	26	350	783	60	37	34	31	28	25	22	18	
150	335	80	43	39	34	30	26	22	18	350	783	80	31	29	25	22	19	16	12	
150	335	100	38	33	29	25	20	16	12	350	783	100	28	25	21	18	15	12	8	
150	335	120	34	29	25	21	16	12	8	350	783	120	25	22	18	15	12	9	5	
150	335	140	31	26	22	17	13	9	5	350	783	140	23	20	16	13	9	6	3	
175	391	40	60	57	53	49	45	41	37	375	839	40	44	42	40	37	34	31	27	
175	391	60	48	44	41	36	32	28	24	375	839	60	36	33	30	27	24	21	18	
175	391	80	41	37	33	29	25	21	17	375	839	80	31	28	25	21	18	15	12	
175	391	100	36	32	28	24	19	15	12	375	839	100	27	24	21	18	14	11	8	
175	391	120	32	28	24	20	16	12	8	375	839	120	24	21	18	15	11	8	5	
175	391	140	29	25	21	17	13	9	5	375	839	140	22	19	16	12	9	6	3	
200	447	40	57	54	51	47	43	40	36	400	894	40	43	41	39	36	33	30	26	
200	447	60	46	43	39	35	31	27	23	400	894	60	35	32	30	26	23	20	17	
200	447	80	39	35	32	28	24	20	16	400	894	80	30	27	24	21	18	14	11	
200	447	100	34	30	26	23	19	15	11	400	894	100	26	23	20	17	14	11	8	
200	447	120	31	27	23	19	15	11	7	400	894	120	23	21	17	14	11	8	5	
200	447	140	28	24	20	16	12	8	5	400	894	140	21	18	15	12	9	6	3	

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

B-3.2.5 Installed spacings listed as zero in the tables indicate that the detector chosen will not respond within the design objectives.

[From NFPA 72E - 1990, Appendix C]

B-3.2.6 Example.

Input:

Ceiling height: 8 ft (2.4 m)

Detector type: Fixed temperature 135°F (57°C)

UL listed spacing: 30 ft (9.1 m)

Fire:

Q_d : 500 Btu/sec (527 kW)

Fire growth rate: Slow

t_g : 600 sec

α : 0.003 Btu/sec³

Environmental conditions:

T_o : 55°F (12.8°C)

Required installed spacing:

From Table B-3.2.2, the detector time constant (τ_o) is 80 seconds.

$$(RTI = 80 \sqrt{5} = 180 \text{ ft}^{1/2} \text{ sec}^{1/2})$$

$$\Delta T = T_s - T_o = 135 - 55 = 80^\circ\text{F}$$

From Table B-3.2.4(j):

For $\tau_o = 75$ sec — spacing = 17 ft

For $\tau_o = 100$ sec — spacing = 16 ft

By interpolation:

Spacing = $17 - [(17-16/80-75/100-75)] = 16.8$, round to 17.0 ft

NOTE: Interpolation for $\tau_o = 80$ seconds was not required, but was included for demonstration. If the ceiling height is 16 ft, the required spacing would be 8.8 ft. Using the detector in the above example, at a ceiling height of 28 ft, no practical spacing would ensure detection of the fire at the threshold fire size of 500 Btu/sec. A more sensitive detector would need to be used. Alternatively, the design objectives could be changed to accept a larger fire. These results clearly illustrate the need to consider ceiling height in the design of a detection system.

For SI Units: 1 ft = 0.305 m.

[From NFPA 72E - 1990, C-3-2.5 modified]

B-3.3 Rate-of-Rise Heat Detector Spacing.

B-3.3.1 Tables B-3.3.2(a) and B-3.3.2(b) are to be used to determine the installed spacing of rate-of-rise heat detectors. The analytical basis for the tables is presented in Section B-6. This section shows how the tables are to be used.

B-3.3.2 Table B-3.3.2(a) provides installed spacings for rate-of-rise heat detectors required to achieve detection for a specific threshold for size, fire growth rate, and ceiling height. This table may be used directly to determine installed spacings for 50-ft (15.2-m) listed spacing detectors.

[From NFPA 72E - 1990, C-5-3.4 modified]

B-3.3.2.1 Tables B-3.3.2(a) and B-3.3.2(b) use the following values for t_g :

Fast fire growth rate, $t_g = 150$ seconds

Medium fire growth rate, $t_g = 300$ seconds

Slow fire growth rate, $t_g = 600$ seconds.

[From NFPA 72E - 1990, Appendix C]

B-3.3.3 For rate-of-rise heat detectors with a listed spacing of other than 50 ft (15.2 m), installed spacing obtained from Table B-3.3.2(a) must be multiplied by the modifier shown in Table B-3.3.2(b) for the appropriate listed spacing and fire growth rate. This takes into account the difference in sensitivity between the detector and a 50-ft (15.2-m) listed detector.

B-3.3.4 Having determined the threshold fire size (*see* B-2.2.2), the fire growth rate (*see* B-2.2.3), the detector's listed spacing, and the ceiling height, use Table B-3.3.2(a) to determine the corrected spacing for 50-ft (15.2-m) listed detectors. Use Table B-3.3.2(b) to determine the spacing modifier. Find the required installed spacing by multiplying the corrected spacing by the spacing modifier.

[From NFPA 72E - 1990, Appendix C modified]

B-3.3.5 Example.

Input:

Ceiling height: 12 ft (3.7 m)

Detector type: Combination rate-of-rise, fixed temperature 30-ft (9.1-m) listed spacing

Q_d : 500 Btu/sec

Fire growth rate: Medium

Spacing:

From Table B-3.3.2(a), installed spacing = 18 ft (5.5 m)

From Table B-3.3.2(b), spacing modifier = 0.86

Installed spacing = $18 \times 0.86 = 15.5$ ft (4.7 m)

NOTE: This answer may be rounded to either 15 ft (4.6 m) or 16 ft (4.9 m). Use of 15 ft (4.6 m) would be slightly conservative. However, depending on field conditions, use of 16 ft (4.9 m) may fit the space better.

[From NFPA 72E - 1990, C-5-3.4 modified]

B-3.4 Design Curves.

B-3.4.1 The design curves [Figures B-3.4.1 (a) through (i)] may also be used to determine the installed spacings of heat detectors. However, they are not as comprehensive as the tables, because the tables include additional fire growth rates, fire sizes, and detector sensitivities.

B-3.4.1.1 Fixed-Temperature Heat Detectors. Figures B-3.4.1(a) through (f) can be used directly to determine the installed spacing for fixed-temperature heat detectors having listed spacings of 30 ft and 50 ft (9.1 m and 15.2 m), respectively, where the difference between the detectors' rated temperature (T_s) and the ambient temperature (T_o) is 65°F (36°C). When ΔT is not 65°F (36°C), tables previously discussed in B-3.3 should be used.

[From NFPA 72E - 1990, Appendix C modified]

B-3.4.1.2 Rate-of-Rise Heat Detectors. Figures B-3.4.1(g), (h), and (i) can be used directly to determine the installed spacing for rate-of-rise heat detectors having a listed spacing of 50 ft (15.2 m).

**B-3.3.2(a) Installed Spacings for Rate-of-Rise Heat Detectors
(Threshold Fire Size and Growth Rate)**

Ceiling Height (ft)	$Q_d = 1000$ Btu/sec			$Q_d = 750$ Btu/sec			$Q_d = 500$ Btu/sec			$Q_d = 250$ Btu/sec			$Q_d = 100$ Btu/sec		
	s	m	f	s	m	f	s	m	f	s	m	f	s	m	f
4	28	32	32	26	28	27	22	24	23	16	17	16	11	11	10
5	27	31	31	25	27	27	21	23	22	15	16	15	10	10	9
6	26	30	31	24	26	27	20	22	22	15	15	15	9	9	9
7	25	29	30	23	26	26	19	21	21	14	14	14	9	9	8
8	24	29	30	22	25	26	18	21	21	13	13	14	8	8	8
9	23	28	29	21	24	25	17	20	20	12	13	13	7	7	7
10	22	27	29	20	23	25	16	19	20	12	12	13	7	7	7
11	21	27	28	18	23	24	15	19	19	11	12	12	6	6	6
12	20	26	26	17	22	24	15	18	19	10	11	12	5	5	5
13	19	25	27	16	22	23	14	18	18	9	11	11	5	5	5
14	18	24	27	15	21	22	13	17	18	9	10	11		4	
15	16	24	26	14	20	21	12	17	17	8	10	10			
16	15	23	25	13	19	21	11	16	16	7	9	10			
17	14	22	25	12	19	20	10	15	16	6	9	9			
18	13	22	24	11	18	20	9	14	15		8	8			
19	12	21	23	10	17	19	8	14	14		8	8			
20	11	20		9	16	19	7	13	14		7	7			
21	10	19		8	15	18		12	13		7				
22	9	19		7	15	17		12	13		6				
23	8	18			14	17		11	12		5				
24		17			13	16		11	11		5				
25		16			12	15		10	10		4				
26		15			12	15		9	10						
27		14			11	14		9							
28		13			11	13		8							
29		13			10			8							
30		12			10			7							

s = slow fire, m = medium fire, f = fast fire.

Table B-3.3.2(b) Spacing Modifiers for Rate-of-Rise Heat Detectors

Listed Spacing (ft)	Fire Growth Rate		
	Slow	Medium	Fast
15	0.57	0.55	0.45
20	0.72	0.63	0.62
25	0.84	0.78	0.76
30	0.92	0.86	0.85
40	0.98	0.96	0.95
50	1.00	1.00	1.00
70	1.00	1.01	1.02

For SI Units: 1 ft = 0.305 m.

B-3.4.2 To use the curves, the same format must be followed as with tables. The designer must first determine how large a fire can be tolerated before detection can occur. This is the threshold fire size, Q_d . Curves are presented, in most cases, for values of $Q_d = 1000, 750, 500, 250$, and 100 Btu/sec (1055, 791, 527, 264, and 105 kW). Interpolation between values of Q_d on a given graph is allowable. Table B-2.2.2.1(a) and Table B-2.2.2.3 also contain examples of various fuels and their fire growth rates under specified conditions.

[From NFPA 72E - 1990, C-3-4.1.3 modified]

B-3.4.3 Once a threshold size and expected fire growth rate have been selected, an installed detector spacing can be obtained from Figures B-3.4.1(a) through (i) for a cer-

tain detector's listed spacing, ambient temperature, and ceiling height. As in B-3.2.6, to determine the installed spacing of 135°F (57°C) fixed temperature heat detectors with a listed spacing of 30 ft (9.1 m) and to detect a slowly developing fire at a threshold fire size of 500 Btu/sec (527 kW) in a room 10 ft (3 m) high with an ambient temperature of 70°F (21°C), the following procedure is used.

[From NFPA 72E - 1990, C-3-4.1.4 modified]

B-3.4.3.1 Example 1.

Input:

Ceiling height: 10 ft (3 m)

Detector type: Fixed temperature 135°F (57°C)

UL listed spacing: 30 ft (9.1 m)

Fire:

Q_d : 500 Btu/sec (527 kW)

Fire growth rate: Slow

t_g : 600 sec

Environmental conditions:

T_o : 70°F (21°C)

$\Delta T = 135 - 70 = 65^\circ\text{F}$ (36°C)

Required installed spacing:

From Figure B-3.4.1(a), use an installed spacing of 18 ft (5.2 m) (17.5 ft rounded to 18 ft).

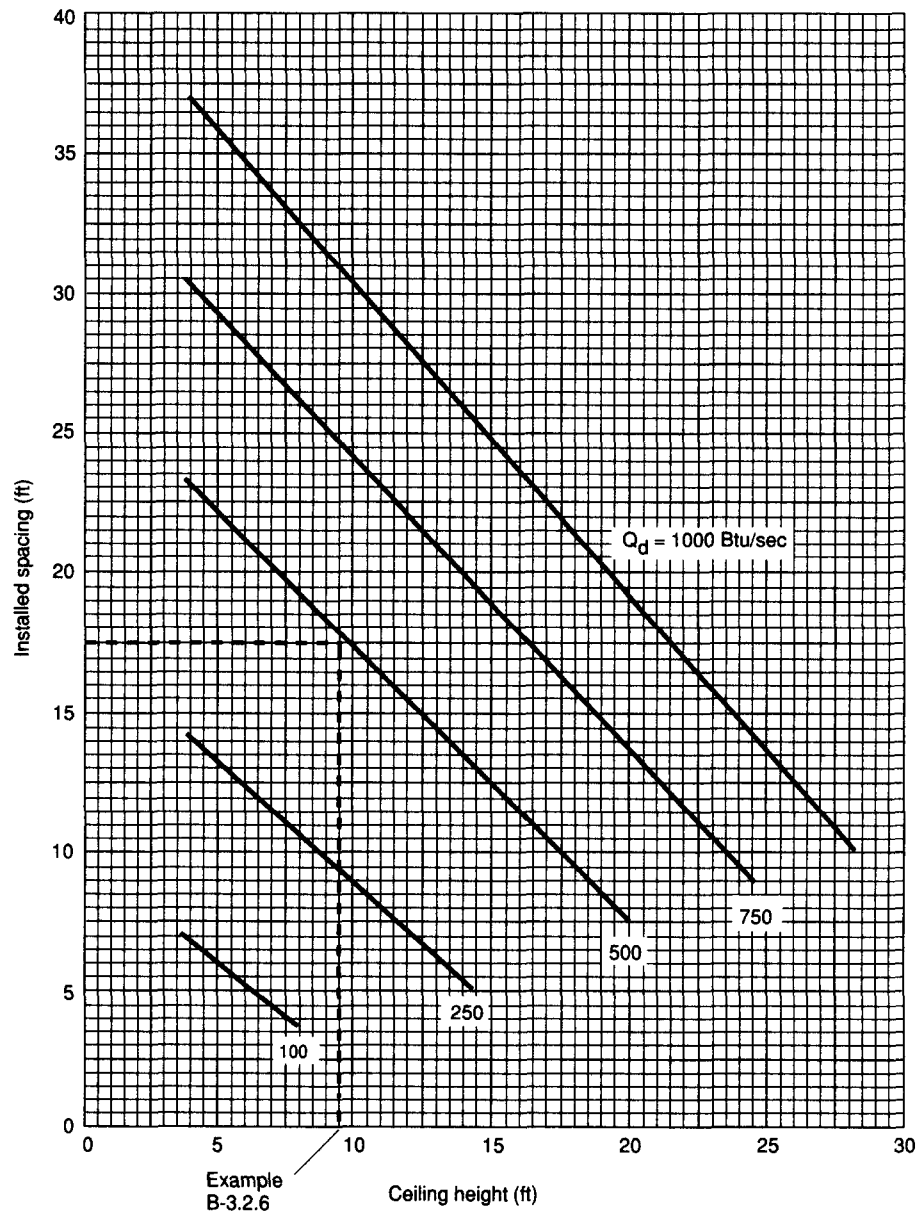


Figure B-3.4.1(a) Heat detector, fixed temperature, 30-ft (9.1-m) listed spacing, slow fire. $\Delta T = 65^\circ\text{F}$ (36.1°C).

