FIRE ALARM SYSTEMS

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1.0 SCOPE

This data sheet applies to the installation, operation, and maintenance of fire alarm systems. In addition, general guidelines relating to alarm systems are included, covering the operation and application of most systems.

To identify the level of supervision needed, refer to Data Sheet (DS) 9-1, *Supervision of Property*. For detailed information on fire detection devices, reference Data Sheet 5-48, *Automatic Fire Detection*.

1.1 Changes

September 2007. The following changes were made for this revision:

- Information was reorganized and reformatted.
- Fire alarm classification description was relocated to DS 9-1.
- Outdated terms were removed.
- New industry terms were added in Appendix A, Glossary of Terms.
- Operation and maintenance recommendations were updated.
- Loss history data has been included.

1.2 Superseded Information

This data sheet supersedes Data Sheets 5-2, Proprietary Protective Signaling Systems (January 1987), 5-5, Local Protective Signaling Systems (September 1978), 5-22, Central Station Signaling Systems (September 1977), 5-40, Protective Signaling Systems (September 1999), 5-43, Auxiliary Protective Signaling Systems (August 1980), and 5-44, Remote Station Protective Signaling Systems (May 1980).

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

Fire alarm control systems and their operating technologies have evolved. Their software-driven system designs have resulted in greater flexibility and control for the end-users. A full range of signal transmission technologies have become available (See Fig. 1). FM Approvals and other accredited laboratories test the systems and their operating software to ensure they meet the minimum performance and reliability requirements of the equipment standard. FM Approvals lists a variety of fire and other alarm initiating devices, general supervision detection devices, notification appliances, as well as, conventional and addressable/ intelligent fire and combination alarm control systems. This equipment is listed by signaling application categories in the *Approval Guide*, a publication of FM Approvals.

Fig 1. Fire alarm control systems and equipment

In addition, FM Approvals lists facilities that provide Standard 3011, “Central Station Service for Fire Alarms and Protective Equipment Supervision” service. These facilities install, inspect, test, and maintain local and proprietary fire alarm control systems (See Fig. 2).

2.2 Installation and Operation Recommendations

2.2.1 Use FM Approved companies to install, inspect, test, and maintain all fire alarm control systems. Find local FM Approved companies in the *Approval Guide*.

If there are no FM Approved companies for the region in question then choose a local company listed by an accredited laboratory such as UL, ULC, VdS (Germany), CNPP (France), or LPC (UK).

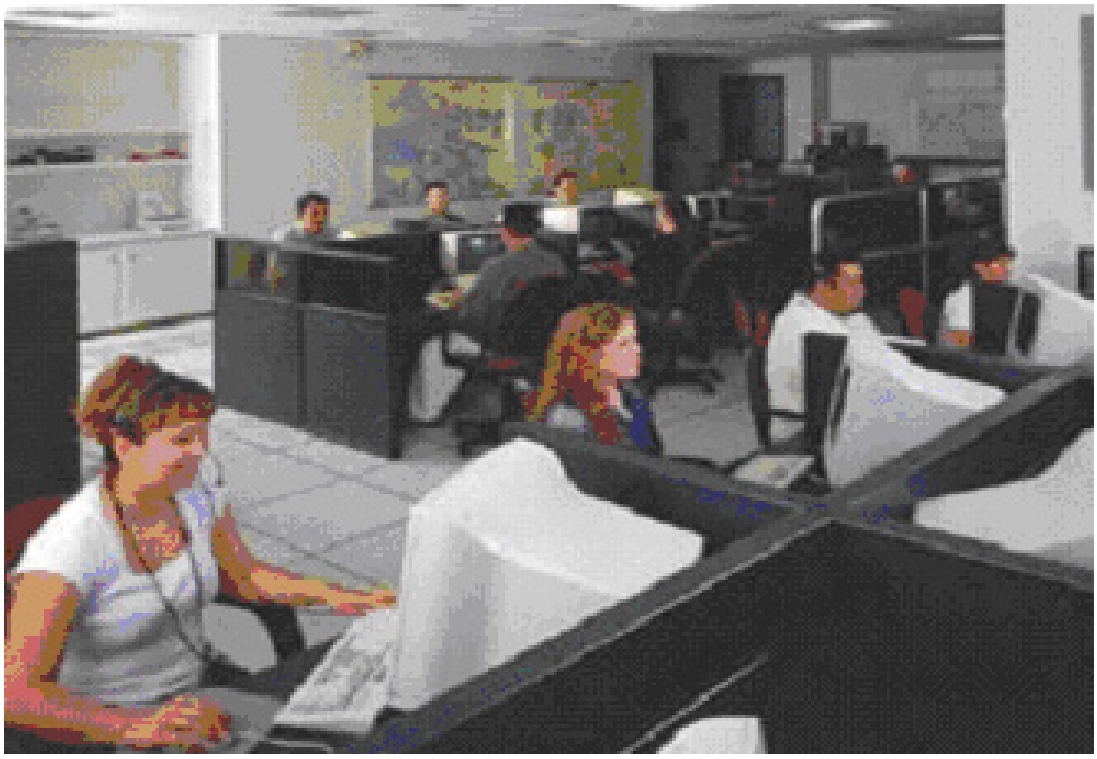

Fig 2. Monitoring and central station facilities

2.2.2 Use FM Approved companies to monitor fire alarm control systems and all signal transmitting equipment when the controls transmit to an off-site monitoring station or a full central station. Monitor-only and full service central stations are also listed in the *Approval Guide, a publication of FM Approvals*.

2.2.3 For new installations, provide FM Approved equipment for the *entire* system. See Figure 3 for an example of a typical fire alarm control system layout.

2.2.4 For a newly installed fire alarm system, or a modified/retrofitted fire alarm system, perform an acceptance test on 100% of the system as described in the checklist below (See Table 1). Have all testing performed by qualified service people and only after the building owner and authority having jurisdiction (AHJ) have been notified and output circuits have been disabled.

Table 1. Performance Checklist for New or Modified Fire Alarm System Installations

Verify these functions	*Check*
Panels, initiating devices, and notification appliances are identical to those specified during plan review. If not, then verify they are functionally and electrically equivalent.	
All equipment is properly located and securely mounted.	

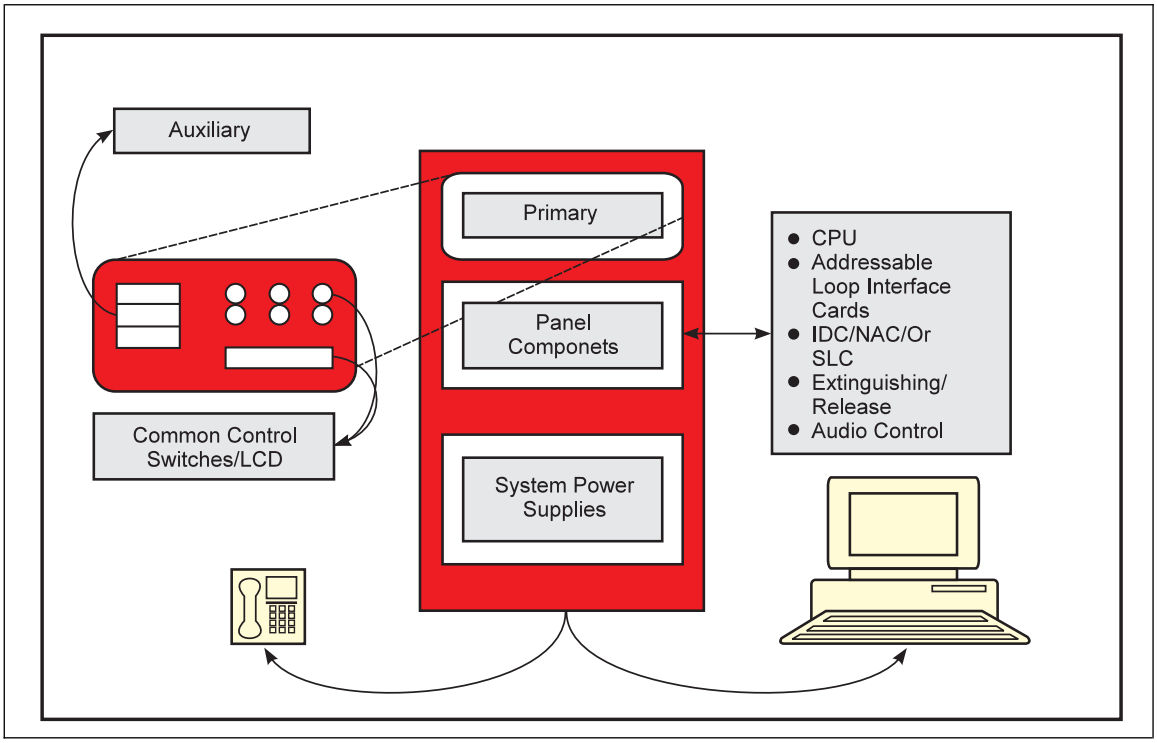

Fig 3. Typical fire alarm control system

The number of initiating and notification devices, as well as their locations matches that specified in proposed plans. If not, ask the installer to recalculate the secondary power supply capacity.	
The source of branch circuits supplying fire alarm system is prominently marked, secured, and accessible only to authorized personnel.	
Power supervisory lights at the panel and all detectors are operating.	
Test and record results of ½ hour run on backup generators under load.	
Test supervision of initiating device circuits: Create a fault condition by removing one wire from the device (smoke or heat detector) at any location in the loop and check for trouble light and audible indication at the panel within 200 seconds.	
Perform waterflow alarm tests. Verify alarm within 60 seconds of flow.	
Check supervision of valves (tamper switches), supervision of water level for tanks, and supervisory alarms for pumps, etc. if applicable.	
Test fire alarm system auxiliary functions such as fire doors closing and ventilation fans stopping, etc.	
Test off-premises signaling for alarm, trouble and supervisory signals. Check transmitter timing for all transmitters (within 90 seconds). Check the accuracy of the signal description received.	
Activation of any alarm initiating device like smoke detector, heat detector, flame detector, etc. is annunciated at the control or activates fire safety functions at the control within 10 seconds.	

2.2.5 For existing, new, or modified/retrofitted installations, request the following documentation:

- Certificate of completion (for new systems); and
- Owner's documentation:
  - Manufacturer's User Manual
  - Installation Instructions for each device in system
  - As-built drawings

2.2.6 For systems monitored by a central station service, request the following:

- From central station fire alarm systems

Installation certificated or placarded

- Certificate placed on or near fire alarm control unit
- Complete records of tests and operations kept for at least two years

- Where off-premises monitoring is used, maintain records of all signals, tests, and operations recorded at the supervising station for at least one year.

2.2.7 Perform re-acceptance tests after any of the following items have been done at protected premises:

- Deletion of devices on the alarm system.
- Addition of new devices to the alarm system.
- Modification of zones, devices, or equipment to the alarm system.
- Repair or adjustment of hardware on the alarm system.

If there is major change or upgrade to the operating software of the alarm system, test 100% of affected equipment and 10% of the initiating devices (up to 50) to verify proper system operation.

2.2.8 Verify that all fire detection, monitoring, and protection equipment is provided with primary and secondary power as per its listed application and monitored for integrity. See section 2.3 for details on Power Supply Recommendations.

2.2.9 Monitor all fire alarm system equipment, and interconnecting wiring and power supplies for faults and failures.

2.2.10 Verify that a single fault on an auxiliary system does not jeopardize the operation of the municipal system. Ensure one municipal transmitter does not serve more than 100,000 ft^2 (9290 m^2) of total fire area. The same box may function as both a municipal street box and transmitter for the auxiliary system if the box is located at the entrance to the property.

2.2.11 For releasing systems like preaction/deluge, wire all detection circuits (including signaling line circuits) used to activate water control valves to meet Class A wiring performance (See Figure 5). Do not use cross-zone or alarm verification features on detection circuits designed to activate water valves. Supervise the releasing circuit to send a trouble signal when there is a ground fault or an open circuit.

2.3 Power Supply

2.3.1 Provide all fire alarm systems with a minimum of two reliable and independent power supplies. Where alarm equipment requiring power is physically separated such that the same power supplies cannot be used for all equipment, provide additional supplies meeting the same reliability requirements at all locations.

2.3.2 The primary power supply operates the system under normal conditions. Power connections are usually made through dedicated branch circuits or separate feeds to minimize power outage due to faults by other equipment. Label these branch circuits ‘‘FIRE ALARM CIRCUIT CONTROL’’ with a red marking, and make them accessible only to authorized personnel. The primary power supply may be from:

- Light and power service
- Engine driven generator

2.3.3 The secondary power supply keeps the equipment operating when a primary power supply fails. Size the source to supply the maximum normal load of the fire alarm system itself, plus the lighting, heating, and air conditioning required to properly operate the fire alarm equipment or supervising station. The secondary power supply provides power automatically within 10 seconds and without loss of signals.

2.3.4 Verify the required duration of standby (secondary) power. The installer provides completed battery calculations to ensure back up power requirements are met.

- Secondary power requirement for detection-only systems, fixed extinguishing, and suppression system controls, and other fire alarm signaling equipment at the protected premises is a minimum of 24 hours standby power followed by 5 minutes of alarm operation.
- Alarm control panels for automatic release of preaction or deluge sprinkler systems are required to have 90 hours of secondary power followed by 10 minutes of release power and alarm operations.

2.3.5 Ensure the secondary power supply consist of any one of the following:

- Storage batteries only
- Automatic starting engine-driven generator backed up by storage batteries that can carry the required load for 4-hours
- Multiple engine-driven generators. One must be automatic starting, and any one must be large enough to carry the required load for the full required duration.
- An uninterruptable power supply (UPS) is required where any interruption of power would result in the loss of alarm signals or where a fire alarm computer system, its monitors, and printers cannot be restored to full operation within 10 seconds. Ensure the UPS for fire alarm system computer equipment is not be shared with another computer.

2.3.6 Ensure the fire alarm panel has over-current protection from a circuit breaker or fuse prominently marked (in red), secured, and accessible only to authorized personnel. Provide mechanical protection, such as electrical conduit, for circuit wiring to prevent mechanical damage. Install all wiring in accordance with ANSI/NFPA 70 *National Electrical Code* (NEC®) or applicable local codes.

2.4 Testing and Maintenance Recommendations

2.4.1 Implement an inspection and maintenance program for all fire alarm and detection systems. Ensure all testing is performed by qualified service people and only after the building owner and authority having jurisdiction (AHJ) have been notified and output circuits have been disabled. The fire alarm maintenance program incorporates details of servicing and routine cleaning and maintenance of detection devices.

2.4.2 For impairments, verify service personnel are available to restore service as soon as possible after an alarm or trouble signal. When a remote service, such as central station, is provided, investigate supervisory and trouble signals within 1 hour. If needed, begin repairs within 4 hours after receiving a signal. Methods for troubleshooting problems include:

- Visual/audible indications
- Diagnostics
- Testing
- Drills
- Recording all alarms, including nuisance alarms

Nuisance alarms can be caused by any of the following:

- Improper type of detection devices installed in protected areas
- Improper installation, wiring, grounding or design (failure to follow manufacturer’s instructions)
- Changes to facility — physical or environmental
- Lack of testing/maintenance or device sensitivity (failure to follow manufacturer’s instructions)
- Human error
- Power supply problems
- Vandalism

Nuisance alarms can be minimized by doing any of the following:

- Change type of detector, its location or sensitivity.
- Use detectors specified by control panel manufacturer (compatible with panel).
- Evaluate wiring and enclosures or cable shielding.
- Use a reliable, clean power supply.
- Re-evaluate system configuration after building changes.
- Review and apply manufacturer’s instructions and consult the manufacturer for assistance.

In case a fire alarm system is impaired during building modifications, ensure the project plan contains an action item to restore the system. In some cases alternate detection can be provided during construction (e.g., heat detectors in place of smoke detectors) to maintain some level of protection. Do not impair entire systems unless absolutely necessary because this will needlessly impair supervision of sprinkler systems, pumps, etc.

2.4.3 For releasing systems like preaction/deluge, fixed extinguishing systems, watermist/waterspray systems, and gaseous extinguishment systems that are activated by a fire alarm control panel after it receives a signal from a fire detector, provide special precaution when working in protected areas. Ensure wiring to the release circuit to activate solenoid valves for extinguishing systems is physically disconnected prior to testing the alarm system. Follow all the manufacturer's instructions on disabling outputs to ensure safety during testing.

2.4.4 Perform visual inspections and test the fire alarm equipment as recommended in Table 2 below:

Table 2. Fire Alarm System Testing Schedule

Component	*Monthly*	*Quarterly*	*Semiannually*	*Annually*
Unmonitored Control Panel				
a. Lamps/LEDs		X		
b. Main power supply		X		
c. Interfaced Equipment		X		
Monitored Control Panel				
a. Lamps/LEDs				X
b. Main power supply				X
c. Interfaced Equipment				X
Batteries				
a. Lead-acid	X			
b. Nickel-cadium			X	
c. Dry cell	X			
d. Sealed Lead-acid			X	
Fire Alarm Box				X
Transmitters and transponders				X

2.4.5 Test Methods

- Test the control equipment to verify correct receipt (at the control) of alarm signals and trouble signals, and to verify detection of loss of both primary and secondary power to the equipment.
- Visually inspect all batteries for corrosion or leakage. Check tightness of connections.
- Visually inspect all detectors to ensure there are no obstructions between the detectors and the protected areas. Verify the detectors have not been painted, mechanically damaged or covered to avoid nuisance alarms.
- Perform all functional tests on detectors and fire alarm boxes as per the manufacturer's instructions using calibrated sensitivity test instruments if provided.
- To test the transmitter of a fire alarm control, actuate initiating devices to verify receipt of the correct initiating device signal at the supervising station within 90 seconds. Upon completion of the test, restore the system to its functional operating condition.

2.4.6 For an established testing and maintenance program at a facility, provide the following:

- Adequate knowledge of proper system design/operation, i.e., what is panel expected to do: activate horns, activate suppression release, etc., and where
- Proper system interconnections
- Adequate notification
- Proper servicing
- Proper disabling of output functions, posting release warnings, valving off special extinguishing systems

- Testing consistency
- Uniform response to an alarm by staff
- Coordination by various maintenance providers

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 General Information

For all applicable installations and according to many authorities having jurisdiction and various nationally recognized testing laboratories, fire alarm equipment is usually classified in signaling categories as follows:

- **Local protective fire alarm systems** — Local systems produce alarm and/or supervisory signals within the protected property, which may not be constantly attended. The systems are electrically supervised, may include standby power, and often are primarily for the purpose of providing occupant evacuation signals.
- **Remote station fire alarm systems** — A remote station signaling system consists of a local alarm system, with a secondary power supply having sufficient capacity to operate the system for 60 hours under maximum normal load, connected to a constantly attended location such as a public fire station. It is essential that there be complete cooperation between the protected property and the remote station personnel; otherwise, substandard service may result regardless of equipment performance.
- **Proprietary fire alarm systems**: A proprietary system is owned or leased by the owner of the protected property who is responsible for system operation and maintenance. Applications requiring proprietary-type signaling systems usually involve the supervision of several phases of facility protection, including sprinkler waterflow, security personnel, and fire alarm. The headquarters of a proprietary system must be constantly attended by trained operators, where all signals are received and automatically recorded. A proprietary system is required to have at least 24 hours of standby power.
- **Central station fire alarm systems** — A central station system consists of equipment designed to transmit alarms, supervisory and trouble signals to a constantly attended central station where the signals are recorded, and experienced operators take proper action according to prescribed procedures. These systems are adaptable to facilities of any size and may consist of a simple fire alarm system, or an extensive system actuating coded signals from manual fire alarm boxes, automatic fire and smoke detection devices, supervisory devices, intrusion sensors, sprinkler waterflow and security personnel tours. Means are provided to identify each signal positively and to record automatically its receipt and time.
- **Automatic release of extinguishing systems** — The function of a release system is to cause, mechanically or electrically, a desired operation to be performed in case of fire. The releases are actuated automatically by fire detection devices. If electrically operated for extinguishing system release, provision of at least 24 hours of standby power is required and means for manual operation should also be provided. Listed releases are also used to operate fire protection equipment such as fire doors, ventilation and blower systems, hatches, dip tank covers and drain valves, motor stops, dampers, and valves controlling hazardous liquids.
- **Automatic releases for preaction and deluge sprinkler systems** - The function of these releases is to open water valves automatically via Listed fire detection devices. Release control panels for deluge and preaction sprinkler systems are compatible with the specified solenoid-operated valves, have standby power supplies capable of providing the required 90-hour system operation should primary power fail, and fire detection circuitry capable of operation during open circuit fault condition.