[From NFPA 72E - 1990, Appendix C modified]

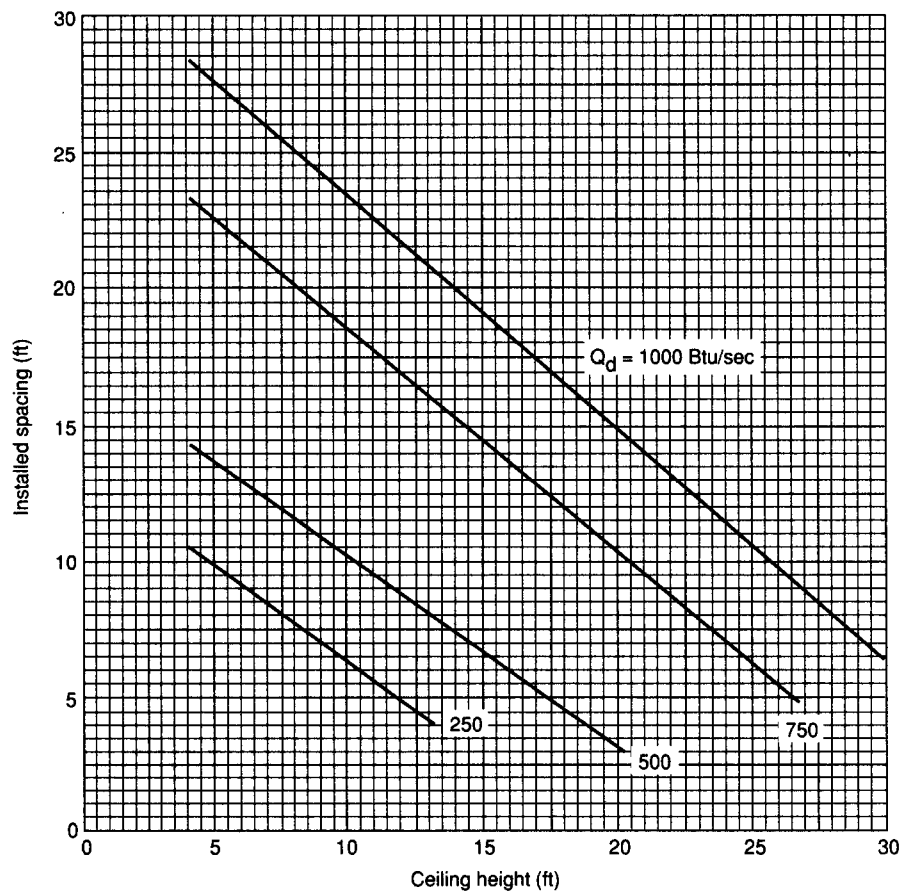


Figure B-3.4.1(b) Heat detector, fixed temperature, 30-ft (9.1-m) listed spacing, medium fire. $\Delta T = 65^\circ\text{F}$ (36°C).

[From NFPA 72E - 1990, Appendix C modified]

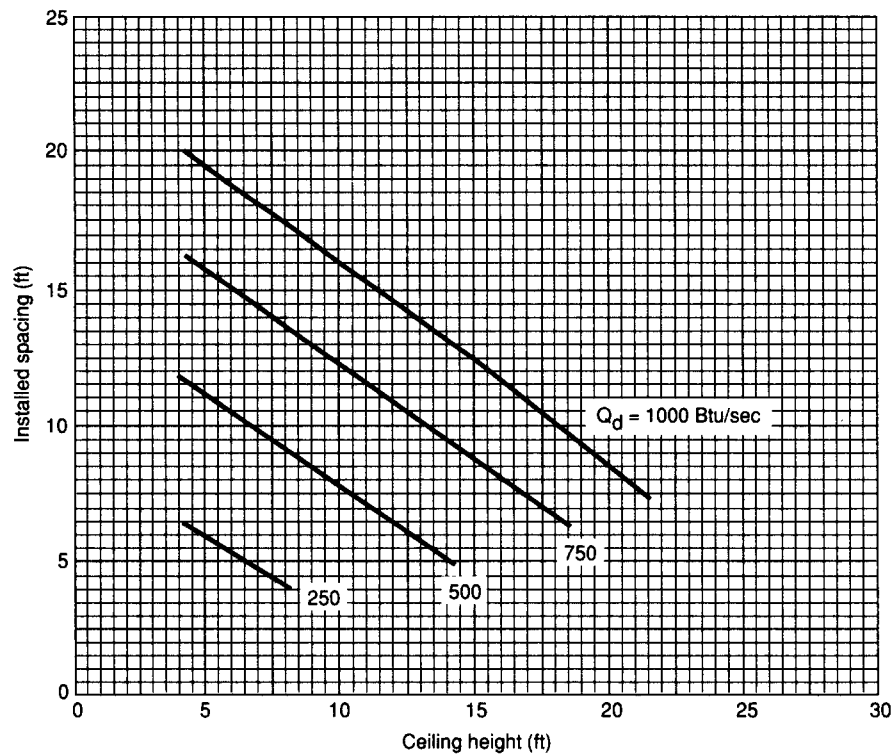


Figure B-3.4.1(c) Heat detector, fixed temperature, 30-ft (9.1-m) listed spacing, fast fire. $\Delta T = 65^\circ\text{F}$ (36°C).

[From NFPA 72E - 1990, Appendix C modified]

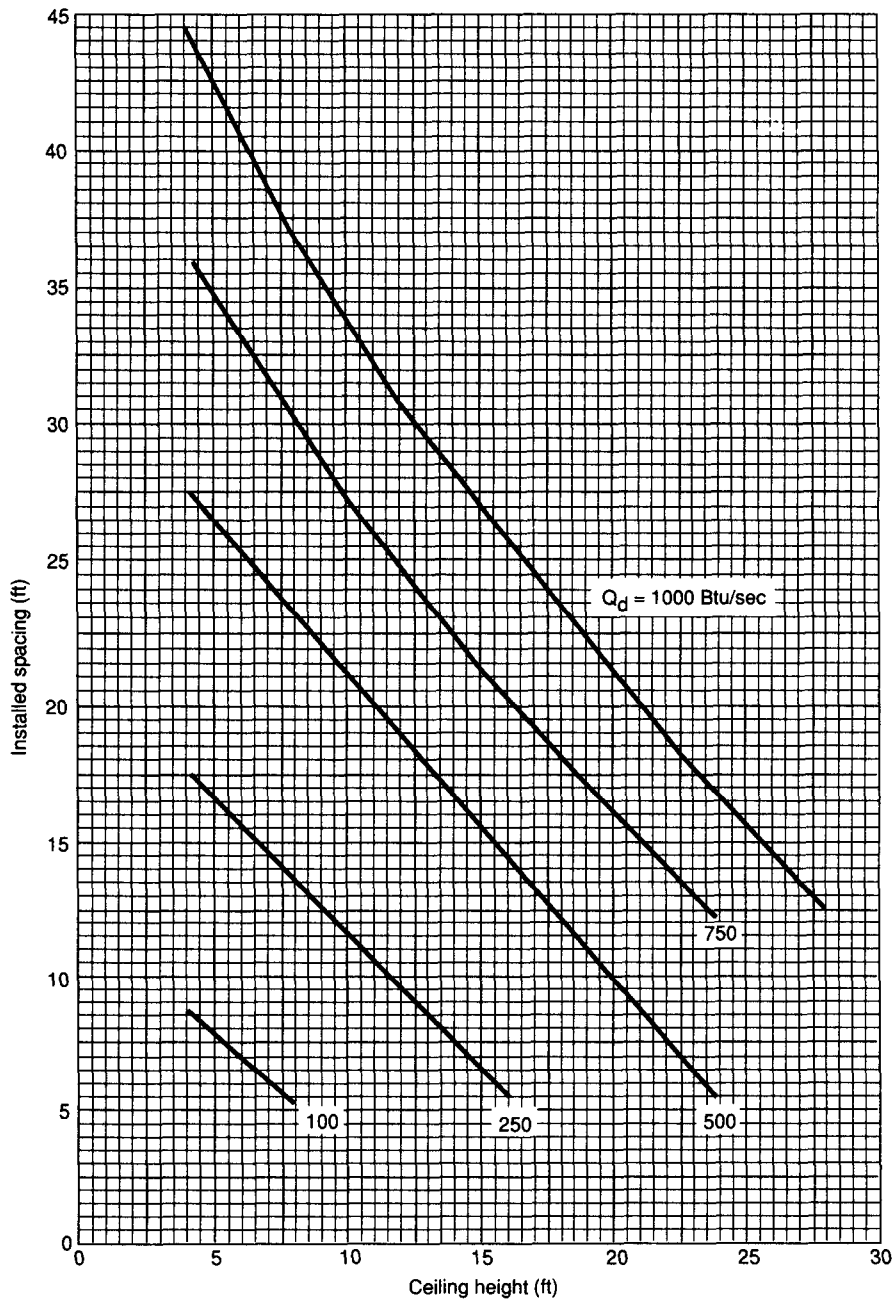


Figure B-3.4.1(d) Heat detector, fixed temperature, 50-ft (15.2-m) listed spacing, slow fire. $\Delta T = 65^\circ\text{F}$ (36°C).

[From NFPA 72E - 1990, Appendix C modified]

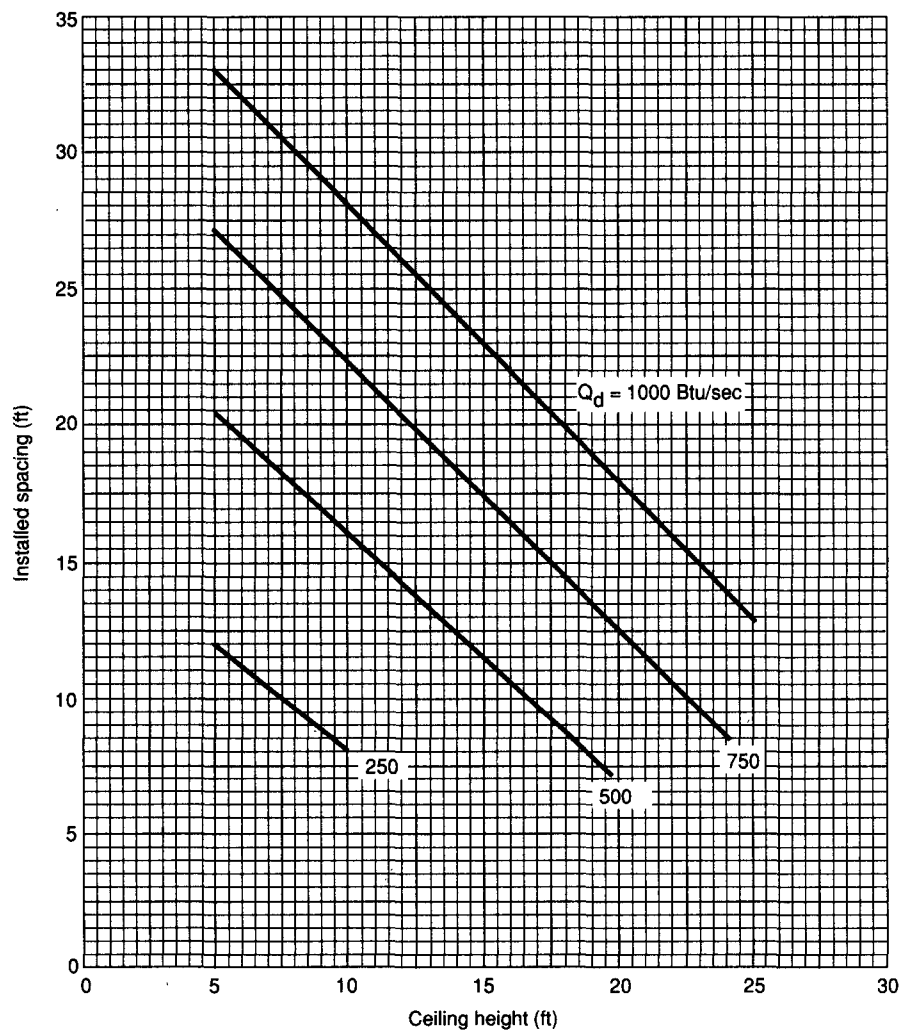


Figure B-3.4.1(e) Heat detector, fixed temperature, 50-ft (15.2-m) listed spacing, medium fire. $\Delta T = 65^\circ\text{F}$ (36°C).

[From NFPA 72E - 1990, Appendix C modified]

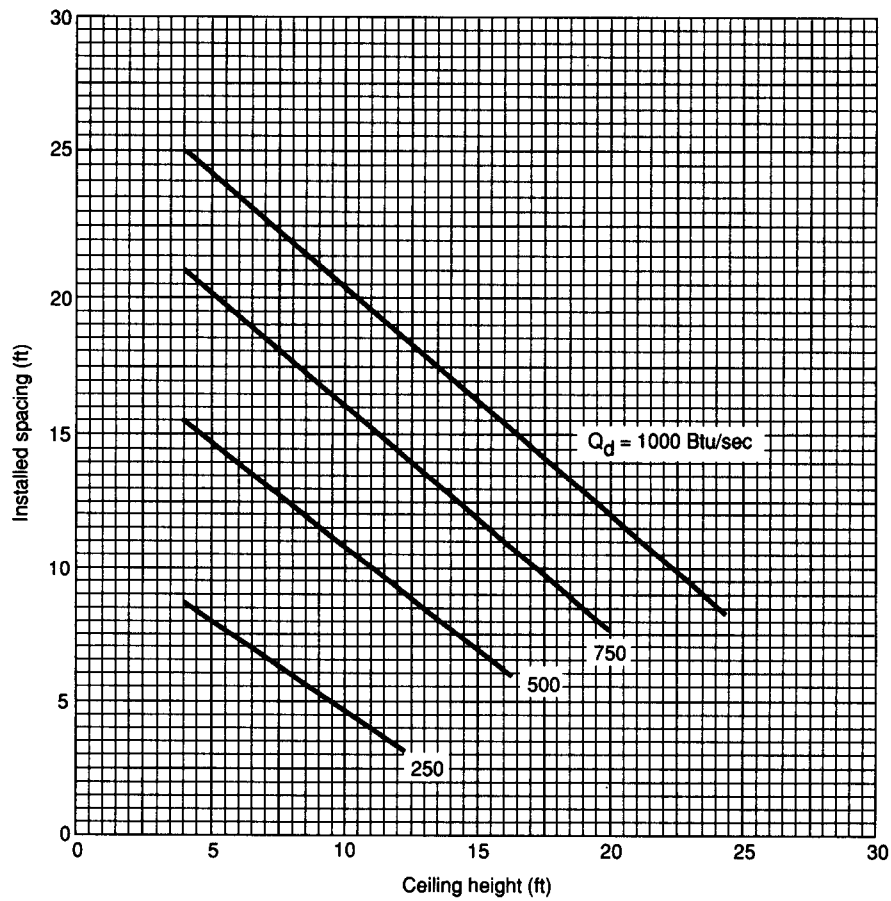


Figure B-3.4.1(f) Heat detector, fixed temperature, 50-ft (15.2-m) listed spacing, fast fire. $\Delta T = 65^\circ\text{F}$ (36°C).