3.2 Loss History

Loss history has shown that due to malfunctioning and unmaintained fire alarm systems, fires started in locations during non-business hours, or fires started within unattended facilities will grow undetected to an uncontrollable size causing extensive smoke, fire, or water damage depending on location and type of occupancy. This scenario is especially true in locations where sprinkler systems or other extinguishing systems are not provided, combined with combustible construction and combustible loading.

4.0 REFERENCES

4.1 FM

Data Sheet 2-81, *Fire Protection Inspection, Testing and Maintenance and Other Fire Prevention Inspections*

Data Sheet 3-7N/13-4N, *Stationary Pumps for Fire Protection*

Data Sheet 4-0, *Special Protection Systems*

Data Sheet 4-1N, *Fixed Water Spray Systems for Fire Protection*

Data Sheet 4-3N, *Medium and High Expansion Foam Systems*

Data Sheet 4-8N, *Halon 1301 Extinguishing Systems*

Data Sheet 4-10, *Dry Chemical Systems*

Data Sheet 4-11N, *Carbon Dioxide Extinguishing Systems*

Data Sheet 5-48, *Automatic Fire Detection*

Data Sheet 9-1, *Supervision of Property*

4.2 National and International Standards

ANSI/NFPA 72 *National Fire Alarm Code*, 2006, National Fire Protection Association, Quincy, MA

Planning and Installation for Automatic Fire Detection and Fire Alarm Systems, 2003; European Property Insurance Committee, Paris, France

EN 54-14, *Fire Detection and Fire Alarm Systems* – Part 14: *Guidelines for Planning, Design, Installation, Commissioning, Use, and Maintenance;* 2003, European Committee for Standardization, Brussels

APPENDIX A GLOSSARY OF TERMS

Addressable device: A fire alarm system component with discrete identification. Its status can be identified or it can be used to directly control other functions.

Adverse condition: Any condition occurring in a communications or transmission channel that interferes with the proper transmission or interpretation, or both, of status change signals at the supervising station. (See also *Trouble signa*l.)

Alarm: A warning of fire danger.

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

Alarm signal: A signal indicating an emergency that requires immediate action.

Annunciator: A unit containing one or more indicator lamps, alphanumeric displays, or equivalent. They show the status of a circuit, condition, or alarm location.

Auxiliary system: A connection to the municipal fire alarm system that transmits a fire alarm to the fire service. Fire alarms from an auxiliary alarm system are received at municipal fire alarm headquarters on the same equipment and by the same alerting methods as alarms transmitted from municipal fire alarm boxes located on streets.

Box: A manually operated device used to send an alarm in the event of an emergency (see *Municipal fire alarm box*).

Central station: A facility with properly trained personnel in attendance at all times who take prescribed action on any and all fire alarm and related supervisory, trouble and test signals. Personnel at central stations can be responsible for retransmission of signals to the designated agency and dispatch of runners (inspection personnel), where required, to the protected premises. Central station service can include provision for regularly scheduled testing and maintenance of fire alarm systems at the protected premises.

Channel: A path for voice or signal transmission between two or more stations or channel terminations. A Channel may consist of wire, radio wave, or equivalent means of signal transmission.

Circuit: The conductors or radio channel and associated equipment used to perform a definite function in connection with an alarm system. Specific types of municipal alarm circuits are defined below.

Combination system: A fire alarm system which shares components, equipment, circuitry, and installation wiring with non-fire alarm system components and wiring (such as a paging system, a musical program system, or a process monitoring service system). The non-fire alarm components and wiring does not interfere with the monitoring integrity of the fire alarm system to prevent alarm, supervisory, or fire safety control signal transmissions.

Communication center: The building or portion of a building used to house the central operating part of the municipal fire alarm system; usually the place where the necessary testing, switching, receiving, retransmitting and power supply devices are located.

Communicating Channel: A signaling channel (usually leased from a communication utility company) having two or more terminal locations and a suitable information handling capacity depending on the characteristics of the system used. One terminal location is the central supervising station; the other terminal location or locations transmit alarm signals, supervisory signals, trouble signals and such other signals the central supervising station is prepared to receive and interpret.

Converter: Any mechanical or electrical device that changes alternating current to direct current or changes direct current voltage to a higher or lower voltage. The latter is commonly referred to as a direct current to direct current converter.

Dual control: Two primary trunk facilities using separate routes or different methods to control one communication channel.

FM Approved: References to ‘‘FM Approved’’ in this data sheet mean the products or services have satisfied the criteria for Approval by FM Approvals. Refer to the *Approval Guide, a publication of FM Approvals,* for a complete listing of products and services that are FM Approved.

Ground fault: Occurs when the resistance between a conductor and ground reaches an unacceptably low level.

Inverter: Any mechanical or electrical device that changes direct current to alternating current.

Local energy auxiliary alarm system: An auxiliary alarm system that uses a complete arrangement of parts, initiating devices, relays, power supply and associated components to automatically actuate a municipal transmitter or master box by means of electric circuits that are electrically isolated from the municipal system circuits.

Master box: A municipal fire alarm box that may be operated locally or by remote means.

Municipal fire alarm box: A specially manufactured enclosure housing a manually operated transmitting device. (May also be referred to as ‘‘street box’’.)

Municipal transmitter: A municipal fire alarm box that can be tripped only remotely.

Notification appliance circuit: A circuit to which indicating devices are connected, e.g., bells, horns, lamps, etc.

Operator: A trained person in the communication center or central station who retransmits alarms to fire stations or other emergency agencies. (Sometimes referred to as a ‘‘dispatcher’’.)

Parallel telephone system: A system that uses a wired circuit for each municipal fire alarm box.

Placard: A means to mark protected premises installations where the equipment and service conform to the requirements of FM Approvals Standard 3011, “Central Station Service for Fire Alarms and Protective Equipment Supervision”. This marking consists of a securely affixed metal sign, adhesive label, or equivalent durable means. The Placard is located on or near the fire alarm system control unit or, if no control unit exists, near a fire alarm system component at the protected premises, or at a location specified by the authority having jurisdiction.

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

Power source: The utility or private distribution system, or an engine-driven generator or a battery.

Power supply: A source of electrical operating power, including the circuits and terminations connecting it to the dependent system components which is converted to alternating or direct current voltage(s) required to operate the system.

Primary trunk facility: Part of a communication channel connecting all leg facilities to a central station or subsidiary station.

Process monitoring alarm system: An alarm system used to supervise the functioning of a commercial process, such as manufacturing operations, heating or refrigerating systems, temperature control, etc., when failure of the supervised process could result in fire or explosion.

Proprietary system: A protective signaling system constantly supervised by personnel in a central supervising station at the protected site. The system includes equipment for testing and operating the system and, upon receipt of a signal, taking action required by the authority having jurisdiction. The system is maintained and tested by owners or contractors. Noncontiguous properties under a single ownership may be considered as ‘‘the property’’ and be connected to a single central supervising station. The proprietary system may be installed at more than one plant as long as the plants are under a single ownership or control.

Protective signaling systems: Electrically operated circuits, instruments, and devices designed to transmit alarms and supervisory and trouble signals.

Protective systems, equipment or apparatus: Automatic sprinklers, standpipes, carbon dioxide systems, automatic covers, and other devices used to extinguish fires.

Rectifier: An electrical device without moving parts which changes alternating current to direct current.

Remote station signaling system: Electrically supervised circuits supplying direct current between signaling devices at the protected premises and receiving equipment in a remote station, such as a municipal fire alarm headquarters, a fire station or other acceptable location.

Repeater facility. Radio equipment that relays radio signals between central supervising station, satellite station, and/or protected premises.

Runner service. Employees available for prompt dispatching to the protected premises. This service is required to assure signal continuity as required by various signaling system standards. This service does not include action pertaining to the fire protection systems other than signaling devices.

Satellite station. A normally unattended location remote from the central supervising station but linked to it. The satellite connects signal receiving equipment or communication channel(s) between protected buildings and the central supervising station.

Satellite trunk facility. Part of a communications channel connecting a satellite station to a central station.

Shunt auxiliary alarm system. Electrically connects the protected property actuating devices to an integral part of the municipal alarm system. When operated, these devices open the municipal circuit. The circuit is shunted around the trip coil of the municipal transmitter or master box, which is then energized to start transmission without a local source of energy.

Note: When the shunt system runs municipal power wires into protected premises, the municipality may lose control of its circuit. In addition, an open circuit in this shunt loop will cause an alarm condition. The use of shunt type system is a matter of individual municipal policy.

Solar cell: Converts light or other radiant energy into electrical energy.

Supervision: Monitors the circuit, switch, or device by receiving and recording the signal when the device actuates or when the circuit is interrupted. Actuation and interruption signals are coded separately for proper interpretation.

Supervisory service: Assures performance of guard patrols and the condition of automatic sprinkler systems and other systems.

Supervisory signal: A signal indicating the need for action in connection with the supervision of guard tours, the sprinkler system and/or fire suppression systems and equipment, or the maintenance features of related systems.

System unit: Active subassemblies at the central station that receive signals and process, display or record status change signals. A failure of one of these subassemblies causes the unit to lose alarm signals.

Telephone Trunk Line: See Trunk Line.