[From NFPA 72E - 1990, Appendix C modified]

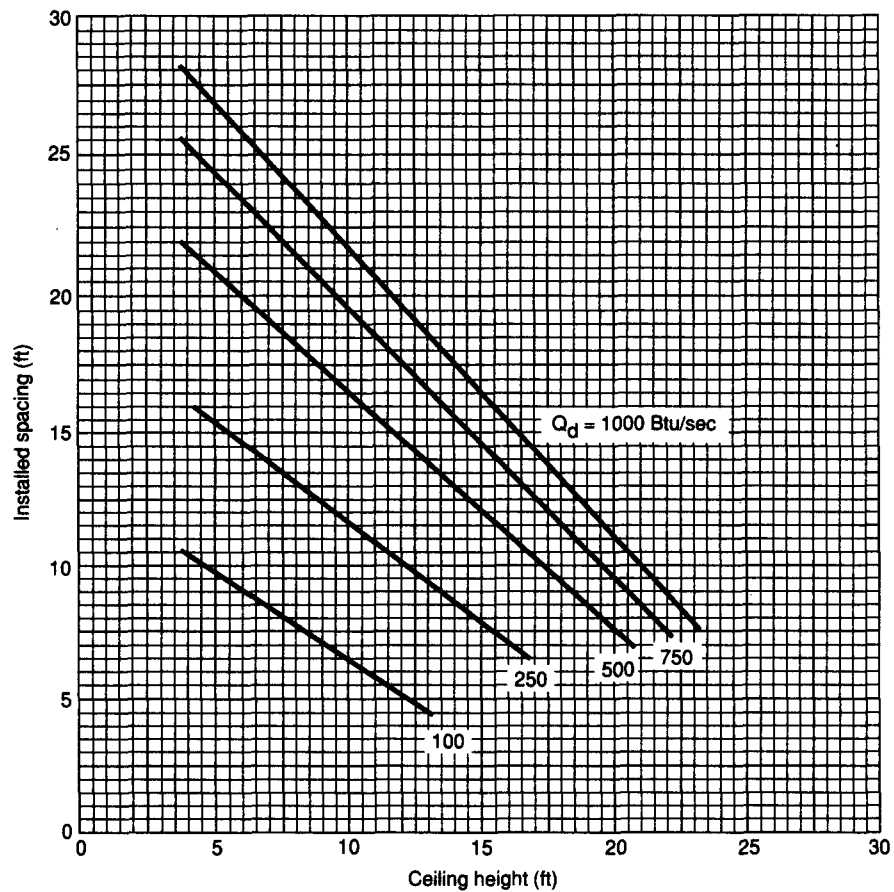


Figure B-3.4.1(g) Heat detector, rate-of-rise, 50-ft (15.2-m) listed spacing, slow fire.

[From NFPA 72E - 1990, Appendix C modified]

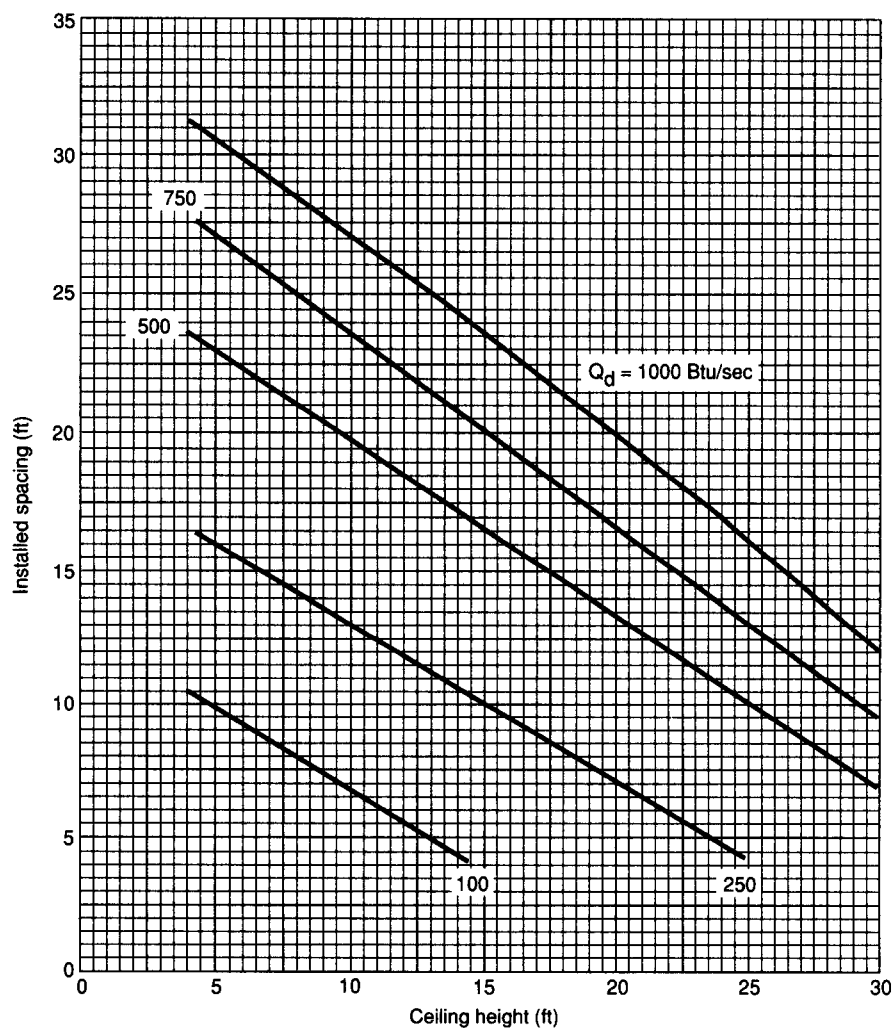


Figure B-3.4.1(h) Heat detector, rate-of-rise, 50-ft (15.2-m) listed spacing, medium fire.

[From NFPA 72E - 1990, Appendix C modified]

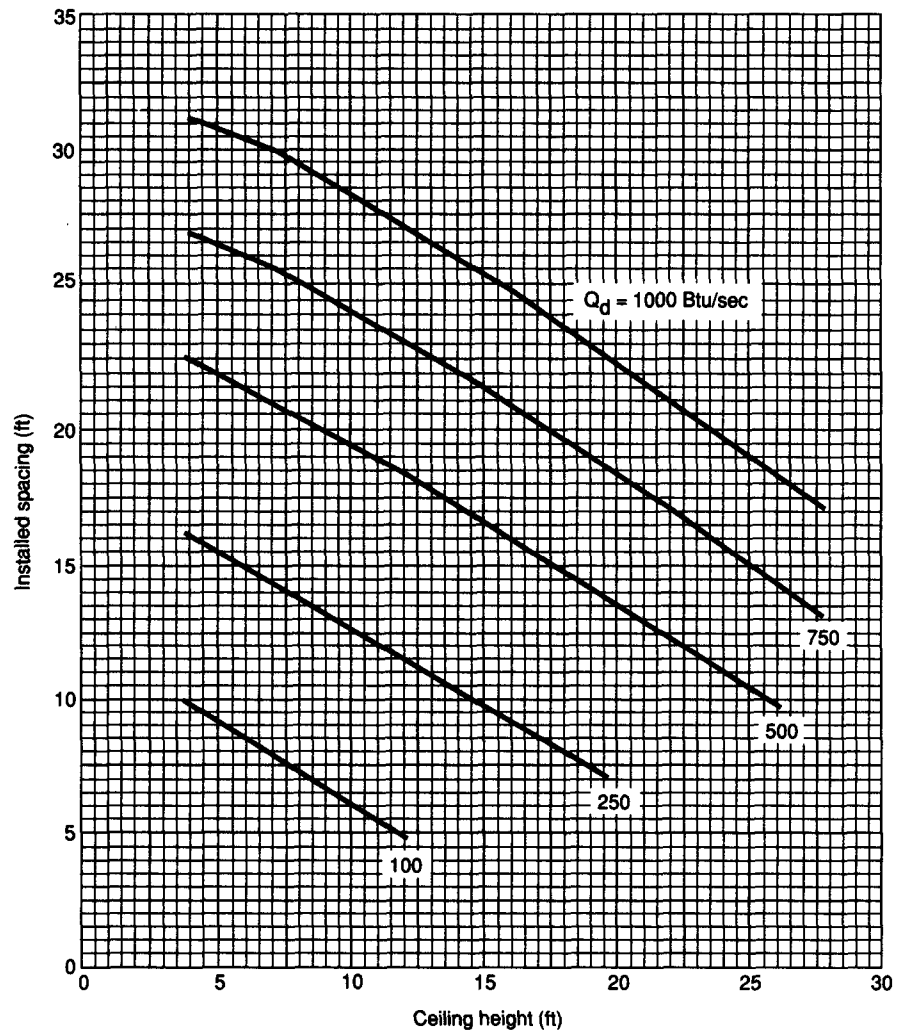


Figure B-3.4.1(i) Heat detector, rate-of-rise, 50-ft (15.2-m) listed spacing, fast fire.

[From NFPA 72E - 1990, Appendix C modified]

Note that if the ceiling height is 15 ft (4.6 m), the same graph gives an installed spacing of 12 ft (3.5 m). A ceiling height of 20 ft (6.1 m) would require a spacing of 8 ft (2.4 m). This change in spacing clearly illustrates the need to consider ceiling height in the design of a detection system.

[From NFPA 72E - 1990, Appendix C modified]

B-3.4.3.2 Example 2.

Input:

Ceiling height: 10 ft (3 m)

Detector type: Combination rate-of-rise and fixed temperature

UL listed spacing: 50 ft (15.2 m)

Fire:

Q_d : 500 Btu/sec (527 kW)

Fire growth rate: Fast

t_g : 150 sec

Environmental conditions:

T_o : 70°F (21°C)

ΔT : 65°F (36°C)

Spacing:

From Figure B-3.4.1(i), use an installed spacing of 20 ft (5.8 m) (19.5 ft rounded to 20 ft).

A 30-ft (9.1-m) fixed temperature detector would require a 7.5-ft (2.5-m) spacing.

If the fire growth rate was slow, as in Example 1, the rate-of-rise detector would require an installed spacing of 16 ft (4.88 m).

[From NFPA 72E - 1990, C-3-4.1.5 modified]

B-4 Analysis of Existing Heat Detection Systems.

B-4.1 Tables B-4.1(a) through (nn) can be used to determine the size fire (heat release rate) that existing fixed-temperature heat detection systems will respond to. Table B-4.1 is an index to Tables B-4.1(a) through (nn).

The use of the analysis tables is similar to that described for new designs. The difference is that the spacing of the existing detectors must be known. An estimate of the fire intensity coefficient (α) or the fire growth time (t_g) must also be made for the fuel that is expected to burn.

[From NFPA 72E - 1990, Appendix C modified]

Table B-4.1 Analysis Tables Index

	Installed Spacing (ft)	Fire Growth Rate (sec) t_g	Alpha (Btu/sec ³) α
Table B-4.1(a)	8	50	0.400
Table B-4.1(b)	8	150	0.044
Table B-4.1(c)	8	300	0.011
Table B-4.1(d)	8	500	0.004
Table B-4.1(e)	8	600	0.003
Table B-4.1(f)	10	50	0.400
Table B-4.1(g)	10	150	0.044
Table B-4.1(h)	10	300	0.011
Table B-4.1(i)	10	500	0.004
Table B-4.1(j)	10	600	0.003
Table B-4.1(k)	12	50	0.400
Table B-4.1(l)	12	150	0.044
Table B-4.1(m)	12	300	0.011
Table B-4.1(n)	12	500	0.004
Table B-4.1(o)	12	600	0.003
Table B-4.1(p)	15	50	0.400
Table B-4.1(q)	15	150	0.044
Table B-4.1(r)	15	300	0.011
Table B-4.1(s)	15	500	0.004
Table B-4.1(t)	15	600	0.003
Table B-4.1(u)	20	50	0.400
Table B-4.1(v)	20	150	0.044
Table B-4.1(w)	20	300	0.011
Table B-4.1(x)	20	500	0.004
Table B-4.1(y)	20	600	0.003
Table B-4.1(z)	25	50	0.400
Table B-4.1(aa)	25	150	0.044
Table B-4.1(bb)	25	300	0.011
Table B-4.1(cc)	25	500	0.004
Table B-4.1(dd)	25	600	0.003
Table B-4.1(ee)	30	50	0.400
Table B-4.1(ff)	30	150	0.044
Table B-4.1(gg)	30	300	0.011
Table B-4.1(hh)	30	500	0.004
Table B-4.1(ii)	30	600	0.003
Table B-4.1(jj)	50	50	0.400
Table B-4.1(kk)	50	150	0.044
Table B-4.1(ll)	50	300	0.011
Table B-4.1(mm)	50	500	0.004
Table B-4.1(nn)	50	600	0.003

[From NFPA 72E - 1990, Appendix C modified]

Table B-4.1(a)
Installed Spacing of Heat Detector: 8 feet
 t_g : 50 Seconds to 1000 Btu/sec
 α : 0.400 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)									
25	56	40	300	402	535	668	832	1016	1219	225	503	40	968	1337	1754	2111	2537	2991	3468
25	56	60	368	508	687	877	1106	1365	1657	225	503	60	1254	1747	2294	2774	3342	3949	4590
25	56	80	450	618	838	1102	1381	1722	2110	225	503	80	1527	2129	2794	3392	4096	4851	5653
25	56	100	512	716	985	1308	1661	2090	2585	225	503	100	1794	2494	3268	3980	4819	5720	6681
25	56	120	573	815	1132	1517	1949	2473	3082	225	503	120	2057	2845	3724	4549	5520	6567	7689
25	56	140	654	919	1282	1730	2265	2870	3601	225	503	140	2317	3185	4168	5104	6206	7400	8683
50	112	40	422	571	755	926	1136	1366	1614	250	559	40	1011	1417	1865	2247	2698	3177	3681
50	112	60	546	738	976	1211	1496	1811	2157	250	559	60	1339	1866	2447	2955	3556	4197	4873
50	112	80	642	883	1181	1484	1846	2251	2699	250	559	80	1637	2278	2982	3614	4358	5155	5999
50	112	100	754	1033	1383	1752	2194	2692	3248	250	559	100	1928	2669	3489	4241	5126	6076	7087
50	112	120	865	1179	1582	2018	2542	3138	3810	250	559	120	2215	3046	3890	4842	5870	6972	8150
50	112	140	928	1305	1773	2318	2895	3592	4386	250	559	140	2499	3412	4356	5431	6597	7852	9197
75	168	40	542	722	908	1137	1389	1659	1948	275	615	40	1093	1513	1981	2380	2854	3358	3887
75	168	60	702	932	1219	1492	1826	2193	2589	275	615	60	1424	1982	2596	3131	3763	4437	5147
75	168	80	813	1111	1472	1824	2245	2710	3217	275	615	80	1746	2422	3165	3829	4612	5449	6334
75	168	100	931	1289	1718	2146	2656	3221	3844	275	615	100	2061	2840	3618	4488	5424	6421	7479
75	168	120	1016	1451	1955	2464	3063	3733	4475	275	615	120	2371	3242	4128	5129	6209	7365	8597
75	168	140	1149	1629	2193	2778	3470	4247	5115	275	615	140	2679	3633	4622	5753	6977	8291	9697
100	224	40	625	841	1101	1332	1614	1920	2246	300	671	40	1151	1595	2089	2508	3005	3533	4087
100	224	60	802	1087	1427	1742	2122	2535	2978	300	671	60	1507	2096	2740	3301	3964	4670	5413
100	224	80	944	1305	1728	2128	2604	3125	3687	300	671	80	1853	2563	3259	4032	4859	5735	6661
100	224	100	1050	1503	2012	2501	3074	3703	4388	300	671	100	2192	3007	3820	4734	5714	6756	7862
100	224	120	1222	1723	2298	2867	3537	4276	5088	300	671	120	2526	3434	4359	5409	6540	7748	9033
100	224	140	1360	1925	2573	3226	3995	4849	5791	300	671	140	2859	3849	4881	6066	7346	8718	10183
125	280	40	729	967	1208	1501	1820	2160	2519	325	727	40	1208	1677	2194	2633	3152	3704	4282
125	280	60	912	1238	1622	1972	2394	2850	3337	325	727	60	1589	2207	2804	3461	4160	4898	5672
125	280	80	1036	1472	1959	2409	2936	3508	4123	325	727	80	1959	2701	3428	4236	5100	6014	6978
125	280	100	1233	1730	2294	2830	3461	4150	4895	325	727	100	2322	3171	4018	4973	5996	7084	8234
125	280	120	1398	1968	2614	3240	3976	4782	5661	325	727	120	2680	3623	4585	5682	6862	8121	9457
125	280	140	1561	2201	2926	3642	4484	5411	6246	325	727	140	3038	4061	5133	6371	7706	9135	10657
150	335	40	793	1066	1340	1664	2013	2384	2775	350	783	40	1265	1756	2297	2754	3296	3871	4472
150	335	60	979	1362	1797	2187	2649	3145	3674	350	783	60	1671	2315	2937	3623	4352	5119	5925
150	335	80	1185	1656	2186	2673	3247	3868	4533	350	783	80	2064	2836	3592	4435	5335	6287	7289
150	335	100	1378	1933	2554	3138	3825	4570	5373	350	783	100	2451	3331	4211	5207	6272	7403	8599
150	335	120	1568	2201	2911	3590	4389	5259	6202	350	783	120	2834	3808	4805	5949	7177	8485	9872
150	335	140	1757	2462	3257	4033	4944	5942	7027	350	783	140	3218	4270	5380	6669	8058	9542	11121
175	391	40	882	1175	1468	1818	2195	2595	3016	375	839	40	1321	1835	2398	2874	3437	4034	4658
175	391	60	1046	1483	1965	2391	2890	3425	3993	375	839	60	1751	2422	3069	3782	4539	5336	6172
175	391	80	1301	1819	2397	2923	3542	4210	4923	375	839	80	2169	2969	3753	4630	5565	6553	7592
175	391	100	1520	2127	2802	3431	4170	4970	5827	375	839	100	2579	3489	4401	5436	6543	7716	8955
175	391	120	1734	2423	3193	3923	4782	5713	6718	375	839	120	2987	3990	5021	6210	7486	8842	10279
175	391	140	1947	2712	3573	4405	5382	6447	7601	375	839	140	3303	4445	5620	6961	8403	9941	11575
200	447	40	925	1257	1586	1964	2369	2797	3247	400	894	40	1377	1912	2423	2982	3574	4193	4840
200	447	60	1168	1625	2136	2587	3121	3692	4298	400	894	60	1831	2527	3197	3937	4723	5549	6415
200	447	80	1415	1977	2599	3162	3825	4537	5295	400	894	80	2272	3100	3911	4821	5791	6814	7890
200	447	100	1658	2313	3040	3711	4501	5352	6262	400	894	100	2707	3645	4586	5660	6807	8023	9304
200	447	120	1897	2637	3464	4242	5158	6148	7212	400	894	120	3141	4169	5233	6466	7788	9192	10677
200	447	140	2133	2952	3875	4761	5802	6932	8152	400	894	140	3456	4640	5857	7247	8741	10332	12020

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(b)
Installed Spacing of Heat Detector: 8 feet
 t_d : 50 Seconds to 1000 Btu/sec
 α : 0.044 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)									
25	56	40	118	167	232	311	400	507	631	225	503	40	425	570	726	906	1102	1312	1538
25	56	60	154	226	322	440	584	752	952	225	503	60	558	759	992	1227	1500	1797	2119
25	56	80	194	286	415	579	781	1026	1309	225	503	80	693	939	1231	1533	1885	2271	2694
25	56	100	228	346	512	726	993	1319	1699	225	503	100	809	1108	1461	1833	2265	2744	3272
25	56	120	263	409	614	883	1221	1633	2118	225	503	120	926	1274	1686	2130	2645	3220	3859
25	56	140	299	473	721	1049	1462	1969	2573	225	503	140	1026	1434	1909	2425	3025	3700	4456
50	112	40	171	237	320	410	517	638	775	250	559	40	453	608	774	964	1170	1392	1628
50	112	60	224	317	435	574	728	913	1126	250	559	60	596	810	1041	1304	1591	1902	2239
50	112	80	281	397	550	735	949	1205	1504	250	559	80	738	1002	1311	1629	1997	2401	2841
50	112	100	329	474	666	901	1185	1516	1912	250	559	100	876	1185	1556	1946	2397	2896	3444
50	112	120	377	552	785	1074	1428	1846	2347	250	559	120	982	1358	1794	2258	2795	3392	4053
50	112	140	424	630	906	1254	1683	2202	2808	250	559	140	1107	1531	2029	2567	3192	3891	4671
75	168	40	216	296	395	498	620	756	906	275	615	40	480	645	820	1021	1237	1469	1716
75	168	60	283	395	533	683	861	1063	1291	275	615	60	646	863	1103	1379	1680	2005	2355
75	168	80	352	492	668	876	1107	1381	1696	275	615	80	783	1063	1389	1722	2107	2527	2984
75	168	100	413	585	803	1063	1360	1714	2125	275	615	100	921	1256	1647	2054	2525	3043	3611
75	168	120	472	678	939	1255	1622	2063	2578	275	615	120	1039	1440	1898	2382	2941	3560	4242
75	168	140	531	770	1076	1451	1901	2427	3055	275	615	140	1177	1624	2146	2706	3355	4078	4881
100	224	40	255	349	462	577	713	863	1027	300	671	40	507	681	865	1075	1301	1543	1801
100	224	60	343	467	622	788	983	1202	1446	300	671	60	680	911	1163	1452	1766	2105	2469
100	224	80	416	578	776	996	1254	1548	1880	300	671	80	827	1123	1445	1811	2213	2650	3123
100	224	100	488	685	929	1214	1530	1904	2333	300	671	100	967	1325	1736	2161	2650	3187	3774
100	224	120	559	792	1081	1424	1811	2273	2806	300	671	120	1109	1523	2000	2503	3083	3723	4427
100	224	140	636	898	1234	1637	2101	2656	3301	300	671	140	1246	1715	2260	2842	3514	4261	5087
125	280	40	291	397	523	650	799	962	1140	325	727	40	533	717	909	1129	1365	1616	1884
125	280	60	391	532	704	885	1097	1333	1593	325	727	60	714	959	1222	1524	1851	2203	2580
125	280	80	476	657	877	1114	1392	1705	2056	325	727	80	881	1184	1517	1899	2317	2770	3259
125	280	100	558	779	1046	1342	1690	2086	2534	325	727	100	1014	1393	1823	2264	2772	3328	3933
125	280	120	647	899	1214	1571	1992	2476	3029	325	727	120	1169	1601	2100	2622	3222	3884	4608
125	280	140	723	1017	1382	1813	2300	2878	3543	325	727	140	1314	1803	2371	2974	3670	4440	5288
150	335	40	325	443	581	719	880	1056	1246	350	783	40	559	751	952	1181	1426	1688	1965
150	335	60	435	593	781	976	1204	1456	1733	350	783	60	747	1005	1280	1594	1933	2298	2688
150	335	80	531	732	971	1226	1523	1855	2224	350	783	80	917	1239	1589	1986	2418	2887	3392
150	335	100	634	869	1157	1473	1842	2259	2728	350	783	100	1072	1462	1885	2365	2892	3466	4089
150	335	120	720	999	1340	1719	2164	2671	3245	350	783	120	1228	1679	2197	2737	3359	4041	4786
150	335	140	805	1128	1522	1967	2491	3093	3780	350	783	140	1380	1890	2480	3104	3822	4615	5486
175	391	40	357	486	637	784	957	1145	1347	375	839	40	584	785	994	1232	1486	1757	2045
175	391	60	478	650	854	1063	1307	1574	1866	375	839	60	780	1050	1336	1662	2014	2391	2795
175	391	80	584	803	1061	1332	1649	1999	2386	375	839	80	953	1294	1658	2070	2518	3002	3523
175	391	100	694	952	1262	1598	1989	2427	2915	375	839	100	1122	1528	1967	2464	3009	3601	4242
175	391	120	790	1094	1460	1861	2330	2860	3456	375	839	120	1286	1754	2292	2851	3492	4195	4960
175	391	140	892	1236	1656	2125	2675	3301	4011	375	839	140	1446	1975	2587	3231	3971	4787	5681
200	447	40	396	530	676	846	1031	1230	1444	400	894	40	609	818	1036	1282	1545	1826	2122
200	447	60	519	705	924	1146	1405	1687	1995	400	894	60	813	1094	1392	1729	2093	2483	2899
200	447	80	646	873	1148	1435	1769	2138	2543	400	894	80	989	1348	1726	2153	2615	3114	3651
200	447	100	752	1031	1363	1718	2129	2588	3096	400	894	100	1171	1593	2048	2562	3123	3733	4393
200	447	120	870	1188	1576	1998	2490	3042	3660	400	894	120	1343	1829	2359	2962	3623	4346	5132
200	447	140	959	1337	1785	2277	2852	3503	4236	400	894	140	1511	2058	2692	3356	4118	4956	5872

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(c)
Installed Spacing of Heat Detector: 8 feet
 t_d : 300 Seconds to 1000 Btu/sec
 α : 0.011 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)									
25	56	40	70	104	152	211	285	374	477	225	503	40	247	337	443	553	680	820	973
25	56	60	95	149	223	321	443	592	767	225	503	60	335	458	606	766	951	1158	1389
25	56	80	122	196	302	442	620	838	1099	225	503	80	413	572	763	976	1223	1503	1819
25	56	100	148	246	387	575	815	1110	1463	225	503	100	489	684	919	1186	1499	1858	2267
25	56	120	174	299	479	719	1027	1405	1858	225	503	120	569	794	1075	1406	1782	2225	2735
25	56	140	201	354	576	873	1253	1721	2283	225	503	140	639	902	1230	1621	2072	2605	3224
50	112	40	101	144	200	267	345	439	547	250	559	40	264	360	471	587	720	866	1025
50	112	60	136	200	284	389	517	668	849	250	559	60	357	488	644	811	1005	1220	1458
50	112	80	172	257	372	520	703	926	1187	250	559	80	441	610	811	1032	1289	1578	1902
50	112	100	205	315	465	661	906	1206	1560	250	559	100	522	728	975	1252	1576	1945	2363
50	112	120	239	374	563	811	1124	1508	1963	250	559	120	607	844	1138	1474	1868	2322	2842
50	112	140	273	437	666	970	1356	1830	2399	250	559	140	682	959	1301	1705	2167	2712	3341
75	168	40	127	178	242	318	402	502	616	275	615	40	280	382	499	620	759	911	1076
75	168	60	170	245	339	453	586	746	931	275	615	60	380	518	681	856	1057	1280	1525
75	168	80	215	311	438	595	786	1012	1280	275	615	80	469	646	856	1086	1352	1651	1984
75	168	100	255	378	540	745	998	1303	1661	275	615	100	555	771	1028	1316	1650	2029	2457
75	168	120	296	445	646	903	1223	1612	2072	275	615	120	643	893	1199	1546	1953	2418	2948
75	168	140	336	514	756	1069	1461	1942	2510	275	615	140	723	1014	1369	1779	2261	2817	3456
100	224	40	150	209	281	361	455	561	682	300	671	40	297	403	520	652	797	955	1126
100	224	60	201	286	390	514	654	821	1013	300	671	60	401	546	717	899	1108	1338	1591
100	224	80	253	361	500	667	864	1099	1374	300	671	80	496	682	901	1140	1415	1722	2064
100	224	100	300	436	611	827	1088	1397	1764	300	671	100	593	813	1081	1378	1723	2113	2550
100	224	120	347	511	725	993	1322	1714	2183	300	671	120	679	941	1259	1617	2035	2512	3052
100	224	140	393	587	843	1167	1568	2055	2628	300	671	140	763	1067	1436	1858	2352	2921	3571
125	280	40	171	237	317	403	504	618	745	325	727	40	317	425	546	684	834	998	1174
125	280	60	230	323	437	567	719	893	1093	325	727	60	422	574	753	941	1157	1395	1656
125	280	80	289	408	557	736	941	1184	1466	325	727	80	522	716	945	1192	1476	1792	2143
125	280	100	342	490	678	906	1173	1493	1867	325	727	100	623	854	1132	1439	1795	2194	2641
125	280	120	395	573	801	1081	1420	1819	2294	325	727	120	713	988	1317	1687	2116	2604	3155
125	280	140	447	656	926	1262	1674	2163	2748	325	727	140	802	1119	1502	1936	2442	3023	3684
150	335	40	192	264	350	443	551	671	805	350	783	40	332	445	571	714	871	1040	1222
150	335	60	261	360	482	619	780	963	1170	350	783	60	443	602	787	982	1206	1451	1719
150	335	80	322	451	612	801	1015	1267	1557	350	783	80	548	750	987	1242	1535	1861	2220
150	335	100	381	542	742	981	1258	1587	1969	350	783	100	653	894	1182	1499	1865	2274	2731
150	335	120	440	631	873	1166	1511	1923	2406	350	783	120	747	1033	1375	1755	2196	2694	3256
150	335	140	497	721	1006	1356	1778	2276	2867	350	783	140	841	1171	1566	2012	2531	3123	3795
175	391	40	211	289	383	481	596	723	863	375	839	40	347	465	596	744	906	1081	1269
175	391	60	287	394	525	670	839	1030	1245	375	839	60	463	629	821	1023	1253	1506	1781
175	391	80	353	493	664	859	1087	1348	1646	375	839	80	573	783	1029	1292	1594	1928	2296
175	391	100	419	591	803	1055	1341	1679	2070	375	839	100	682	933	1232	1558	1933	2353	2820
175	391	120	482	687	943	1248	1603	2025	2517	375	839	120	781	1078	1431	1822	2274	2784	3356
175	391	140	545	784	1083	1447	1875	2387	2987	375	839	140	885	1221	1629	2086	2618	3222	3906
200	447	40	229	314	413	518	639	772	919	400	894	40	362	485	620	774	941	1121	1314
200	447	60	311	426	566	719	896	1095	1318	400	894	60	483	655	846	1062	1300	1560	1842
200	447	80	384	533	715	918	1156	1427	1733	400	894	80	604	817	1070	1341	1651	1994	2371
200	447	100	454	638	862	1119	1421	1770	2169	400	894	100	710	971	1280	1615	2001	2430	2907
200	447	120	523	741	1010	1328	1694	2126	2626	400	894	120	814	1122	1486	1888	2351	2872	3454
200	447	140	596	844	1158	1535	1974	2497	3106	400	894	140	919	1270	1690	2160	2704	3320	4015