Transmitter: A system component connected to a fire alarm control system with initiating devices. It transmits signals to the central supervising station showing the status of the initiating devices and their circuits.

Trouble signal: An audible or visual signal initiated by the fire alarm system or device indicative of a fault such as a circuit break or a ground fault in a monitored circuit or component of the fire alarm system.

Trunk facility: Part of a communication channel connecting two or more leg facilities to a central supervising or satellite station.

Trunk line: A telephone line or channel between telephone central offices or switching devices, including lines to the municipal fire alarm telephone switchboard.

Type A municipal fire alarm system: Operators at a public fire alarm communications center receive signals and then retransmit them to the designated fire department. A system that can transmit more than 2500 alarms annually on the dispatch circuit is required to be Type A.

Type B municipal fire alarm system: Equipment at a public fire alarm communications center automatically retransmits alarm signals to all fire stations on the system.

APPENDIX B DOCUMENT REVISION HISTORY

September 2007. The following changes were made for this revision:

- Information was reorganized and reformatted.
- Fire alarm classification description was relocated to DS 9-1.
- Outdated terms were removed.
- New industry terms were added in Appendix A, Glossary of Terms.
- Operation and maintenance recommendations were updated.
- Loss history data has been included.

May 2003. New terms added. Some figures removed and others updated. Recommendations revised. Loss history information added. Loss expectancy guidelines added.

January 2003. Figure 1 ‘‘FM Global placard for central station service’’ was replaced with an updated one.

September 2001. Clarification was made in Section C.2.

APPENDIX C FIRE ALARM SYSTEMS BACKGROUND

C.1 Basic Architecture

- Control Unit (Conventional or Addressable/Intelligent)
- Initiating Device Circuits (IDC) or Addressable Signaling Line Circuits (SLC).
- Notification Appliance Circuits (NAC)
- Release Circuits
- Power Supplies
- Method of Off-Site Reporting (if applicable).

C.2 Control Unit (Conventional vs. Addressable/Intelligent)

In all cases, the heart of a signaling system consists of a control unit (either conventional or addressable/intelligent) to which are connected the initiating and signal indicating circuits. The control unit is usually in a separate enclosure, provides power to its external circuits, and often is of modular design to enable flexibility in obtaining multiple functions. In some signaling systems, transmitters may be either separate from or integral to a control; they transmit to the control or from a control to remote receiving equipment.

A conventional fire alarm system consists of a fire alarm control panel (FACP) connected to one or more initiating device circuits (IDCs) such as sprinkler waterflow detection devices and smoke, heat or flame

detectors, etc.; and one or more notification appliance circuits (NACs) wired to audible or visual notification appliances to alert personnel. Systems may be combined with other functions (such as paging, intrusion detection, building management) provided (1) the alternate system function(s) do not interfere with the supervision or operation of the fire alarm portion of the system and (2) the entire system has been FM Approved for fire alarm use.

It is important to note that for conventional (non-addressable) control panels, any FM Approved, four-wire, electrically compatible device may be connected. In addition, a two-wire initiating device can also be connected to activate an alarm as long as it has been tested and FM Approved for use with that particular control.

Addressable/intelligent control systems differ from their conventional counterparts in that they communicate more information from an initiating device to the control panel than a simple alarm. In an addressable/ intelligent system, the signaling and initiating devices continually report the output of their detecting circuitry over the signaling line circuit (SLC). The decision to alarm is made at the control panel rather than at the device. These systems are commonly referred to as analog-addressable or intelligent. An advantage with this type of system is that the control panel continually monitors the sensor's output to check its status. The information is sent back and forth to relay conditions at that particular location with a specific address. The signaling pathway between control and devices can be wires, optical fibers, or radio waves. An important advantage to addressable/intelligent systems is that a system can be designed using many different types of input and output devices as long as they have been tested and are compatible with the control. The amount of wiring can also be reduced by using the same signaling circuit for both inputs and outputs. Control action commands to output devices can also be sent at very high speeds.

It is important to note that in addition to addressable/intelligent sensors, simple two or four-wire detection devices may be connected to an addressable/intelligent control, provided that an FM Approved and compatible circuit interface module is used to connect the devices back to the control. For addressable/ intelligent control panels, product performance standards require that any connected initiating, notification, and signaling devices be specifically tested and FM Approved with that control thereby assuring that they are compatible due to the individual communication protocol of that system. Addressable/intelligent controls have the ability to monitor signals from both conventional devices and intelligent/addressable ones.

Circuit interfaces send out signals to each conventional initiating device to check its status and then report to the central control unit. Part of the information sent from an initiating device is its address. Other information that can be sent is whether there is an alarm, a trouble signal, a detector status signal (e.g., detector dirty) and the type of device, such as smoke detector. For an example of a typical system configuration, see Figure 4.

C.3 Initiating Device Circuits (IDC) or Addressable Signaling Line Circuits (SLC).

An initiating device circuit is a circuit to which automatic or manual signal initiating devices are connected either directly to the fire alarm control or to a circuit interface module. The initiating device circuit does not identify the address of the individual device operated but may identify the operating zone and type of device. Two or four-wire physical connections provide operating voltage and supervision for input devices on initiating device circuits.

A Signaling Line Circuit is a circuit or a path between any combination of circuit interfaces, sensors, control units, or transmitters over which multiple system input signals or output signals, or both, are carried. The signaling line circuit interface module is 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.

Initiating device circuits and signaling line circuits may be connected to operate any of the following:

1. Manual fire alarm box
2. Automatic fire detection like smoke, heat, flame, etc.
3. Sprinkler waterflow detection
4. Control valves
5. Dry pipe air pressure supervision
6. Pressure supervision for pressurized water storage tanks

7. Water level supervision for gravity tanks, pressurized water tanks and pump suction tanks

8. Water temperature supervision for exposed water storage tanks

9. Automatic fire pump supervision

10. Supervision of other fire suppression systems

11. Supervision of processes or detection of abnormal plant conditions

12. Guard's tour supervision

13. Building temperature

14. Building ventilation and air handling

C.4 Fire Alarm System Wiring and Installation

The installation of all wiring and cable, whether actual metallic conductors or fiber optic media, must conform to applicable requirements of ANSI/NFPA 70 National Electrical Code (NEC®)9 or applicable local codes. Article 760 of ANSI/NFPA 70 is specifically devoted to fire alarm systems, but many other code provisions directly affect the system installation, such as those for general provisions, wiring and protection, grounding, wiring methods and materials, special occupancies (such as hazardous locations), emergency systems, optical fiber cables, etc. The requirements in ANSI/NFPA 70 National Electrical Code are for the most part coordinated with ANSI/NFPA 72 National Fire Alarm Code. Metallic (current carrying) fire alarm circuits are typically classified as non-power-limited (NPLFA) or power-limited (PLFA) as defined in ANSI/NFPA 70 National Electrical Code (NEC®). These refer to the actual circuits for signaling or controlling equipment related to the fire alarm system. Typically circuits providing power to fire alarm systems are covered by other sections of the code as branch circuits. While most fire alarm system control panels operate from primary power supplies of 120 or 240 V AC, the signaling circuits operate at reduced voltages and less available power. The designation of NPLFA or PLFA provides the installer with different options as to the materials required for installation because of different inherent fire and shock hazards presented by the two classifications. Installers can reduce costs considerably by using the different methods and materials permitted by the code. There are also numerous code rules placing strict limits on the installation of signaling circuits of different voltages, and light and power wiring, within the same enclosure or raceway (i.e., conduit or wireway). The insulation rating of the wires and cables for the various circuits is a concern as well as the association of the different circuits (all must be related to the fire alarm system or fire alarm controlled equipment). It is important to refer to manufacturer's instructions for installation of control equipment in which different systems can be located and to observe directions for routing and separating of wiring.

When fire alarm signaling circuits are installed as cables (metallic or fiber optic) there are many concerns regarding selection of the proper cables for the intended purpose, location and voltage. Cabling is rated and listed for use in general applications, risers (vertical chases or shafts) or in plenums (air handling spaces). These ratings are concerned with fire spread and smoke. Cable marking reflects the rating. For example, a cable marked ''FPLP'' would be rated for power-limited, plenum, fire alarm signaling applications. Cable listings along with ANSI/NFPA 70 National Electrical Code (NEC®) rules permit some substitution of different types of cables for fire alarm use. Thus, some cables identified for communications circuits for example could, under the proper conditions, be applied for fire alarm use.

Other concerns which must be addressed with cable installation are:

- separation from non-fire alarm circuits or circuits of other voltages (less restrictive separation rules for optical fiber cables)
- proper wire sizing for the intended loads
- physical protection where mechanical damage of the cables is possible
- proper support of cables
- proper methods for passage of the cables through fire separations in the building

ANSI/NFPA 70, *National Electrical Code*, also does permit the more typical wiring methods (described in Chapters 1-4 of the code) to be used for fire alarm systems. These include conduits and other raceways, armored cables, etc. Systems may be installed using these methods where the overall location calls for a more physically robust construction.