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(d)
Installed Spacing of Heat Detector: 8 feet
 t_d : 500 Seconds to 1000 Btu/sec
 α : 0.004 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
			FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)						
25	56	40	49	78	118	171	237	318	413	225	503	40	169	233	310	394	491	599	721
25	56	60	70	116	183	272	385	523	689	225	503	60	232	321	432	558	705	873	1065
25	56	80	91	158	256	386	553	759	1005	225	503	80	288	406	553	727	926	1162	1435
25	56	100	113	203	336	513	740	1020	1357	225	503	100	343	490	675	897	1158	1469	1832
25	56	120	136	252	422	651	944	1306	1741	225	503	120	397	574	799	1073	1403	1792	2254
25	56	140	160	304	515	799	1163	1613	2154	225	503	140	451	659	925	1254	1656	2134	2703
50	112	40	70	104	148	204	273	355	453	250	559	40	181	249	329	417	518	630	756
50	112	60	96	149	220	312	427	568	735	250	559	60	247	342	458	588	740	914	1110
50	112	80	124	196	297	431	601	809	1058	250	559	80	307	432	584	765	970	1211	1488
50	112	100	150	246	381	562	792	1075	1415	250	559	100	366	520	712	941	1208	1524	1892
50	112	120	178	298	471	703	1000	1365	1803	250	559	120	424	609	841	1122	1455	1853	2320
50	112	140	206	353	567	855	1222	1676	2221	250	559	140	480	697	971	1309	1717	2200	2774
75	168	40	87	126	176	236	309	393	493	275	615	40	192	264	348	439	544	660	789
75	168	60	120	178	255	351	470	612	782	275	615	60	263	362	483	618	775	953	1154
75	168	80	152	231	338	476	649	860	1109	275	615	80	326	456	615	798	1012	1258	1541
75	168	100	184	286	427	612	845	1131	1471	275	615	100	388	549	748	984	1257	1578	1951
75	168	120	215	343	521	757	1057	1425	1867	275	615	120	449	642	882	1171	1510	1914	2386
75	168	140	247	402	621	912	1283	1740	2289	275	615	140	509	734	1017	1362	1773	2266	2844
100	224	40	103	147	201	266	341	430	533	300	671	40	203	278	366	461	569	690	823
100	224	60	141	205	288	389	512	658	830	300	671	60	277	381	507	647	809	992	1198
100	224	80	179	264	378	521	698	912	1163	300	671	80	345	481	645	834	1053	1305	1593
100	224	100	214	324	472	661	898	1188	1530	300	671	100	410	578	783	1026	1305	1632	2010
100	224	120	250	386	571	811	1114	1486	1928	300	671	120	474	674	922	1219	1564	1974	2451
100	224	140	286	449	674	970	1345	1805	2354	300	671	140	541	770	1062	1415	1833	2331	2915
125	280	40	118	166	225	295	374	466	573	325	727	40	214	292	384	482	594	719	855
125	280	60	160	231	319	426	552	702	878	325	727	60	292	400	531	676	843	1030	1240
125	280	80	203	295	415	564	746	961	1218	325	727	80	362	504	675	869	1094	1351	1644
125	280	100	243	360	515	711	952	1245	1590	325	727	100	431	606	818	1063	1352	1685	2069
125	280	120	282	427	619	865	1173	1548	1993	325	727	120	498	706	961	1266	1617	2033	2516
125	280	140	322	494	727	1028	1407	1871	2423	325	727	140	568	806	1106	1467	1892	2396	2985
150	335	40	131	184	248	320	404	501	611	350	783	40	224	306	401	503	619	747	887
150	335	60	179	255	349	462	592	747	926	350	783	60	306	419	555	704	875	1068	1282
150	335	80	226	325	452	607	793	1013	1273	350	783	80	380	527	704	903	1134	1397	1694
150	335	100	270	395	557	759	1005	1300	1650	350	783	100	452	633	852	1104	1398	1738	2126
150	335	120	313	466	666	918	1231	1610	2058	350	783	120	522	737	1000	1312	1670	2092	2580
150	335	140	356	537	778	1085	1469	1937	2492	350	783	140	594	841	1149	1518	1949	2460	3055
175	391	40	144	201	269	345	434	535	649	375	839	40	235	320	419	523	643	774	918
175	391	60	196	278	378	496	631	790	973	375	839	60	320	437	577	731	907	1104	1324
175	391	80	247	353	487	648	837	1063	1327	375	839	80	397	550	732	937	1173	1442	1744
175	391	100	295	428	597	806	1058	1356	1711	375	839	100	472	659	885	1143	1444	1790	2184
175	391	120	342	503	711	971	1289	1669	2123	375	839	120	545	767	1038	1357	1722	2150	2644
175	391	140	389	579	828	1142	1532	2004	2562	375	839	140	619	875	1191	1569	2007	2524	3125
200	447	40	157	217	290	370	463	568	685	400	894	40	245	333	435	543	666	801	949
200	447	60	213	300	405	526	668	832	1020	400	894	60	333	455	600	758	939	1141	1364
200	447	80	268	380	520	688	882	1113	1381	400	894	80	414	572	760	970	1212	1486	1794
200	447	100	320	460	637	852	1107	1413	1771	400	894	100	492	685	918	1182	1489	1841	2241
200	447	120	370	539	755	1022	1346	1731	2189	400	894	120	572	798	1075	1396	1773	2208	2707
200	447	140	421	620	877	1199	1594	2067	2633	400	894	140	645	908	1233	1619	2063	2588	3194

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(e)
Installed Spacing of Heat Detector: 8 feet
 t_d : 600 Seconds to 1000 Btu/sec
 α : 0.003 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
			FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)						
25	56	40	44	71	110	160	225	303	397	225	503	40	148	205	274	351	440	541	654
25	56	60	63	108	173	259	370	505	668	225	503	60	202	284	385	504	639	798	981
25	56	80	83	148	244	372	536	738	980	225	503	80	254	362	496	658	848	1073	1336
25	56	100	104	192	323	497	721	997	1328	225	503	100	303	438	609	818	1070	1368	1720
25	56	120	126	240	408	633	922	1279	1709	225	503	120	352	515	725	985	1302	1681	2132
25	56	140	149	291	499	780	1139	1584	2119	225	503	140	401	593	843	1158	1546	2013	2572
50	112	40	62	93	135	188	254	334	429	250	559	40	158	219	291	371	463	567	684
50	112	60	86	135	203	292	404	542	705	250	559	60	215	302	407	528	670	832	1019
50	112	80	111	180	278	409	575	779	1024	250	559	80	271	384	524	691	885	1114	1380
50	112	100	136	228	360	537	763	1042	1376	250	559	100	323	464	641	856	1110	1414	1770
50	112	120	161	279	448	676	968	1328	1761	250	559	120	375	545	761	1027	1350	1732	2187
50	112	140	188	332	542	826	1188	1636	2175	250	559	140	426	626	884	1204	1598	2069	2630
75	168	40	77	112	158	215	284	365	462	275	615	40	168	232	307	390	486	593	713
75	168	60	106	160	233	325	440	579	744	275	615	60	231	320	429	554	700	866	1056
75	168	80	136	210	312	446	614	821	1066	275	615	80	287	405	550	723	921	1155	1425
75	168	100	165	262	398	578	807	1088	1425	275	615	100	343	490	673	893	1152	1460	1820
75	168	120	194	316	489	720	1015	1378	1813	275	615	120	397	574	797	1069	1397	1783	2241
75	168	140	224	373	586	872	1238	1689	2231	275	615	140	451	658	923	1250	1649	2123	2689
100	224	40	91	130	180	241	312	396	495	300	671	40	178	244	323	409	508	619	742
100	224	60	124	184	261	357	475	616	784	300	671	60	244	337	451	579	729	900	1093
100	224	80	158	238	346	483	654	863	1110	300	671	80	303	426	577	754	957	1195	1469
100	224	100	191	295	436	619	851	1134	1471	300	671	100	362	514	703	930	1193	1506	1869
100	224	120	224	353	531	765	1062	1428	1866	300	671	120	419	602	831	1110	1440	1834	2296
100	224	140	257	413	631	920	1288	1742	2287	300	671	140	475	690	962	1295	1699	2178	2747
125	280	40	103	147	201	265	339	427	528	325	727	40	187	257	339	428	530	644	770
125	280	60	141	206	288	388	510	653	824	325	727	60	256	353	471	604	758	933	1130
125	280	80	180	265	378	520	695	905	1155	325	727	80	319	447	602	782	992	1234	1512
125	280	100	216	326	472	660	895	1181	1520	325	727	100	380	538	733	965	1234	1551	1919
125	280	120	252	388	571	810	1110	1478	1916	325	727	120	440	630	865	1150	1485	1884	2350
125	280	140	289	451	675	968	1340	1796	2341	325	727	140	499	721	999	1340	1746	2233	2806
150	335	40	115	162	220	288	366	456	561	350	783	40	196	269	354	446	551	668	797
150	335	60	158	227	313	419	542	690	863	350	783	60	269	370	492	628	786	965	1166
150	335	80	200	291	409	556	734	947	1200	350	783	80	334	467	627	811	1026	1273	1555
150	335	100	239	355	508	701	939	1229	1570	350	783	100	398	562	763	1000	1274	1596	1968
150	335	120	279	421	611	854	1158	1530	1970	350	783	120	461	657	899	1190	1530	1934	2404
150	335	140	318	488	718	1016	1391	1851	2398	350	783	140	523	751	1037	1384	1796	2287	2864
175	391	40	127	177	239	309	391	485	593	375	839	40	205	281	369	464	572	692	824
175	391	60	173	247	338	448	575	727	903	375	839	60	281	386	512	652	814	997	1201
175	391	80	218	315	439	591	774	989	1246	375	839	80	349	486	652	841	1060	1312	1598
175	391	100	261	384	543	741	983	1274	1620	375	839	100	416	585	792	1035	1313	1640	2016
175	391	120	304	454	650	898	1206	1581	2024	375	839	120	481	683	932	1229	1574	1983	2458
175	391	140	347	524	761	1064	1443	1906	2456	375	839	140	549	781	1073	1427	1844	2341	2922
200	447	40	138	192	257	330	416	513	624	400	894	40	214	292	383	481	592	715	851
200	447	60	187	266	362	476	607	763	942	400	894	60	292	401	531	675	841	1028	1236
200	447	80	237	339	468	625	810	1031	1291	400	894	80	364	506	676	869	1094	1350	1640
200	447	100	283	412	576	780	1027	1321	1670	400	894	100	433	608	820	1065	1352	1684	2065
200	447	120	329	485	688	942	1255	1630	2078	400	894	120	501	709	964	1268	1618	2032	2511
200	447	140	374	559	802	1111	1495	1961	2513	400	894	140	571	810	1110	1470	1893	2395	2981

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(f)
Installed Spacing of Heat Detector: 10 feet
 t_d : 50 Seconds to 1000 Btu/sec
 α : 0.400 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
			FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)						
25	56	40	376	499	623	779	956	1152	1366	225	503	40	1234	1667	2041	2468	2925	3406	3911
25	56	60	486	641	811	1027	1273	1550	1860	225	503	60	1622	2186	2681	3249	3858	4503	5183
25	56	80	570	769	1013	1271	1591	1957	2371	225	503	80	1998	2671	3274	3976	4731	5535	6386
25	56	100	675	902	1193	1517	1916	2377	2906	225	503	100	2367	3132	3838	4670	5569	6529	7551
25	56	120	751	1024	1371	1766	2249	2814	3465	225	503	120	2731	3577	4380	5340	6382	7499	8692
25	56	140	827	1146	1551	2040	2593	3268	4050	225	503	140	3096	3911	4902	5994	7178	8452	9818
50	112	40	552	692	904	1084	1306	1550	1813	250	559	40	1317	1778	2175	2628	3111	3620	4152
50	112	60	712	895	1171	1418	1723	2059	2426	250	559	60	1740	2337	2860	3461	4105	4786	5503
50	112	80	828	1106	1391	1738	2129	2561	3038	250	559	80	2150	2859	3494	4237	5035	5882	6778
50	112	100	945	1282	1633	2055	2531	3064	3658	250	559	100	2553	3355	4096	4976	5925	6936	8011
50	112	120	1035	1446	1905	2371	2936	3575	4292	250	559	120	2953	3739	4669	5689	6787	7963	9215
50	112	140	1177	1626	2143	2685	3343	4094	4942	250	559	140	3267	4270	5234	6384	7631	8970	10402
75	168	40	673	890	1088	1331	1598	1885	2191	275	615	40	1398	1886	2305	2783	3291	3826	4386
75	168	60	885	1157	1418	1744	2104	2495	2916	275	615	60	1855	2484	3033	3667	4345	5061	5813
75	168	80	1000	1370	1725	2136	2590	3086	3625	275	615	80	2300	3042	3707	4489	5329	6219	7159
75	168	100	1174	1602	2024	2518	3066	3670	4333	275	615	100	2737	3485	4340	5272	6270	7331	8456
75	168	120	1330	1822	2315	2893	3538	4255	5047	275	615	120	3175	3975	4954	6027	7181	8413	9723
75	168	140	1484	2037	2602	3264	4010	4843	5769	275	615	140	3488	4440	5548	6761	8070	9472	10968
100	224	40	801	1051	1276	1554	1858	2183	2528	300	671	40	1478	1992	2432	2933	3467	4027	4613
100	224	60	985	1337	1662	2037	2446	2885	3356	300	671	60	1970	2628	3202	3867	4578	5328	6115
100	224	80	1195	1623	2026	2494	3005	3560	4158	300	671	80	2448	3221	3915	4735	5615	6547	7529
100	224	100	1389	1893	2375	2934	3550	4221	4951	300	671	100	2922	3687	4584	5560	6605	7716	8890
100	224	120	1581	2155	2714	3365	4086	4877	5742	300	671	120	3301	4199	5231	6356	7563	8850	10217
100	224	140	1771	2411	3046	3790	4618	5532	6537	300	671	140	3705	4696	5858	7129	8498	9962	11520
125	280	40	908	1193	1447	1759	2097	2457	2837	325	727	40	1557	2096	2555	3079	3637	4222	4834
125	280	60	1130	1528	1889	2307	2761	3246	3763	325	727	60	2084	2769	3367	4063	4805	5588	6409
125	280	80	1364	1853	2303	2823	3389	3998	4652	325	727	80	2596	3397	4117	4975	5894	6866	7889
125	280	100	1595	2164	2699	3319	3997	4732	5525	325	727	100	3106	3883	4821	5842	6933	8090	9313
125	280	120	1822	2466	3083	3803	4594	5456	6392	325	727	120	3489	4421	5501	6677	7937	9278	10699
125	280	140	2046	2759	3458	4277	5183	6175	7257	325	727	140	3919	4945	6160	7488	8915	10439	12059
150	335	40	971	1308	1605	1949	2320	2713	3127	350	783	40	1635	2198	2676	3222	3804	4413	5049
150	335	60	1257	1702	2101	2560	3055	3583	4144	350	783	60	2196	2908	3528	4253	5027	5842	6696
150	335	80	1528	2070	2564	3132	3749	4410	5117	350	783	80	2744	3476	4308	5209	6166	7178	8241
150	335	100	1794	2421	3004	3681	4418	5213	6067	350	783	100	3291	4076	5052	6117	7253	8456	9726
150	335	120	2055	2760	3430	4214	5072	6002	7006	350	783	120	3675	4639	5765	6991	8302	9695	11170
150	335	140	2314	3089	3845	4737	5716	6782	7939	350	783	140	4130	5189	6456	7839	9323	10905	12585
175	391	40	1035	1419	1755	2130	2531	2954	3400	375	839	40	1713	2298	2794	3362	3966	4600	5260
175	391	60	1381	1869	2303	2800	3335	3903	4505	375	839	60	2308	3044	3685	4440	5244	6090	6976
175	391	80	1688	2277	2811	3426	4091	4801	5558	375	839	80	2891	3636	4501	5438	6433	7483	8586
175	391	100	1988	2666	3294	4025	4818	5670	6582	375	839	100	3366	4257	5279	6386	7566	8814	10130
175	391	120	2284	3042	3760	4606	5527	6521	7591	375	839	120	3858	4853	6024	7298	8659	10104	11631
175	391	140	2577	3406	4214	5173	6223	7361	8590	375	839	140	4339	5428	6745	8183	9723	11362	13100
200	447	40	1151	1552	1902	2302	2732	3185	3661	400	894	40	1790	2396	2909	3499	4126	4782	5466
200	447	60	1503	2030	2495	3029	3601	4209	4851	400	894	60	2419	3178	3840	4622	5457	6334	7251
200	447	80	1844	2477	3047	3706	4417	5175	5980	400	894	80	3038	3793	4691	5662	6694	7782	8923
200	447	100	2179	2903	3571	4353	5201	6108	7076	400	894	100	3522	4440	5501	6649	7872	9165	10527
200	447	120	2509	3313	4076	4980	5962	7019	8151	400	894	120	4040	5062	6278	7599	9009	10504	12083
200	447	140	2837	3712	4567	5591	6709	7917	9215	400	894	140	4546	5662	7029	8519	10115	11810	13606

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(g)
Installed Spacing of Heat Detector: 10 feet
 t_d : 150 Seconds to 1000 Btu/sec
 α : 0.044 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
			FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU/SEC)						
25	56	40	152	209	280	362	461	576	709	225	503	40	544	694	871	1064	1273	1497	1737
25	56	60	205	284	389	519	671	856	1071	225	503	60	727	931	1173	1441	1734	2052	2395
25	56	80	252	358	502	683	904	1164	1473	225	503	80	895	1170	1460	1803	2181	2595	3046
25	56	100	298	435	621	858	1151	1504	1912	225	503	100	1034	1378	1738	2157	2623	3136	3701
25	56	120	345	514	746	1044	1416	1864	2385	225	503	120	1195	1587	2011	2507	3063	3680	4634
25	56	140	392	595	877	1241	1696	2247	2890	225	503	140	1345	1790	2280	2856	3504	4230	5040
50	112	40	221	296	380	481	596	727	872	250	559	40	580	742	928	1132	1352	1588	1840
50	112	60	297	398	525	669	841	1040	1268	250	559	60	775	994	1250	1532	1840	2173	2531
50	112	80	362	496	664	860	1097	1374	1695	250	559	80	948	1246	1555	1915	2311	2743	3212
50	112	100	426	593	805	1064	1366	1730	2154	250	559	100	1116	1473	1849	2289	2775	3310	3895
50	112	120	490	691	950	1269	1649	2107	2645	250	559	120	1279	1694	2138	2658	3237	3878	4585
50	112	140	561	791	1098	1482	1952	2506	3166	250	559	140	1440	1909	2422	3024	3698	4450	5284
75	168	40	277	369	467	584	715	861	1021	275	615	40	616	787	984	1198	1429	1676	1939
75	168	60	372	495	635	803	995	1212	1456	275	615	60	822	1055	1324	1621	1943	2290	2663
75	168	80	454	614	807	1022	1280	1576	1913	275	615	80	1001	1322	1647	2024	2438	2888	3375
75	168	100	535	731	971	1245	1574	1957	2397	275	615	100	1187	1564	1958	2417	2924	3479	4085
75	168	120	622	848	1135	1472	1879	2355	2908	275	615	120	1362	1797	2261	2804	3406	4070	4800
75	168	140	697	963	1302	1713	2194	2772	3446	275	615	140	1534	2025	2560	3187	3887	4664	5523
100	224	40	328	435	545	677	823	983	1158	300	671	40	663	832	1038	1263	1504	1762	2036
100	224	60	439	582	738	926	1136	1371	1632	300	671	60	880	1115	1397	1707	2043	2405	2792
100	224	80	537	720	926	1171	1450	1766	2122	300	671	80	1065	1398	1736	2130	2561	3028	3533
100	224	100	641	857	1122	1418	1770	2174	2633	300	671	100	1256	1652	2063	2542	3069	3644	4270
100	224	120	730	990	1307	1667	2098	2596	3168	300	671	120	1443	1898	2382	2946	3571	4258	5010
100	224	140	819	1121	1492	1920	2434	3034	3726	300	671	140	1625	2138	2695	3346	4071	4873	5757
125	280	40	383	487	617	763	923	1097	1286	325	727	40	695	875	1091	1325	1577	1845	2130
125	280	60	501	662	835	1040	1268	1520	1799	325	727	60	918	1172	1467	1791	2141	2516	2918
125	280	80	625	822	1044	1310	1611	1947	2322	325	727	80	1123	1471	1823	2234	2681	3166	3687
125	280	100	729	973	1249	1580	1956	2382	2862	325	727	100	1325	1738	2166	2664	3210	3805	4451
125	280	120	831	1121	1467	1850	2307	2828	3421	325	727	120	1522	1996	2499	3085	3732	4441	5216
125	280	140	935	1268	1670	2123	2665	3288	4002	325	727	140	1716	2249	2827	3502	4252	5078	5986
150	335	40	426	543	685	844	1017	1204	1406	350	783	40	727	918	1142	1387	1648	1927	2222
150	335	60	559	738	925	1147	1392	1662	1957	350	783	60	957	1229	1537	1873	2236	2626	3041
150	335	80	694	914	1155	1442	1762	2119	2513	350	783	80	1179	1542	1909	2335	2799	3300	3839
150	335	100	812	1081	1380	1733	2133	2581	3082	350	783	100	1392	1822	2266	2783	3348	3963	4628
150	335	120	930	1246	1602	2025	2507	3052	3667	350	783	120	1600	2093	2614	3222	3890	4621	5418
150	335	140	1034	1406	1839	2317	2886	3535	4271	350	783	140	1805	2330	2955	3655	4428	5279	6211
175	391	40	467	595	750	920	1106	1306	1521	375	839	40	758	959	1193	1447	1718	2007	2312
175	391	60	628	798	1011	1249	1511	1797	2108	375	839	60	996	1304	1605	1954	2330	2733	3162
175	391	80	760	1002	1261	1567	1907	2283	2697	375	839	80	1234	1589	1992	2434	2914	3432	3987
175	391	100	899	1186	1504	1880	2302	2772	3295	375	839	100	1459	1880	2364	2900	3484	4118	4802
175	391	120	1013	1362	1744	2192	2699	3268	3906	375	839	120	1678	2161	2726	3355	4045	4798	5616
175	391	140	1146	1540	1981	2503	3099	3773	4534	375	839	140	1894	2434	3081	3804	4601	5476	6431
200	447	40	506	646	811	994	1191	1403	1631	400	894	40	789	1000	1242	1505	1787	2085	2400
200	447	60	678	866	1093	1347	1625	1927	2254	400	894	60	1035	1359	1671	2032	2422	2837	3280
200	447	80	825	1086	1362	1687	2047	2442	2874	400	894	80	1289	1657	2074	2532	3027	3561	4132
200	447	100	966	1284	1623	2021	2465	2957	3501	400	894	100	1524	1959	2461	3014	3617	4269	4973
200	447	120	1109	1477	1880	2352	2884	3478	4138	400	894	120	1754	2251	2837	3486	4197	4971	5810
200	447	140	1247	1667	2133	2682	3305	4005	4790	400	894	140	1982	2536	3205	3951	4771	5669	6648

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(h)
Installed Spacing of Heat Detector: 10 feet
 t_d : 300 Seconds to 1000 Btu/sec
 α : 0.011 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)									FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)										
25	56	40	91	131	183	249	330	424	537	225	503	40	323	415	526	650	787	936	1099
25	56	60	126	187	271	379	513	675	863	225	503	60	432	570	723	901	1101	1324	1570
25	56	80	160	246	367	524	720	957	1234	225	503	80	535	713	914	1150	1417	1718	2056
25	56	100	195	309	471	682	947	1268	1645	225	503	100	639	853	1103	1399	1738	2125	2563
25	56	120	230	377	582	853	1193	1605	2091	225	503	120	734	990	1299	1650	2066	2545	3092
25	56	140	267	448	701	1036	1456	1967	2574	225	503	140	828	1125	1487	1906	2403	2980	3645
50	112	40	131	180	241	313	399	500	616	250	559	40	345	443	560	690	833	989	1159
50	112	60	179	250	344	459	597	762	956	250	559	60	461	608	768	955	1163	1394	1649
50	112	80	224	322	451	615	816	1054	1338	250	559	80	572	759	969	1215	1493	1804	2151
50	112	100	269	395	565	782	1051	1377	1758	250	559	100	682	907	1168	1476	1826	2224	2672
50	112	120	314	470	684	960	1305	1723	2213	250	559	120	783	1052	1374	1738	2166	2656	3214
50	112	140	359	549	810	1150	1575	2092	2700	250	559	140	888	1196	1572	2003	2514	3103	3778
75	168	40	164	222	293	371	465	572	694	275	615	40	366	470	593	729	878	1041	1217
75	168	60	224	306	410	532	679	851	1050	275	615	60	490	644	812	1007	1224	1463	1725
75	168	80	279	389	530	703	909	1155	1444	275	615	80	613	806	1024	1280	1567	1888	2244
75	168	100	333	473	654	881	1158	1485	1874	275	615	100	723	961	1232	1551	1913	2321	2780
75	168	120	386	558	784	1068	1420	1839	2338	275	615	120	831	1113	1439	1823	2264	2766	3334
75	168	140	440	645	918	1266	1697	2220	2833	275	615	140	938	1264	1655	2098	2622	3223	3910
100	224	40	194	260	335	424	526	640	769	300	671	40	387	496	624	767	922	1091	1273
100	224	60	265	357	471	602	757	937	1143	300	671	60	518	680	855	1058	1283	1530	1800
100	224	80	328	451	604	784	1001	1255	1550	300	671	80	647	850	1077	1342	1639	1969	2335
100	224	100	391	545	739	977	1258	1596	1991	300	671	100	763	1012	1294	1624	1997	2416	2885
100	224	120	453	639	879	1175	1534	1959	2464	300	671	120	883	1173	1510	1907	2360	2873	3453
100	224	140	519	735	1022	1380	1821	2344	2967	300	671	140	988	1330	1725	2191	2728	3342	4040
125	280	40	222	296	377	474	583	705	841	325	727	40	407	521	656	804	965	1140	1328
125	280	60	302	404	528	667	832	1020	1234	325	727	60	546	715	897	1107	1340	1595	1873
125	280	80	374	508	673	863	1090	1353	1656	325	727	80	680	892	1128	1403	1710	2050	2425
125	280	100	445	612	820	1065	1360	1706	2108	325	727	100	803	1063	1355	1696	2080	2510	2989
125	280	120	514	716	969	1278	1642	2079	2591	325	727	120	925	1230	1579	1989	2454	2979	3570
125	280	140	587	820	1122	1493	1938	2473	3103	325	727	140	1038	1395	1803	2283	2833	3459	4168
150	335	40	248	329	417	521	637	766	909	350	783	40	427	546	686	840	1007	1188	1382
150	335	60	366	448	577	729	903	1100	1321	350	783	60	572	749	937	1156	1396	1659	1945
150	335	80	417	563	739	939	1176	1448	1759	350	783	80	713	934	1179	1463	1779	2128	2513
150	335	100	495	676	897	1153	1458	1814	2224	350	783	100	842	1113	1415	1766	2161	2602	3091
150	335	120	577	789	1056	1372	1752	2199	2718	350	783	120	967	1287	1647	2069	2546	3083	3685
150	335	140	651	901	1218	1603	2058	2602	3239	350	783	140	1092	1459	1879	2372	2935	3574	4295
175	391	40	273	361	455	566	689	825	975	375	839	40	446	571	716	875	1048	1235	1435
175	391	60	370	490	627	789	972	1177	1407	375	839	60	606	774	977	1203	1451	1722	2016
175	391	80	458	615	796	1012	1259	1541	1860	375	839	80	745	976	1228	1521	1847	2205	2599
175	391	100	544	737	971	1237	1554	1920	2339	375	839	100	886	1162	1473	1835	2241	2692	3192
175	391	120	631	858	1140	1468	1859	2316	2844	375	839	120	1009	1342	1714	2148	2637	3185	3798
175	391	140	712	979	1311	1703	2175	2730	3375	375	839	140	1141	1521	1953	2460	3036	3688	4421
200	447	40	301	386	491	609	739	882	1038	400	894	40	465	595	745	910	1089	1281	1487
200	447	60	401	531	676	846	1038	1251	1489	400	894	60	631	807	1017	1250	1505	1784	2085
200	447	80	497	665	856	1082	1339	1631	1959	400	894	80	776	1016	1277	1579	1913	2281	2684
200	447	100	595	796	1042	1319	1647	2023	2452	400	894	100	920	1209	1530	1903	2319	2781	3291
200	447	120	684	925	1220	1560	1964	2432	2969	400	894	120	1055	1397	1780	2225	2726	3286	3910
200	447	140	771	1053	1400	1806	2290	2856	3510	400	894	140	1190	1582	2027	2547	3136	3800	4544

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(i)
Installed Spacing of Heat Detector: 10 feet
t_g: 500 Seconds to 1000 Btu/sec
α: 0.004 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
			FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)						
25	56	40	65	98	143	202	274	362	465	225	503	40	219	291	370	463	568	685	815
25	56	60	92	146	222	322	447	598	775	225	503	60	300	400	518	657	817	998	1204
25	56	80	121	200	312	458	643	867	1133	225	503	80	374	507	668	854	1074	1329	1622
25	56	100	150	258	410	609	861	1166	1530	225	503	100	446	612	816	1056	1343	1680	2070
25	56	120	181	320	516	773	1098	1493	1963	225	503	120	518	717	966	1268	1625	2051	2548
25	56	140	214	386	630	950	1352	1844	2430	225	503	140	591	823	1120	1484	1919	2441	3055
50	112	40	91	130	179	241	316	405	510	250	559	40	234	310	393	490	599	720	854
50	112	60	127	186	266	369	495	649	828	250	559	60	320	426	549	693	858	1045	1255
50	112	80	162	246	361	511	698	924	1191	250	559	80	399	538	706	898	1124	1385	1683
50	112	100	198	309	464	666	920	1229	1593	250	559	100	476	649	861	1107	1401	1743	2139
50	112	120	235	376	574	835	1162	1561	2031	250	559	120	555	760	1017	1323	1689	2121	2623
50	112	140	272	447	692	1015	1422	1917	2506	250	559	140	628	870	1176	1548	1990	2517	3135
75	168	40	114	158	212	279	356	449	556	275	615	40	249	328	415	517	630	755	893
75	168	60	158	223	308	415	545	699	882	275	615	60	339	451	578	728	898	1090	1305
75	168	80	199	290	410	564	754	981	1251	275	615	80	423	569	743	941	1173	1440	1742
75	168	100	241	359	519	725	982	1293	1660	275	615	100	505	685	904	1157	1458	1806	2206
75	168	120	283	431	634	898	1228	1630	2103	275	615	120	588	801	1066	1379	1753	2190	2697
75	168	140	326	506	756	1082	1492	1991	2580	275	615	140	665	916	1231	1611	2059	2593	3216
100	224	40	134	183	243	312	395	491	602	300	671	40	266	343	437	542	659	788	930
100	224	60	185	257	348	460	592	751	937	300	671	60	358	475	607	762	938	1135	1355
100	224	80	233	330	458	616	810	1040	1313	300	671	80	447	599	755	983	1221	1493	1801
100	224	100	280	406	572	783	1044	1356	1727	300	671	100	533	720	947	1207	1513	1868	2273
100	224	120	328	484	693	961	1295	1700	2176	300	671	120	619	841	1115	1435	1815	2259	2772
100	224	140	376	564	819	1150	1563	2065	2657	300	671	140	701	961	1285	1668	2128	2668	3296
125	280	40	153	207	272	345	432	533	647	325	727	40	280	361	458	567	688	821	967
125	280	60	210	288	386	501	640	803	992	325	727	60	377	499	636	796	976	1178	1403
125	280	80	264	369	503	667	863	1099	1375	325	727	80	470	628	810	1024	1269	1546	1860
125	280	100	317	451	624	841	1106	1421	1795	325	727	100	564	755	988	1255	1568	1929	2340
125	280	120	370	534	751	1024	1362	1768	2250	325	727	120	650	880	1162	1489	1877	2327	2845
125	280	140	422	619	882	1218	1635	2141	2736	325	727	140	735	1005	1338	1729	2196	2742	3376
150	335	40	171	229	297	377	468	572	690	350	783	40	293	378	479	592	717	854	1003
150	335	60	234	318	422	542	686	853	1046	350	783	60	395	522	664	829	1014	1221	1451
150	335	80	293	405	546	717	918	1158	1437	350	783	80	493	657	844	1064	1315	1598	1917
150	335	100	351	493	674	897	1165	1486	1864	350	783	100	591	789	1024	1302	1622	1989	2406
150	335	120	409	582	807	1087	1430	1838	2324	350	783	120	681	919	1209	1543	1938	2394	2919
150	335	140	466	673	944	1285	1707	2213	2815	350	783	140	770	1048	1389	1788	2263	2816	3456
175	391	40	187	250	322	407	503	611	733	375	839	40	306	394	499	616	744	885	1039
175	391	60	257	346	456	582	731	903	1100	375	839	60	413	544	691	861	1051	1263	1498
175	391	80	321	440	588	762	971	1216	1499	375	839	80	515	685	878	1104	1360	1649	1974
175	391	100	384	534	723	953	1225	1551	1933	375	839	100	616	822	1064	1348	1675	2048	2471
175	391	120	447	629	861	1148	1494	1909	2398	375	839	120	710	957	1254	1596	1998	2461	2991
175	391	140	512	725	1004	1352	1780	2289	2895	375	839	140	803	1091	1440	1847	2329	2889	3535
200	447	40	204	271	347	435	536	648	774	400	894	40	319	410	519	639	772	916	1074
200	447	60	279	374	489	620	774	951	1152	400	894	60	431	567	718	893	1088	1305	1544
200	447	80	348	474	629	809	1023	1273	1561	400	894	80	537	712	911	1143	1405	1700	2030
200	447	100	416	574	770	1007	1285	1616	2002	400	894	100	642	854	1102	1394	1728	2107	2536
200	447	120	483	674	915	1209	1560	1980	2473	400	894	120	740	994	1299	1648	2057	2527	3063
200	447	140	552	775	1062	1419	1848	2365	2975	400	894	140	836	1132	1490	1905	2395	2692	3614