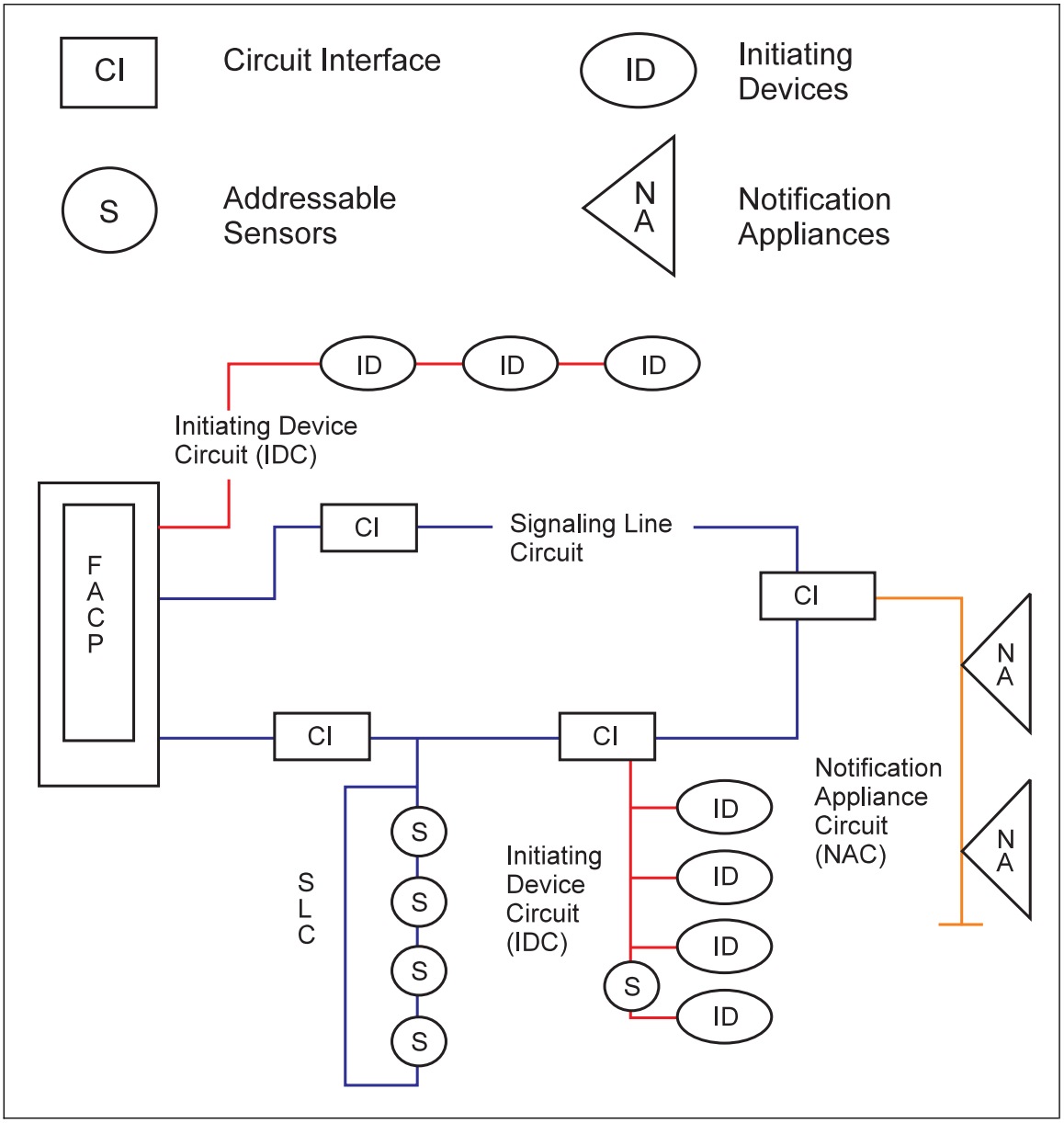

Fig 4. Addressable/Intelligent Fire Alarm Control connected to circuit interface modules and initiating, indicating, and signaling devices

- the amount of different systems occupying the same space is great
- the construction can realize a savings by using like materials and methods to other systems

A new initiating device should have at least 2 wires in and 2 out for signaling plus four more wire connections if it is a powered device. Older devices may be two-wire types. See Fig. 5 for proper wiring connections.

C.5 Fire Alarm System Monitoring and Supervision

ANSI/NFPA 72, National Fire Alarm Code, requires fire alarm system equipment, interconnecting wiring and power supplies to be extensively monitored for faults and failures. In general, a single fault, which could prevent the initiation, transmission or notification of a fire alarm signal, or a single ground fault, must be annunciated by an audible trouble signal within 200 seconds. A single open or ground fault should not cause an alarm signal. It is not acceptable to use a double loop or other multiple path conductor circuit to avoid electrical monitoring. Exceptions exist to the monitoring requirements of equipment at the protected premises.

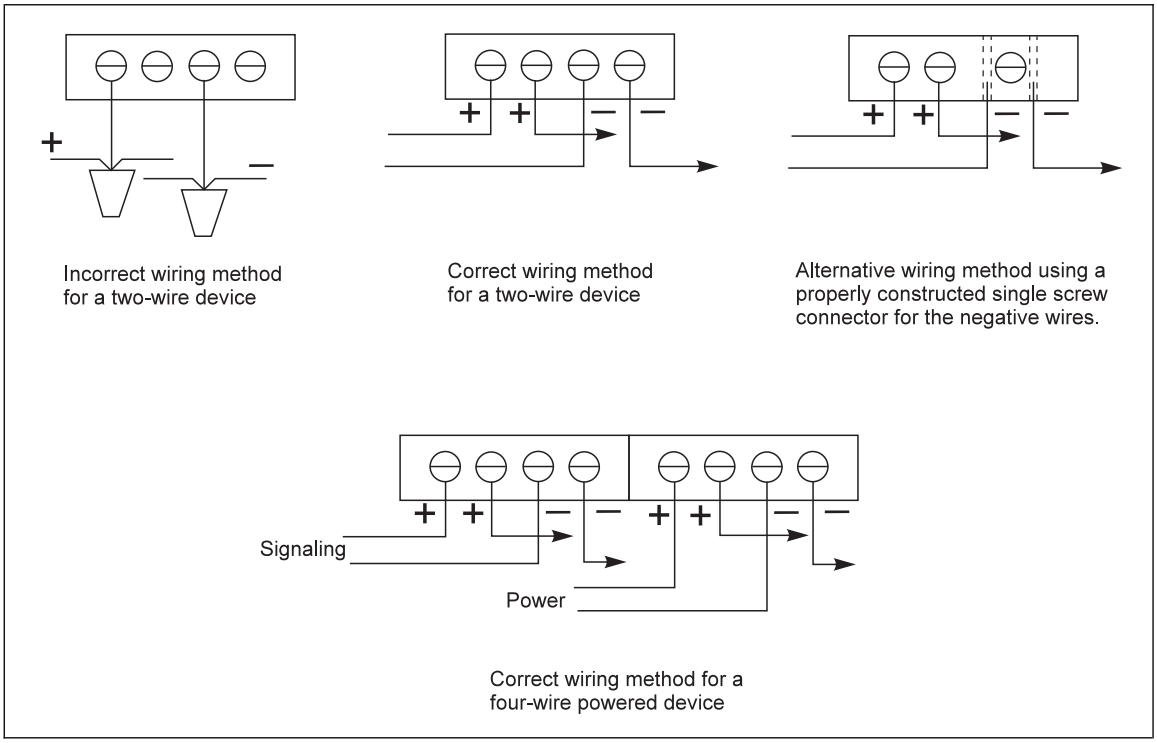

Fig 5. Initiating device wiring connections

Requirements for off-premises signaling vary somewhat from those of protected premises systems. Trouble signals should annunciate where they will be noticed by premises occupants. Because the Approval of the fire alarm equipment includes checks for required monitoring, adhere to the manufacturer's instructions and wiring diagrams when installing the equipment to prevent compromising monitoring techniques.

ANSI/NFPA 72 contains the performance requirements for initiating device circuits, signaling line circuits and notification appliance circuits. These requirements define the conditions under which these circuits must signal trouble due to various faults. Also included are specific supervision requirements for supervising station fire alarm systems. In addition, some fire alarm systems may use connected supplementary equipment that does not have to be monitored. Typically this equipment performs functions that are not required to properly operate the fire alarm system (such as a printer on a protected premises system to log signals during testing).

C.6 Storage Batteries and Battery Calculations

Storage batteries are commonly used in the secondary supply for all types of fire alarm systems. A storage battery is comprised of one or more rechargeable cells of lead acid, nickel cadmium or other electrochemical types. Batteries may be wet-cell (with liquid electrolyte) or sealed (with paste or gelled electrolyte). Electrolyte is typically corrosive. Some types of batteries emit flammable gases during charging, requiring adequate and reliable ventilation. Larger battery installations must also conform to the requirements of ANSI/NFPA 70, *National Electrical Code* (NEC®), or applicable local codes.

Batteries are usually rated by voltage (in volts) and capacity (in ampere-hours). The capacity also has a rated time base associated with it (usually 8 or 20 hours). Thus, a 20 ampere-hour battery with a 20 hour time base will typically supply 1 ampere for 20 hours before its voltage falls below a usable level. The rated capacity will not be accurate for durations significantly different from the time base i.e., the 20 ampere-hour battery will provide about 0.9 ampere for 24 hours, 0.4 ampere for 60 hours or 0.3 ampere for 90 hours, but only about 10 amperes for 1 hour.

Proper sizing of batteries for fire alarm systems is a critical factor. Most manufacturers provide calculation methods, tables or other techniques to assure a minimum size battery is provided based on the system configuration, standby load and required duration, and alarm load and required duration. It is important that the selection is made according to the manufacturer's instructions.

Battery recharging capability must ensure full recharge within 48 hours after the battery has provided the required standby time and do so without damage to the battery.

Batteries should be protected by overcurrent devices rated between 150 and 250% of the maximum battery load.

C.6.1 Battery Sizing

Battery calculations must account for all normal supervisory currents in the panel and alarm circuits for the required standby period, and alarm currents in all components including panel, modules, notification appliances (horns, lights, speakers) and all of the initiating devices for an additional 5 minutes (1/12 hour). Before sizing a battery, first determine the electrical load by adding all the normal supervisory currents and all of the alarm currents using the worst case with all devices operating. The supervisory and alarm currents should be labeled on each component.

When sizing a battery, use the following equation to calculate the system Ampere-hours:

$$AH = 1.1 \left[(I_p + I_s) \times H + \frac{I_a + I_b}{12} \right]$$

Where:

1.1 = 110% safety factor
H = Required standby hours
I_p = Control panel operating (supervisory) current
I_s = Supervisory current
I_a = Notification appliance alarm current
I_b = Initiating circuit alarm current

Example: Standby hours = 60 hours
I_p = 0.050 Amps
I_s = 0.125 Amps
I_a = 0.120 Amps
I_b = 1.250 Amps

$$AH = 1.1 \left[(0.05 + 0.125) \times 60 + \frac{0.12 + 1.25}{12} \right] = 11.675 \text{ Ampere-hours}$$

The battery must be sized at minimum 11.675 Amp-hours. Use the next standard size.