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(j)
Installed Spacing of Heat Detector: 10 feet
 t_g : 600 Seconds to 1000 Btu/sec
 α : 0.003 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)									
25	56	40	58	89	133	190	260	346	446	225	503	40	192	256	328	413	509	618	739
25	56	60	84	136	210	307	429	577	752	225	503	60	264	354	465	591	741	912	1108
25	56	80	110	188	298	442	623	843	1105	225	503	80	330	451	600	775	984	1227	1510
25	56	100	139	244	394	591	838	1139	1498	225	503	100	395	547	737	968	1240	1564	1944
25	56	120	168	305	499	753	1073	1463	1928	225	503	120	460	644	878	1165	1510	1924	2410
25	56	140	200	371	611	927	1325	1811	2391	225	503	140	526	742	1022	1371	1797	2304	2906
50	112	40	81	116	163	222	295	381	483	250	559	40	205	272	348	437	536	648	773
50	112	60	114	170	246	346	469	619	795	250	559	60	281	377	492	623	776	952	1152
50	112	80	146	226	338	485	668	890	1153	250	559	80	352	478	633	813	1026	1274	1561
50	112	100	179	287	439	637	887	1191	1550	250	559	100	421	579	776	1009	1289	1618	2001
50	112	120	214	352	547	803	1126	1519	1987	250	559	120	489	681	921	1215	1564	1982	2472
50	112	140	249	420	662	981	1382	1871	2454	250	559	140	559	783	1070	1425	1853	2367	2972
75	168	40	100	140	191	254	328	417	521	275	615	40	218	289	367	459	563	678	806
75	168	60	140	201	282	384	510	661	839	275	615	60	298	398	515	653	811	991	1194
75	168	80	178	264	379	528	714	938	1203	275	615	80	373	505	665	850	1068	1321	1611
75	168	100	216	329	484	685	937	1244	1605	275	615	100	446	611	813	1052	1337	1671	2058
75	168	120	256	398	596	855	1180	1576	2043	275	615	120	518	716	964	1264	1618	2040	2534
75	168	140	295	470	715	1036	1440	1932	2515	275	615	140	591	823	1118	1479	1912	2430	3039
100	224	40	118	162	218	283	361	452	559	300	671	40	230	304	386	482	588	707	839
100	224	60	164	230	316	422	550	704	884	300	671	60	315	419	541	683	845	1029	1237
100	224	80	207	298	419	572	760	985	1253	300	671	80	394	531	697	886	1110	1367	1661
100	224	100	250	369	529	734	988	1297	1660	300	671	100	471	641	850	1094	1385	1723	2114
100	224	120	294	443	645	907	1235	1633	2103	300	671	120	549	752	1006	1309	1671	2098	2596
100	224	140	338	519	767	1091	1498	1994	2579	300	671	140	622	862	1164	1532	1970	2493	3106
125	280	40	134	183	242	311	393	487	596	325	727	40	242	320	405	503	614	736	871
125	280	60	186	257	348	459	590	746	930	325	727	60	331	440	565	712	879	1067	1278
125	280	80	234	332	458	615	806	1034	1304	325	727	80	414	557	728	922	1150	1412	1711
125	280	100	282	408	573	782	1040	1349	1716	325	727	100	495	671	886	1136	1432	1775	2170
125	280	120	330	486	694	959	1290	1692	2164	325	727	120	576	786	1047	1356	1724	2156	2658
125	280	140	379	566	820	1148	1557	2056	2643	325	727	140	652	900	1210	1585	2028	2556	3173
150	335	40	150	202	266	338	423	521	633	350	783	40	257	332	423	525	638	764	902
150	335	60	207	283	379	493	629	789	975	350	783	60	347	460	589	740	911	1104	1319
150	335	80	260	363	495	657	851	1083	1356	350	783	80	434	581	754	957	1190	1457	1760
150	335	100	312	445	616	829	1091	1403	1773	350	783	100	518	701	922	1177	1478	1826	2226
150	335	120	365	527	741	1012	1346	1747	2225	350	783	120	602	819	1087	1402	1776	2213	2719
150	335	140	417	612	872	1204	1617	2118	2708	350	783	140	682	937	1254	1632	2085	2618	3239
175	391	40	164	221	286	364	453	554	669	375	839	40	268	346	440	546	662	791	933
175	391	60	226	308	409	527	667	831	1020	375	839	60	363	480	613	768	944	1140	1359
175	391	80	284	394	531	698	896	1131	1407	375	839	80	453	606	783	991	1230	1501	1808
175	391	100	341	480	657	876	1140	1457	1830	375	839	100	545	730	957	1217	1524	1877	2281
175	391	120	398	568	788	1064	1402	1806	2286	375	839	120	628	852	1127	1447	1828	2270	2781
175	391	140	454	657	923	1260	1677	2178	2774	375	839	140	711	974	1299	1683	2142	2680	3306
200	447	40	178	239	308	389	482	587	705	400	894	40	280	361	458	566	686	818	963
200	447	60	245	331	437	559	704	872	1064	400	894	60	378	499	636	796	975	1176	1399
200	447	80	308	423	566	736	940	1180	1459	400	894	80	472	630	812	1025	1268	1544	1856
200	447	100	369	514	698	922	1190	1511	1887	400	894	100	567	758	991	1257	1569	1927	2336
200	447	120	429	606	833	1115	1458	1865	2348	400	894	120	654	884	1166	1492	1878	2326	2842
200	447	140	489	700	973	1316	1737	2241	2840	400	894	140	740	1010	1342	1733	2198	2742	3372

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(k)
Installed Spacing of Heat Detector: 12 feet
 t_g : 50 Seconds to 1000 Btu/sec
 α : 0.400 Btu/sec⁵

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)									
25	56	40	482	585	730	897	1085	1291	1518	225	503	40	1535	2023	2398	2845	3325	3831	4360
25	56	60	593	751	952	1184	1446	1740	2069	225	503	60	2046	2586	3145	3747	4389	5068	5783
25	56	80	722	913	1168	1467	1810	2200	2640	225	503	80	2543	3159	3843	4588	5386	6234	7130
25	56	100	821	1090	1384	1753	2182	2675	3238	225	503	100	3036	3702	4507	5391	6342	7357	8435
25	56	120	927	1243	1598	2043	2565	3169	3864	225	503	120	3416	4215	5145	6168	7271	8452	9712
25	56	140	1007	1389	1836	2339	2959	3683	4518	225	503	140	3834	4714	5765	6925	8180	9529	10973
50	112	40	668	831	1026	1244	1482	1740	2017	250	559	40	1643	2161	2556	3029	3537	4071	4630
50	112	60	878	1078	1338	1633	1958	2314	2702	250	559	60	2021	2763	3355	3992	4671	5388	6142
50	112	80	993	1328	1635	2006	2422	2880	3385	250	559	80	2746	3378	4101	4889	5732	6626	7569
50	112	100	1162	1552	1923	2374	2882	3450	4079	250	559	100	3289	3959	4809	5744	6748	7816	8949
50	112	120	1316	1766	2206	2739	3345	4026	4788	250	559	120	3671	4505	5490	6570	7733	8976	10298
50	112	140	1469	1977	2486	3105	3812	4613	5516	250	559	140	4123	5039	6151	7375	8697	10114	11627
75	168	40	867	1043	1273	1533	1815	2117	2438	275	615	40	1750	2294	2709	3208	3742	4304	4892
75	168	60	1021	1370	1663	2011	2392	2804	3248	275	615	60	2354	2936	3558	4230	4944	5698	6489
75	168	80	1255	1668	2030	2466	2947	3472	4042	275	615	80	2947	3590	4351	5181	6067	7006	7995
75	168	100	1461	1946	2382	2907	3491	4132	4834	275	615	100	3423	4200	5102	6087	7141	8262	9448
75	168	120	1665	2216	2726	3342	4031	4793	5632	275	615	120	3921	4788	5824	6961	8182	9484	10866
75	168	140	1867	2480	3065	3774	4570	5458	6441	275	615	140	4408	5355	6525	7811	9198	10681	12261
100	224	40	957	1257	1497	1790	2111	2452	2814	300	671	40	1856	2425	2858	3381	3942	4531	5145
100	224	60	1226	1625	1954	2349	2781	3245	3741	300	671	60	2507	3104	3756	4461	5210	5999	6826
100	224	80	1486	1971	2383	2878	3420	4006	4638	300	671	80	3149	3797	4594	5465	6393	7375	8409
100	224	100	1742	2303	2795	3388	4042	4753	5525	300	671	100	3635	4441	5387	6420	7524	8696	9933
100	224	120	1993	2624	3195	3888	4654	5494	6410	300	671	120	4168	5063	6150	7341	8618	9978	11419
100	224	140	2242	2937	3587	4380	5263	6234	7300	300	671	140	4690	5663	6889	8236	9686	11233	12879
125	280	40	1047	1409	1695	2026	2382	2761	3160	325	727	40	1960	2475	2995	3550	4136	4751	5392
125	280	60	1399	1852	2220	2661	3139	3651	4195	325	727	60	2658	3268	3949	4686	5469	6292	7155
125	280	80	1708	2253	2709	3258	3857	4501	5190	325	727	80	3259	3992	4831	5741	6711	7736	8813
125	280	100	2011	2636	3176	3833	4552	5330	6168	325	727	100	3844	4676	5666	6745	7897	9118	10407
125	280	120	2309	2933	3625	4393	5233	6147	7137	325	727	120	4412	5331	6467	7711	9044	10460	11959
125	280	140	2605	3283	4067	4943	5907	6960	8106	325	727	140	4840	5956	7244	8651	10162	11772	13482
150	335	40	1199	1584	1886	2246	2636	3049	3483	350	783	40	2064	2594	3136	3715	4326	4966	5634
150	335	60	1566	2067	2470	2953	3475	4032	4622	350	783	60	2809	3428	4138	4906	5721	6579	7476
150	335	80	1923	2520	3015	3615	4267	4965	5710	350	783	80	3430	4188	5062	6012	7022	8087	9207
150	335	100	2272	2874	3530	4250	5031	5872	6774	350	783	100	4050	4906	5938	7062	8262	9531	10869
150	335	120	2618	3277	4032	4868	5778	6763	7824	350	783	120	4653	5594	6778	8074	9460	10931	12486
150	335	140	2961	3668	4522	5473	6514	7646	8870	350	783	140	5089	6249	7591	9056	10627	12299	14071
175	391	40	1313	1736	2064	2455	2876	3321	3789	375	839	40	2166	2712	3275	3876	4511	5176	5869
175	391	60	1729	2273	2707	3229	3793	4392	5026	375	839	60	3599	4379	5289	6276	7326	8432	9593
175	391	80	2133	2699	3300	3953	4656	5406	6204	375	839	80	3599	4379	5289	6276	7326	8432	9593
175	391	100	2529	3161	3869	4647	5487	6388	7350	375	839	100	4254	5132	6204	7373	8619	9936	11322
175	391	120	2922	3605	4419	5319	6297	7350	8479	375	839	120	4765	5844	7081	8428	9867	11392	13003
175	391	140	3317	4035	4954	5977	7092	8299	9599	375	839	140	5334	6535	7931	9453	11082	12815	14649
200	447	40	1425	1882	2234	2654	3105	3581	4081	400	894	40	2268	2827	3410	4034	4693	5382	6100
200	447	60	1889	2471	2934	3493	4097	4737	5412	400	894	60	3112	3740	4503	5332	6211	7134	8098
200	447	80	2339	2933	3577	4277	5028	5828	6676	400	894	80	3766	4567	5511	6535	7623	8769	9970
200	447	100	2783	3436	4194	5026	5923	6882	7903	400	894	100	4456	5353	6465	7677	8968	10332	11766
200	447	120	3226	3919	4789	5752	6793	7911	9107	400	894	120	4979	6095	7379	8776	10266	11845	13509
200	447	140	3538	4378	5367	6460	7646	8925	10298	400	894	140	5575	6817	8264	9842	11529	13321	15215

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(I)
Installed Spacing of Heat Detector: 12 feet
 t_d : 150 Seconds to 1000 Btu/sec
 α : 0.044 Btu/sec³

			CEILING HEIGHT IN FEET										CEILING HEIGHT IN FEET						
τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0	τ	RTI	ΔT	4.0	8.0	12.0	16.0	20.0	24.0	28.0
			FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)						
25	56	40	190	254	327	418	525	648	790	225	503	40	685	837	1023	1228	1450	1687	1940
25	56	60	256	345	461	602	766	964	1194	225	503	60	905	1122	1380	1665	1976	2313	2676
25	56	80	316	437	596	794	1030	1313	1644	225	503	80	1104	1390	1718	2085	2488	2927	3405
25	56	100	375	531	738	999	1318	1693	2136	225	503	100	1304	1647	2047	2496	2993	3540	4139
25	56	120	435	628	888	1217	1623	2100	2665	225	503	120	1499	1898	2369	2902	3497	4155	4882
25	56	140	501	729	1045	1448	1946	2542	3230	225	503	140	1691	2143	2688	3307	4002	4778	5639
50	112	40	275	359	447	556	679	818	972	250	559	40	729	894	1091	1307	1540	1789	2054
50	112	60	368	483	613	774	959	1173	1415	250	559	60	958	1197	1470	1771	2097	2450	2829
50	112	80	452	602	779	997	1253	1550	1893	250	559	80	1182	1483	1829	2214	2636	3095	3592
50	112	100	534	722	954	1228	1561	1953	2407	250	559	100	1396	1757	2178	2648	3167	3736	4357
50	112	120	621	842	1127	1475	1886	2380	2957	250	559	120	1606	2024	2519	3076	3695	4378	5129
50	112	140	700	963	1303	1725	2227	2832	3540	250	559	140	1813	2284	2855	3501	4223	5025	5913
75	168	40	353	439	549	675	814	969	1139	275	615	40	772	949	1156	1383	1628	1889	2166
75	168	60	462	590	747	929	1134	1366	1625	275	615	60	1012	1271	1557	1873	2215	2583	2977
75	168	80	567	745	943	1184	1461	1778	2137	275	615	80	1257	1574	1937	2340	2780	3258	3774
75	168	100	675	889	1138	1443	1798	2209	2679	275	615	100	1487	1864	2305	2796	3336	3927	4569
75	168	120	772	1030	1334	1708	2148	2660	3251	275	615	120	1712	2146	2664	3245	3888	4595	5370
75	168	140	878	1173	1543	1980	2510	3132	3854	275	615	140	1934	2421	3017	3690	4439	5267	6180
100	224	40	415	516	641	782	937	1107	1292	300	671	40	814	1002	1220	1458	1713	1985	2274
100	224	60	545	692	869	1070	1295	1545	1822	300	671	60	1079	1343	1643	1972	2329	2712	3121
100	224	80	678	862	1091	1355	1655	1993	2371	300	671	80	1332	1662	2042	2463	2921	3417	3951
100	224	100	794	1039	1311	1642	2021	2454	2943	300	671	100	1576	1968	2428	2940	3501	4113	4776
100	224	120	914	1202	1531	1932	2397	2932	3542	300	671	120	1816	2265	2805	3409	4076	4807	5605
100	224	140	1017	1361	1752	2227	2783	3427	4168	300	671	140	2027	2554	3175	3874	4649	5503	6442
125	280	40	472	587	726	881	1050	1235	1435	325	727	40	870	1055	1282	1530	1796	2080	2379
125	280	60	634	788	982	1202	1445	1714	2009	325	727	60	1137	1413	1726	2069	2440	2838	3262
125	280	80	771	978	1230	1516	1837	2196	2594	325	727	80	1404	1749	2145	2582	3058	3572	4124
125	280	100	910	1164	1473	1829	2233	2688	3199	325	727	100	1664	2070	2549	3081	3663	4295	4979
125	280	120	1029	1359	1715	2144	2635	3194	3826	325	727	120	1919	2381	2943	3570	4260	5014	5836
125	280	140	1168	1540	1957	2462	3045	3714	4476	325	727	140	2136	2684	3330	4054	4855	5735	6699
150	335	40	526	654	806	974	1157	1356	1570	350	783	40	904	1105	1342	1601	1878	2172	2483
150	335	60	704	877	1088	1326	1587	1873	2186	350	783	60	1193	1481	1807	2164	2549	2961	3400
150	335	80	871	1089	1360	1668	2010	2390	2809	350	783	80	1476	1833	2245	2699	3192	3723	4293
150	335	100	1004	1293	1626	2006	2434	2913	3446	350	783	100	1750	2169	2667	3218	3820	4473	5178
150	335	120	1159	1493	1889	2345	2863	3446	4101	350	783	120	2021	2495	3078	3727	4440	5218	6062
150	335	140	1306	1708	2152	2686	3297	3992	4778	350	783	140	2243	2812	3481	4230	5056	5961	6951
175	391	40	578	717	881	1062	1259	1471	1698	375	839	40	938	1155	1401	1670	1957	2262	2583
175	391	60	771	962	1190	1443	1722	2026	2356	375	839	60	1249	1548	1887	2257	2656	3082	3535
175	391	80	944	1193	1484	1812	2176	2576	3014	375	839	80	1547	1916	2343	2814	3324	3872	4459
175	391	100	1111	1416	1772	2176	2627	3129	3684	375	839	100	1836	2267	2783	3353	3975	4648	5373
175	391	120	1276	1633	2056	2538	3081	3690	4369	375	839	120	2088	2606	3210	3881	4617	5417	6284
175	391	140	1438	1847	2337	2900	3450	4262	5072	375	839	140	2348	2937	3629	4402	5253	6184	7198
200	447	40	640	779	954	1147	1356	1581	1821	400	894	40	973	1203	1460	1738	2035	2350	2682
200	447	60	836	1043	1286	1556	1852	2172	2519	400	894	60	1304	1614	1965	2348	2760	3200	3668
200	447	80	1017	1293	1604	1951	2334	2754	3213	400	894	80	1617	1997	2440	2926	3453	4018	4622
200	447	100	1209	1534	1912	2339	2813	3338	3915	400	894	100	1921	2362	2896	3486	4127	4819	5564
200	447	120	1389	1768	2215	2723	3292	3926	4629	400	894	120	2180	2715	3340	4033	4790	5612	6502
200	447	140	1566	1998	2515	3107	3775	4523	5359	400	894	140	2451	3059	3775	4572	5447	6403	7441

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(m)
Installed Spacing of Heat Detector: 12 feet
t_g: 300 Seconds to 1000 Btu/sec
α: 0.011 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)									
25	56	40	115	160	218	290	375	479	599	225	503	40	401	500	619	751	897	1056	1229
25	56	60	159	228	322	442	588	761	964	225	503	60	538	682	851	1043	1257	1494	1756
25	56	80	203	302	437	611	825	1082	1380	225	503	80	672	855	1077	1332	1619	1941	2301
25	56	100	247	380	562	797	1087	1435	1840	225	503	100	796	1025	1301	1621	1987	2401	2869
25	56	120	294	463	697	998	1370	1818	2339	225	503	120	919	1201	1525	1914	2363	2877	3462
25	56	140	341	551	840	1212	1673	2228	2875	225	503	140	1034	1366	1750	2212	2750	3370	4081
50	112	40	164	219	283	363	456	564	688	250	559	40	428	534	659	798	950	1116	1295
50	112	60	224	305	408	534	682	861	1069	250	559	60	575	726	904	1105	1328	1574	1844
50	112	80	282	392	536	716	932	1192	1496	250	559	80	717	911	1143	1408	1705	2037	2407
50	112	100	339	482	672	911	1206	1554	1967	250	559	100	849	1090	1378	1710	2087	2513	2991
50	112	120	396	575	815	1121	1498	1946	2476	250	559	120	977	1266	1613	2015	2477	3003	3598
50	112	140	458	672	966	1343	1809	2369	3022	250	559	140	1106	1451	1848	2324	2875	3508	4230
75	168	40	205	270	342	429	530	645	775	275	615	40	455	566	697	843	1002	1174	1360
75	168	60	280	372	482	617	776	961	1174	275	615	60	617	770	956	1165	1397	1651	1930
75	168	80	349	473	629	814	1040	1305	1615	275	615	80	761	964	1207	1482	1789	2132	2511
75	168	100	418	576	777	1025	1322	1679	2096	275	615	100	905	1153	1453	1797	2186	2623	3111
75	168	120	487	680	931	1245	1628	2080	2616	275	615	120	1035	1339	1699	2114	2588	3126	3733
75	168	140	558	787	1092	1476	1948	2508	3170	275	615	140	1174	1522	1944	2434	2999	3644	4377
100	224	40	243	312	395	491	600	722	859	300	671	40	481	598	735	886	1052	1231	1423
100	224	60	330	433	552	697	865	1058	1278	300	671	60	651	812	1006	1224	1464	1726	2013
100	224	80	411	548	711	910	1145	1418	1734	300	671	80	804	1017	1269	1554	1872	2224	2613
100	224	100	490	662	877	1132	1440	1804	2227	300	671	100	952	1215	1526	1882	2282	2730	3229
100	224	120	573	778	1042	1367	1753	2216	2757	300	671	120	1097	1409	1782	2211	2698	3248	3865
100	224	140	649	895	1213	1608	2083	2653	3321	300	671	140	1240	1601	2037	2542	3120	3778	4523
125	280	40	281	354	445	548	665	795	939	325	727	40	506	628	771	929	1101	1286	1485
125	280	60	376	485	618	773	950	1151	1379	325	727	60	685	854	1056	1281	1529	1800	2096
125	280	80	468	617	791	1001	1246	1528	1852	325	727	80	846	1068	1329	1624	1952	2315	2713
125	280	100	562	744	966	1237	1556	1928	2359	325	727	100	999	1275	1598	1965	2376	2836	3346
125	280	120	648	871	1149	1480	1880	2352	2899	325	727	120	1155	1478	1864	2305	2805	3367	3996
125	280	140	734	998	1331	1732	2220	2798	3473	325	727	140	1305	1679	2128	2647	3239	3910	4667
150	335	40	313	393	491	602	727	864	1015	350	783	40	531	658	807	971	1148	1340	1546
150	335	60	419	537	680	845	1031	1241	1477	350	783	60	717	894	1104	1337	1593	1873	2176
150	335	80	521	683	867	1089	1344	1636	1967	350	783	80	892	1118	1389	1693	2031	2403	2812
150	335	100	624	821	1055	1338	1668	2050	2489	350	783	100	1047	1334	1668	2046	2469	2939	3460
150	335	120	720	958	1245	1594	2005	2486	3042	350	783	120	1211	1546	1943	2398	2910	3484	4125
150	335	140	814	1095	1444	1857	2356	2943	3626	350	783	140	1368	1754	2218	2751	3356	4040	4809
175	391	40	344	430	536	654	786	930	1089	375	839	40	555	688	842	1011	1195	1393	1605
175	391	60	461	587	739	913	1109	1328	1573	375	839	60	749	934	1151	1392	1656	1944	2255
175	391	80	579	739	940	1172	1438	1740	2081	375	839	80	929	1167	1447	1761	2109	2490	2908
175	391	100	684	895	1140	1435	1777	2170	2617	375	839	100	1099	1392	1736	2125	2560	3041	3573
175	391	120	788	1042	1342	1704	2127	2618	3183	375	839	120	1267	1612	2022	2488	3013	3600	4252
175	391	140	895	1189	1546	1979	2490	3087	3778	375	839	140	1431	1828	2305	2852	3472	4169	4950
200	447	40	373	466	578	704	842	994	1160	400	894	40	579	717	876	1052	1241	1445	1663
200	447	60	500	635	796	979	1184	1413	1666	400	894	60	781	972	1197	1446	1718	2013	2333
200	447	80	626	798	1010	1253	1530	1842	2192	400	894	80	966	1215	1504	1827	2185	2576	3003
200	447	100	741	958	1222	1530	1883	2287	2744	400	894	100	1146	1448	1803	2204	2649	3141	3684
200	447	120	861	1115	1435	1811	2247	2749	3323	400	894	120	1321	1677	2099	2578	3115	3714	4378
200	447	140	964	1279	1649	2097	2621	3230	3930	400	894	140	1493	1901	2391	2952	3585	4295	5089

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW

Table B-4.1(n)
Installed Spacing of Heat Detector: 12 feet
 t_d : 500 Seconds to 1000 Btu/sec
 α : 0.004 Btu/sec³

τ	RTI	ΔT	CEILING HEIGHT IN FEET							τ	RTI	ΔT	CEILING HEIGHT IN FEET						
			4.0	8.0	12.0	16.0	20.0	24.0	28.0				4.0	8.0	12.0	16.0	20.0	24.0	28.0
FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)										FIRE SIZE AT DETECTOR RESPONSE (BTU / SEC)									
25	56	40	82	120	170	235	314	408	519	225	503	40	276	348	436	536	648	773	911
25	56	60	117	180	266	376	512	676	866	225	503	60	374	481	611	762	933	1128	1348
25	56	80	154	246	373	536	738	982	1265	225	503	80	468	615	786	991	1229	1503	1816
25	56	100	192	318	491	713	989	1321	1710	225	503	100	563	743	962	1227	1538	1900	2318
25	56	120	233	395	618	906	1262	1692	2195	225	503	120	652	872	1146	1471	1861	2320	2854
25	56	140	275	478	755	1113	1556	2090	2717	225	503	140	740	1001	1328	1723	2200	2764	3422
50	112	40	115	158	213	280	361	457	570	250	559	40	295	371	463	567	684	813	955
50	112	60	160	227	317	430	568	732	926	250	559	60	399	512	647	803	980	1180	1405
50	112	80	205	301	431	596	801	1046	1332	250	559	80	499	653	830	1042	1286	1565	1884
50	112	100	251	379	554	779	1057	1392	1783	250	559	100	599	788	1014	1286	1604	1972	2394
50	112	120	298	462	687	976	1336	1768	2274										
50	112	140	347	549	828	1188	1634	2173	2803										
75	168	40	143	191	252	322	407	506	621	275	615	40	313	393	489	598	719	852	998
75	168	60	198	271	366	483	623	790	987	275	615	60	424	541	682	844	1026	1231	1461
75	168	80	251	353	488	657	864	1110	1400	275	615	80	530	685	873	1091	1342	1627	1951
75	168	100	304	439	618	846	1127	1462	1858	275	615	100	635	832	1064	1344	1668	2042	2470
75	168	120	358	528	756	1048	1411	1846	2355	275	615	120	734	972	1258	1601	2007	2478	3021
75	168	140	413	620	902	1265	1714	2256	2889	275	615	140	833	1113	1459	1868	2359	2934	3602
100	224	40	168	222	286	362	451	555	673	300	671	40	330	414	515	627	752	890	1041
100	224	60	232	312	413	533	678	849	1048	300	671	60	447	570	716	883	1071	1282	1516
100	224	80	292	402	543	717	926	1176	1469	300	671	80	563	721	915	1140	1396	1688	2017
100	224	100	353	495	680	913	1197	1535	1933	300	671	100	669	874	1114	1400	1732	2112	2546
100	224	120	414	591	825	1121	1487	1922	2437	300	671	120	774	1021	1314	1666	2078	2555	3104
100	224	140	477	690	976	1342	1795	2336	2976	300	671	140	881	1168	1517	1939	2437	3019	3692
125	280	40	191	251	319	400	494	601	723	325	727	40	348	435	539	656	785	927	1082
125	280	60	263	350	455	582	732	907	1109	325	727	60	471	598	750	922	1115	1331	1570
125	280	80	331	449	596	774	989	1243	1539	325	727	80	592	755	956	1187	1450	1747	2082
125	280	100	398	549	741	979	1265	1608	2010	325	727	100	703	910	1162	1456	1794	2181	2620
125	280	120	466	651	892	1194	1563	2001	2519	325	727	120	813	1068	1369	1729	2148	2632	3187
125	280	140	535	756	1050	1421	1877	2421	3064	325	727	140	922	1221	1578	2009	2514	3103	3782
150	335	40	213	275	350	436	535	646	772	350	783	40	364	455	564	685	818	964	1122
150	335	60	293	386	496	629	784	964	1170	350	783	60	493	626	782	960	1158	1379	1624
150	335	80	368	493	647	830	1051	1309	1609	350	783	80	619	789	996	1234	1503	1806	2146
150	335	100	441	600	800	1042	1335	1682	2087	350	783	100	736	950	1209	1510	1855	2249	2694
150	335	120	518	709	958	1266	1637	2081	2602	350	783	120	851	1115	1423	1791	2218	2708	3269
150	335	140	589	820	1122	1498	1959	2506	3153	350	783	140	963	1272	1638	2077	2591	3186	3871
175	391	40	237	301	380	471	574	690	819	375	839	40	381	475	587	712	849	999	1162
175	391	60	321	420	536	675	835	1020	1230	375	839	60	516	653	814	997	1201	1427	1676
175	391	80	402	535	693	885	1111	1374	1678	375	839	80	646	823	1036	1280	1555	1864	2210
175	391	100	482	650	857	1105	1403	1755	2164	375	839	100	768	989	1256	1564	1916	2316	2767
175	391	120	564	765	1022	1337	1712	2161	2686	375	839	120	891	1154	1476	1852	2286	2784	3350
175	391	140	641	883	1192	1576	2038	2592	3242	375	839	140	1005	1323	1697	2145	2667	3269	3960
200	447	40	257	325	409	504	612	732	866	400	894	40	397	495	611	739	881	1034	1201
200	447	60	348	450	574	719	885	1074	1289	400	894	60	538	679	846	1034	1243	1474	1728
200	447	80	436	575	740	939	1171	1439	1747	400	894	80	673	856	1075	1325	1606	1921	2273
200	447	100	522	697	913	1167	1471	1828	2241	400	894	100	800	1028	1301	1617	1976	2382	2840
200	447	120	609	819	1085	1403	1787	2241	2770	400	894	120	926	1198	1528	1912	2354	2858	3431
200	447	140	691	943	1261	1652	2119	2678	3332	400	894	140	1047	1373	1756	2212	2741	3351	4048

NOTE: Detector time constant at a reference velocity of 5 ft/sec.

For SI Units: 1 ft = 0.305 m

1000 BTU/sec = 1055 kW