C.6.2 Battery Charger Sizing

After sizing the battery, the battery charger must be sized. The charger must be able to recharge the battery at the highest selected system voltage within a specified time limit while supplying the system electrical load. The charger must be able to fully recharge the battery and so charger efficiency must be accounted for. The charger is also derated above 122°F (50°C) or above 3000 ft (1000 m).

When sizing a battery charger, use one of the following equations:

Lead Acid batteries :

$$A = \left(\frac{AH \times 1.10}{H} \right) + L) \times 1/K_1 \times 1/K_2$$

NiCad batteries:

$$A = \left(\frac{AH \times 1.4}{H} \right) + L) \times 1/K_1 \times 1/K_2$$

Where:

A = DC output capacity of charger
AH = Battery capacity
H = Recharging time
L = Load on charger and battery during recharging
1.1 = Charger efficiency factor for lead acid batteries
1.4 = Charger efficiency factor for NiCad batteries

K_1 = Derating factor for temperature
K_2 = Derating factor for altitude

Table 3. Battery Charger Derating Factors

Temperature	*K_1 Factor*	*Altitude*	*K_2 Factor*
To 122°F (50°C)	1.0	To 3000 ft (1000 m)	1.0
To 131°F (55°C)	0.80	To 5000 ft (1500 m)	0.90
To 140°F (60°C)	0.60	To 10000 ft (3000 m)	0.60

Example: A lead acid battery was sized at 11.5 Ampere-hours. The specified recharging time is 12 hours. The charger must also supply a continuous load of 5.25 Amps. The charger ambient temperature can be as high as 131°F (55°C). The altitude is 2500 ft. What size battery charger is needed?

$$A = \left(\frac{11.5 \times 1.10}{12}\right) + 5.25) \times 1/0.8 \times 1/1.0 = 7.88 \text{ Amps}$$

C.7 Alarm Verification, Cross Zoning, and Advanced Detector Technologies

Alarm verification is another feature available with some fire alarm control panels. This feature essentially automatically resets the first alarm from a smoke detector. If a second alarm occurs (or the same detector continues to report the presence of smoke) within 60 seconds, an alarm must be initiated. Alarm verification is sometimes used with smoke detectors to eliminate nuisance alarms. Alarm verification should not be used with other types of detectors or with manual pull stations.

The requirement for *two* automatic detection devices to alarm before the fire alarm control initiates an alarm response is commonly referred to as cross zoning. With certain restrictions this is permitted but must be acceptable to the authority having jurisdiction. In addition, the alarm verification feature cannot be used when using the cross zoning feature. Finally, double the normally required number of detection devices when using cross zoning.

More advanced detector designs and the ability to exchange data among detectors and control units have permitted the development of multi-criteria and multi-sensor devices and ‘‘shared decision’’ techniques. Multicriteria detectors use more than one sensing element (e.g., heat with photoelectric smoke) and then combine the outputs to aid in the alarm decision. Although many variations exist between manufacturers, the general goal is to provide better response to fire conditions and better rejection of accidental alarm stimuli. ‘‘Shared decision’’ techniques also vary among manufacturers. Generally, they all involve a slower or less sensitive alarm response when a single detector is reporting fire conditions. Response is faster or more sensitive when more than one detector is reporting fire conditions. Field programming is important with these techniques, because the proper detector addresses must be associated together for the scheme to be effective.

C.8 Supervising Station Fire Alarm Systems

C.8.1 Supervising station or *off-premises* fire alarm systems protect the premises by communicating alarm, supervisory and trouble signals between the protected premises and a continuously attended supervising station facility. These systems include:

- Central station fire alarm systems
- Proprietary supervising station fire alarm systems
- Remote supervising station fire alarm systems
- Public (Municipal) fire alarm reporting systems and auxiliary fire alarm systems

C.8.2 Numerous FM Approved communication methods may be used to perform the above functions. The choice of a particular method may depend upon local conditions and availability of equipment or service. If a control panel is capable of communicating directly with a supervising station, it must be compatible with the supervising station receiving equipment. Communication methods include:

- Digital alarm communicator system
- Digital alarm radio system

- One-way private radio alarm system
- Private microwave radio system
- Coded radio (public)
- Direct connect (public)
- Private Transmission via LAN or WAN

C.8.2.1 Digital Alarm Communicator System

Digital communicator systems use a type of automatic telephone dialer. Instead of transmitting taped voice messages to a telephone, the dialer transmits electronically coded signals to a receiver. Approved dialer systems consist of transmitting and receiving devices interconnected by two or more regular (voice grade) telephone lines. A secondary device can also be a one-way radio or cellular telephone. Approved devices are designed for alarm and supervisory signaling from protected premises to an Approved central station. They provide:

- fire alarm
- sprinkler waterflow alarm
- guard tour supervisory
- fire extinguishing equipment monitoring.

A digital alarm communicator transmitter (DACT) is a system component located at a protected premises. Initiating devices or groups of devices are connected to it. The DACT seizes the connected telephone line (not a party line), dials a preselected number to connect to a digital alarm communicator receiver (DACR), and transmits signals indicating a status change of an initiating device, trouble signals or other control unit messages. The whole sequence must take place within 90 seconds. The DACT must try to transmit at least 5 times and no more than 10 times before the system signals failure at the protected premises. A DACT does not communicate continuously, but sends a signal once per day to verify the system is operational; there must be two paths. If no signal is received, the system will indicate trouble.

C.8.2.2 Digital Alarm Radio System

A digital alarm radio system transmits signals from a digital alarm radio transmitter located at protected premises through a radio channel to a digital alarm radio receiver. A digital alarm radio transmitter is a system component that is connected to (or is an integral part of) a digital alarm communicator transmitter. It provides an alternate radio transmission channel. A digital receiver is comprised of two subcomponents: one that receives and decodes radio signals, and another that annunciates the decoded data. Both subcomponents can reside at a central station or be separated by a data transmission channel.

C.8.2.3 One-way Private Radio Alarm System

Private radio systems are controlled by a central station or proprietary supervising station. This type of system does not communicate continuously and only transmits a signal when there is something to report such as a fire alarm or trouble signal. It also does a daily test. Because the system does not continuously communicate, the radio transmitter located at the protected premises must transmit to two repeater stations to increase its reliability. The operating times for recording signals must also be within certain parameters.

C.8.2.4 Private Microwave Radio System

The microwave system is similar to a radio system except it operates at higher frequencies in the microwave range. Network reliability is ensured by standardized microwave relay link requirements. Transmitting and receiving equipment must be supervised at supervising, subsidiary, and repeater stations.

C.8.2.5 Coded Radio (Public)

Coded radio systems transmit alarm signals to a municipal fire headquarters without using a hard wired path. Each fire alarm box is an individual transmitter and operates independently of all other boxes on the system. These systems provide either amplitude or frequency modulated, coded radio transmissions to a base station console.

Batteries power the boxes locally with a minimum of six months' operating capability. At least once every 24 hours, each box must automatically transmit a supervisory signal to the central console, indicating that it is operating. The box must also transmit a tamper signal when the box is knocked down or tilted.

C.8.2.6 Direct Connect (Public)

A direct-connect system uses non-coded signaling to transmit between a protected property and the supervising station. Individual zones are connected to the receiving equipment by an electrically-supervised, two conductor cable (usually a leased telephone line).

Electrical supervision is provided by either of two ways. In one method a small supervisory current circulates through the receiving equipment, the conductor and an end-of-line resistor. A signal initiating device operating shorts the end-of-line resistor, substantially increasing the current flow. This sends an alarm signal. An interruption in the flow of supervisory current, such as that from an open circuit, reduces current flow. This results in a trouble signal.

The second method, polarity reversal, is similar except a polarity reversing relay is added. An alarm reverses the current flow in the circuits. This reversal actuates signaling devices. Because polarity reversal depends on a complete reversal (rather than a change in only a few milliamperes), the method is not apt to actuate falsely due to transients. An interruption in the current flow, such as from an open circuit, operates a trouble signal.

C.8.2.7 Other Transmission Technologies (LAN or WAN)

Other transmission technologies include those transmissions which operate differently from the specific transmission methods described above.

For an LAN or a WAN transmission network, a modular interface connected to an intelligent/addressable fire alarm control panel at the protected property provides information through a graphical or non-graphical menu system and a display while operating over a high-speed Ethernet LAN/WAN or single-user network. Each alarm, trouble, or supervisory event is displayed on a color-coded display or with a floor plan pinpointing the exact alarm location. The interface provides authorized users monitor and control over an entire network of up to a variable number of fire alarm panels from a single or multiple PC workstations. It is required that all user actions and events are logged and recorded to create customized reports. Provisions must be made to monitor the integrity of the transmission technology and its communications path. Any failure must be annunciated at the supervising station within 5 minutes of failure. A redundant communication path is also required. In addition, the system units at the supervising station must have backup power depending on the signaling application, i.e., 24 hrs of backup power for local, proprietary, remote station, and central station systems, and 90 hrs of backup for systems monitoring preaction/deluge systems. Finally, system units at the supervising stations are required to be restored to service within 30 minutes of a failure.

C.9 Central Station Systems

A central station provides fire alarm service for many properties. See Fig. 6. Signaling circuits extend from the constantly attended central station office through one or more telephone exchanges to protected properties. Operating FM Approved signaling equipment at a protected premises sends alarm, supervisory, and trouble signals to the central station where they are recorded.

Central station systems are operated by organizations that furnish and maintain the central station service. One or several firms may provide the entire service. In either case, one firm must act as the prime contractor responsible for the contract and subcontracting the portion of service it does not provide. An FM Approved fire alarm service-local company may perform the field installation, testing and maintenance, but does none of the monitoring, retransmission and associated record keeping. Central station companies can be FM Approved to ''monitoring only'' or full service categories. Protected premises send signals to the central station using one of the methods described in Section C.8.2.

Some conventional (manually controlled) central station system offices are still in use. Changes in the status of monitored equipment at protected properties are visibly and/or audibly displayed for central station personnel, who then notify the fire department of alarm signals and designated persons from the protected property of supervisory signals. Signal interpretation and associated record keeping is performed manually by the operators.

Most central stations are automated. Computers and associated equipment monitor and interpret the signals, alert the operators and maintain service records, schedules, and emergency information for all protected properties. The computer analyzes incoming signals. It also handles and records routine signals such as tests. The computer alerts central station personnel to emergency signals like fire alarms, and displays the information needed to properly act on these signals, and logs the operator's actions.

The *Approval Guide* lists FM Approved equipment for central stations, FM Approved central station services including ''monitoring only'', and Approved fire alarm service-local companies.

Approval of a full service central station company means that the company can provide FM Standard Service. This requires compliance with both ANSI/NFPA 72 and with FM Approval Standard 3011 Central Station Service for Fire Alarms and Protective Equipment Supervision. An Approved central station system can provide FM Class V and Class VI Alarm Service, but the installation must be marked to show that the service complies with Standard 3011.

Use of an FM Approved ''monitoring only'' central station together with an FM Approved ''fire alarm service-local company'' also qualifies as Class V and VI Alarm Service.

The central station must retransmit all fire alarm signals to the public fire communications center immediately upon receipt and notify the subscriber by the quickest available method. Supervisory and trouble signals must be reported immediately to person(s) designated by the subscriber, and to the authority having jurisdiction (if required) if the fire suppression system will be out of service for more than 8 hours. All records of signals must be maintained by the central station for at least one year and be available for inspection by the authority having jurisdiction.

A significant feature of central station service is to provide runner and maintenance response at all times.

A runner or technician must arrive at the protected premises within one hour after a supervisory or trouble signal is received at the central station or when equipment must be manually reset by the prime contractor.

Personnel must also start maintenance (when needed) at the protected premises within four hours after a trouble signal is received.

Because many central stations are remote from the subscriber, intermediate facilities are frequently used to relay signals between the protected property and the central station. These facilities may be controlled by a central station or a public utility like a telecommunications company. When controlled by a central station, the facility is equipped to receive and retransmit (but not necessarily interpret) signals. This is typically referred to as a subsidiary or satellite station. It must meet the same basic requirements as a central station.

C.10 Proprietary Supervising Station System

A proprietary fire alarm system is supervised at a proprietary supervising station located on site or at a remote location. As with a commercial central station system, it may monitor several locations and is constantly attended by trained operators. The principal difference is the equipment. Owned (or leased) by the property owner, the equipment supervises the owner's contiguous or noncontiguous properties. The principal advantage is the owner completely controls and (is responsible for) his own property. Automatic recording equipment provides a permanent record of all alarms, trouble and supervisory signals.

An FM Approved proprietary system can provide Class V or VIA fire alarm service. It can also provide area and perimeter protection for burglar alarm service. (See Data Sheet 9-16, B*urglary and Theft*.) It can also monitor critical in-plant processes.

The proprietary supervising station must be constantly-attended. It is usually located in a detached fire resistive building or a suitable cutoff room of fire-resistive construction. It should not be located near any hazardous areas of the facility. Because security is always important, access to the station is usually restricted to those directly involved in directing emergency action and maintaining the equipment.

The principal station equipment receives and records alarm signals. The receiver annunciates the alarm, activates an audible alarm, activates the alarm recorder and, in some cases, activates another transmitter that retransmits the fire alarm signal to the public fire department.

An alarm recorder punches or prints a code or message on a paper tape, card, or regular printer paper. The recording system records the signal and the time it was received. Some modern microprocessor-based

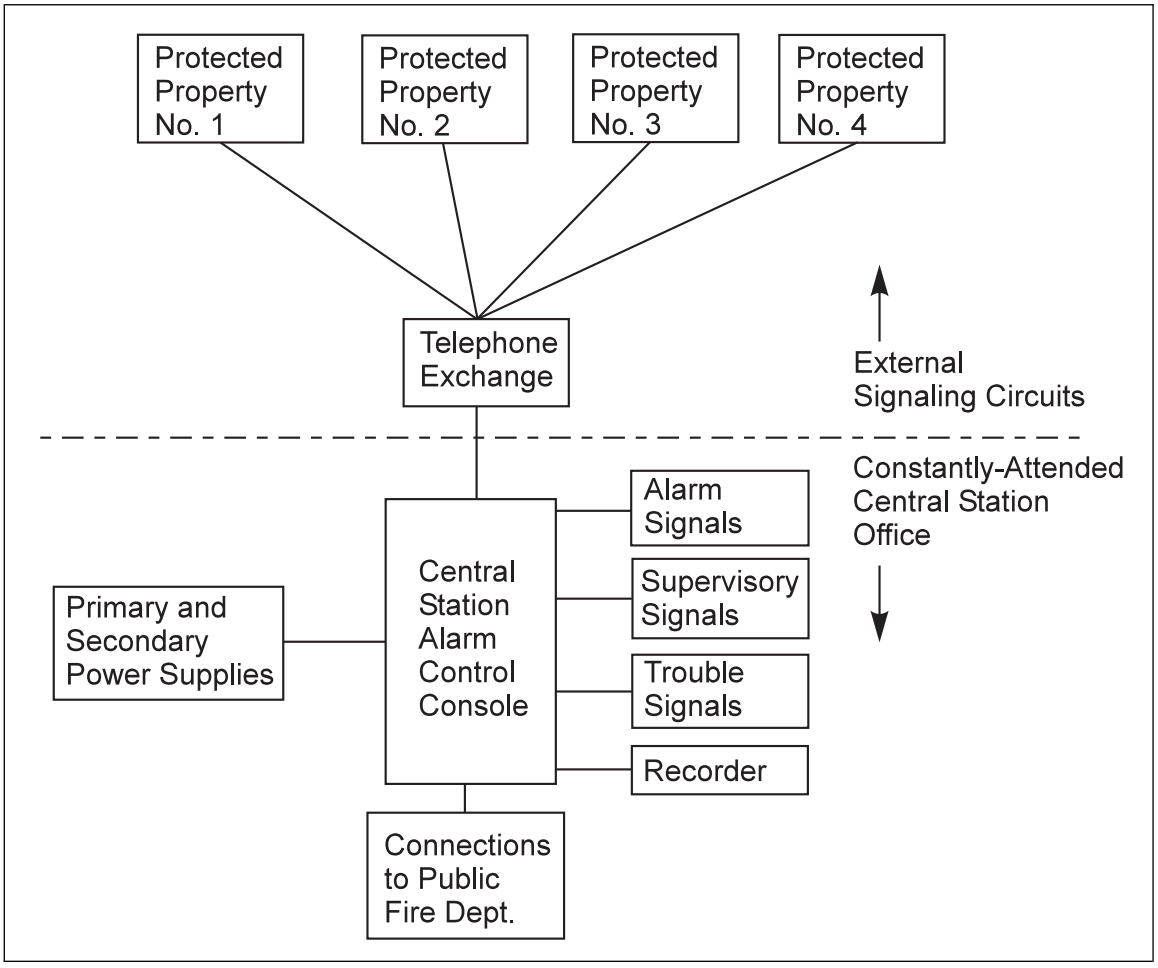

Fig 6. Typical central station system

systems also use alphanumeric displays or monitors indicating the type of signal and transmitter location and, in some cases, additional relevant information. The recorded information generally contains the same data.

Some of these recorders will also use a different color print for different types of signals such as red for fire, black for supervisory or restoration signal, etc.

Reliable telephone and power services are essential for an effective central supervising station. A 2-way radio system for communicating with the public fire department, guard/runner service or the Emergency Organization may be used as a back-up.

C.10.1 Classification of Proprietary Systems

FM classifies Proprietary systems in accordance with reliability and supervision features. Unapproved equipment is Class IV, or less, because its reliability is unknown. FM Approved systems are Class V or Class VI. The Class V system includes waterflow detection and automatic fire detectors. A system is Class VI if it provides complete supervision like valve position, dry pipe valve enclosure temperature, tank temperature, fire pump supervision, etc.

C.10.2 Operators and Runners

Personnel are the key element of a proprietary alarm system. Most are operators and runners; some can also be guards and firefighters. The operators (or dispatchers) are employed by the station. They monitor alarm, supervisory, and trouble signals and respond to formal procedures that define the notification sequences required. A fire alarm signal, for example, requires the following order of notification:

1. Public fire service and/or facility fire department

2. Emergency response team (or fire brigade)

3. Runners

For a supervisory signal, the notification will vary, depending on the type of signal received. A runner is usually dispatched, but dispatch of maintenance personnel may also be necessary. It usually depends on whether or not the runner can perform the necessary maintenance. For a trouble signal, a runner will be dispatched. If the signal can not be cleared by resetting the panel, maintenance personnel must be dispatched.

Impairments to extinguishing systems may also require the notification of a jurisdictional authority. Because situations vary, a detailed operations manual outlining emergency procedures, telephone numbers, etc. is usually kept at the station. Note that when special extinguishing systems must be taken out of service for repairs to the system or because of repair work in the protected area, the system should be physically isolated; disabling the system at the control panel is not always a reliable method of disconnect.

The number of operators on duty will vary according to the method of alarm retransmission to the public fire department. If the alarm-receiving equipment can send an automatic signal to the fire department (auxiliary connection), one operator may be sufficient. If an operator notifies the fire department by telephone, radio or other means, a second operator, who may be a runner, is required. This ensures the fire service or police are notified if the first operator becomes ill or incapacitated.

A runner is an employee dispatched to investigate the cause of a supervisory or trouble signal. In the case of a fire alarm, the fire department is always notified immediately even though a runner is to be dispatched. Often the runner assists the fire service in gaining access, checking sprinkler valves and fire pumps, de-energizing equipment, etc. The runner will also advise operators about the problem so that they can notify the appropriate facility personnel. In some instances, runners are trained to repair alarm equipment.

Runners may be located at the proprietary supervising station or at runner stations. (Multiple runner stations may be used when the proprietary system protects one or more remotely located sites.) This runner station may be a guard station serving one or more sites or a moving guard vehicle. A remote runner station may serve facilities located within one hour travel time. If values are high enough to warrant guard's tour supervisory service, the runner station may be used to supervise guards within one-half hour travel time.

C.10.3 Guard's Tour Supervisory Service

Proprietary systems often supervise guard service, which improves reliability. This is especially important for protecting a high value commodity. Supervision is accompllished by a series of key-actuated signaling stations located at various points along the guard's route. Stations can either send a signal, or suppress a signal (exception reporting).

A guard station functioning as a signal transmitting station keeps a permanent record showing the time each signaling station is operated. When intermediate, nontransmitting stations are used with transmitting stations, distinctive signals are sent at the beginning and end of each round by the first and last station.

When the guard's tour supervisory system is an exception reporting system, the first guard station will transmit a ″start″ signal at the beginning of each round. Conversely, the last station will be designed to transmit a finish signal at the end of the round. If any signaling station along the route is not actuated by the guard within 15 minutes of when actuation is expected, a ″delinquency″ signal is automatically transmitted to the central supervisory station. The operator will then attempt to contact the guard through whatever means possible (telephones, facility P.A. system, radio, etc.). If contact cannot be established in a reasonable time, a runner is dispatched to investigate.

C.10.4 Remote Supervising Station Fire Alarm System

An FM Approved remote, supervising fire alarm system usually consists of a supervised (local) protected premises fire alarm system connected by a supervised, leased telephone circuit to a constantly attended public fire alarm headquarters or fire station. If the public fire station is not constantly attended, signals are best handled by a local government agency responsible for assuring prompt response to the receipt of alarms. If such an agency is not available, a commercial organization with qualified personnel can receive the primary signal and retransmit the alarm to the fire department. In most cases, a fire department that

receives alarm signals directly is not willing to accept supervisory signals because of the fear of confusion. Supervisory signals are thus best handled by a commercial organization qualified to recognize the signal and take appropriate action.

Experience shows the failure rate of equipment in remote station systems is high, due to many incidents of inadequate maintenance.

C.10.5 Auxiliary Fire Alarm System

An auxiliary protective signaling system can be used to provide services such as:

- Manual fire alarm boxes
- Sprinkler systems waterflow alarm service
- Automatic fire detection (not with a shunt system)

An auxiliary connection can be made for all protected premises systems where the equipment is FM Approved for this connection.

Alarms from an auxiliary system are transmitted to municipal alarm headquarters. The alarms are received on the same equipment, using the same alerting methods as those transmitted from fire alarm boxes on the streets. The auxiliary system comprises equipment and circuits in the protected premises which are insufficient, in themselves, to notify the fire service.

A municipal fire alarm system consists of signaling equipment whose purpose is to receive fire alarms or other emergency calls from the public and to transmit these alarms or emergency calls to the public fire service communications center and other interested agencies. The municipality controls the installation, use, maintenance of the system and alarm retransmission, if necessary. Equipment is usually provided to identify and automatically record each signal.

Alarm transmission of municipal systems may be accomplished by telegraph circuits (coded wired), or coded radio.

Two basic types of auxiliary signaling systems are allowed today:

1. The local energy type system, the most common type, is electrically isolated from the municipal system and has its own power supply. Tripping the municipal transmitter by the auxiliary system does not depend upon the current in the municipal circuit. The ability to transmit alarms if a municipal circuit opens depends on the transmitting device and the alarm headquarters' equipment. (See Fig. 7.)

2. The shunt type system is much less common and is electrically connected to, and an integral part of, the municipal system. A ground fault on the auxiliary system is a ground fault on the municipal system. An open circuit on the auxiliary system will transmit a false alarm to the fire department. (See Fig. 8.)

An open circuit in the transmitter trip coil will not be indicated at the protected property or fire department headquarters. If a signaling device operates, an alarm will not be transmitted, but an open circuit indication will occur at the fire department. If the municipal circuit is open when the shunt type system operated, the transmitter will not trip until the municipal circuit returns to normal. This system is no longer allowed by many AHJs, and can only be used if there is no more than one waterflow transmitter at a protected premise.

Certain variations allow an auxiliary connection to all types of public systems. Some more advanced coded radio systems combine a basic protected premises fire alarm control unit with the municipal system coded radio transmitter.

Auxiliary systems are used only in connection with a municipal system suitable for the service. The operation of the auxiliary system, including its circuits, instruments and devices, is controlled by the municipality starting from the transmitter at the protected premises.

APPENDIX D BIBLIOGRAPHY

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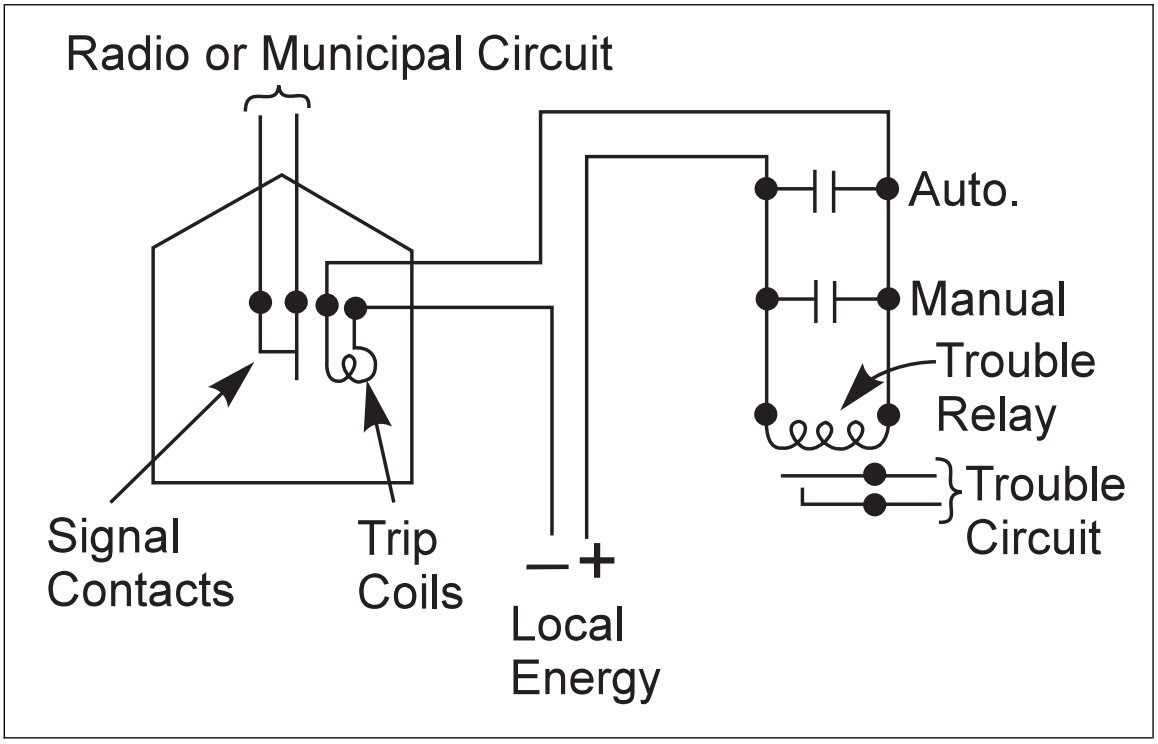

Fig 7. A local energy auxiliary fire alarm system

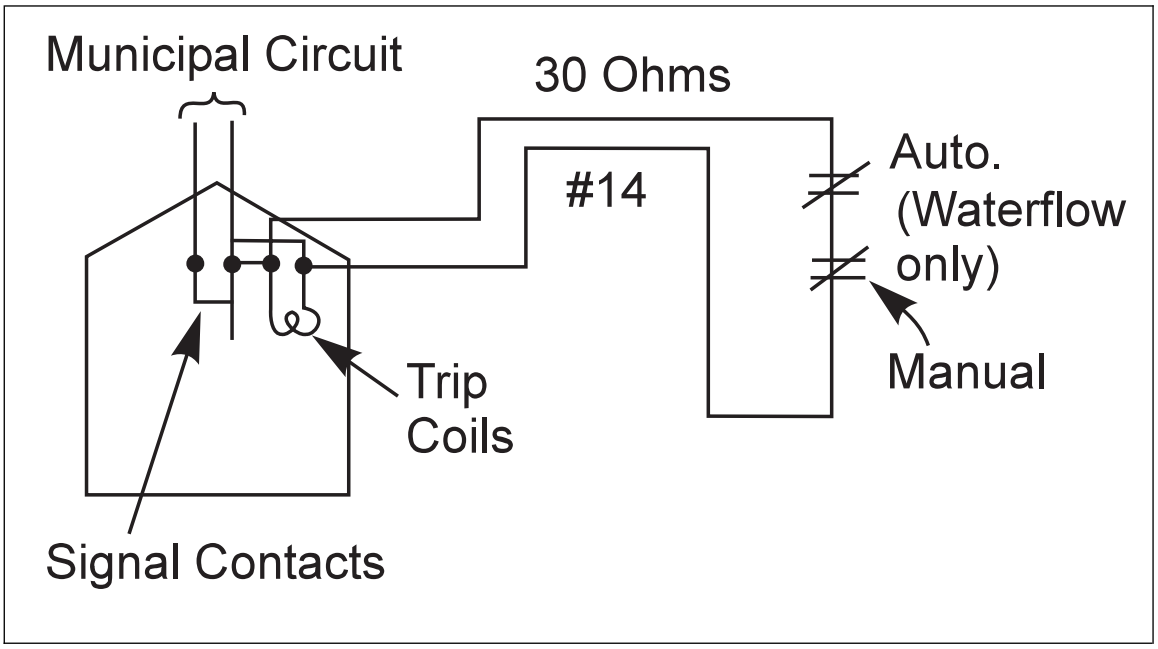

Fig 8. A shunt-type auxiliary fire alarm system

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